Original Article

Study to Evaluate the Role of Computer aided Detection Using Full Field Digital Mammography in Breast Cancer Imaging

R Naveen [1], **N Aarthi Reddy** [2]

[1]Assistant Professor, Department of Radiodiagnosis, S.V.S Medical College, Mahabubnagar, Telangana, India, [2]Senior resident, Department of Radiodiagnosis, S.V.S Medical College, Mahabubnagar, Telangana, India.

Abstract

Background: Mammography is acknowledged as the single most effective method of screening for breast cancer and is credited with helping to reduce breast cancer mortality by approximately 30%. CAD systems are a new tool in detecting breast cancers on screening mammograms and in detecting potentially suspicious abnormalities on a mammogram. The aim & objective is to main aim of the present study to evaluate the performance of Computer Aided Detection using Full Field Digital Mammography in Breast Cancer imaging. **Subjects and Methods:**In the present study, Cases with lump breast with clinical suspicion of breast cancer and post op recurrence of breast cancer were imaged with FFDM and images were read on the viewing monitor without and with the aid of CAD software. The present study confirms that the diagnosis of breast cancer is made only following histopathology of respected specimen. **Results:** The maximum incidence was in 41-50 years and 51-60 years which was 13 cases in each group (30 %). There were 25 cases out of 40 (62.5%) in which the lesion was marked by CAD. Out of which in 20 cases (50%) only one lesion was marked by CAD and in 4 cases (10%) two lesions were marked by CAD. The total number of lesions marked by CAD was 25 (62.5%). Majority of patients had scattered fibro glandular density of breast. This was present in 19 patients (47.5%). 10 patients (20%) had heterogeneously dense breast, 07 patients (17.5%) had fatty breast and 04 patients (10%) had extremely dense breast. In majority of cases the lesion type was mass alone which was present in 26 cases (60%). While 10 cases (25%) presented as mass with microcalcifications and 4 cases (10%) presented with microcalcifications alone. In 24 cases there was no spread of cluster of micro calcification (60%). In 7 cases (17.5%) the spread of cluster of micro calcification was <10mm, in 4 cases (10%) the spread of cluster of micro calcification was 21-30 mm and in 5 cases (12.5%) the spread of cluster of micro calcification was > 40mm. In majority of cases the HPE revealed DCIS which was seen in 22 cases (55%), 08 cases (20%) were invasive ductal carcinoma and 02 cases was invasive lobular carcinoma. In 22 cases (55%) the BIRADS for the breast affected with cancer was BIRADS-V. While in 14 cases (35%) the score was BIRADS-IV, 04 cases (10%) the score was BIRADS-VI and in 02 case (5%) the score was BIRADS-III. The sensitivity, specificity and accuracy of CAD for detection of mass were 70%, 100% and 85% respectively and for detection of cluster of microcalcification were 100% respectively. **Conclusion:** CAD with FFDM is good at detection of Microcalcifications. Detection of masses is better without the aid of CAD as compared to CAD. However detection of lesion improves if reading of mammogram is done both with and without CAD.

Keywords: Breast cancer, Computer aided Diagnosis, Micro calcification.

Corresponding Author: R Naveen, Assistant Professor, Department of Radiodiagnosis, S.V.S Medical College, Mahabubnagar, Telangana, India.
E-mail: dr.navin84@gmail.com

Introduction

Mammography is presently the best existing tool for detecting symptoms of breast cancer early on. It is alsocapable of revealing obvious distinctive physical aberrations, such as masses and calcifications, as well as subtle signs such as bilateral asymmetry and architectural distortion (Rangayyan et al., 2007). [1] The prompt detection of breast cancer is of paramount significance since early detection of benign cancer leads to a 5 years survival rate of 97.5%, whereas malignant cancer has a 5 years survival rate of only 20.4% (Jemal et al., 2004). [2] Mammography is an exceptional type of X-ray imaging that provides detailed visual images of the breast using intrinsic advanced features such as low dose X-ray, high contrast, high-resolution film and an X-ray system designed purposely for imaging the breasts (Helms et al., 2008). [3]

Computer-Aided Detection (CAD) is a technique that combines diagnostic imaging with computer science, image processing, pattern recognition and artificial intelligence tech-

nologies (Rangayyan et al., 2007). [1] It is a diagnostic tool (Giger, 2000), [4] developed in radiology to utilize the output of computerized analysis of medical images as a secondary opinion in the detection of lesions and making diagnostic assessments. In recent times, CAD systems have garnered several interests from both research scientists and radiologists because of the related complex research subjects and prospective clinical applications. The incorporation of computer processing in biomedical image analyses provides a more precise diagnosis since humans are prone to making errors and their analysis is generally biased and qualitative rather than quantitative. Improved biomedical image analysis using CAD leads to a more accurate diagnostic decision by the physician (Rangayyan and Ferrari, 2004). [5]

Thus this study was undertaken to evaluate the accuracy of CAD in detecting the breast cancers based on lesion type, lesion size, breast density, microcalcifications, BIRADS classification, histopathology and stage of cancer in Full Field Digital Mammography.

The objectives of this study are to evaluate the performance of Computer Aided Detection in Breast cancers using Full Field Digital Mammography as an imaging modality. The study aims at the following:

1. To evaluate the accuracy of CAD in Full Field Digital Mammography (FFDM) in detecting breast cancers based on detection of microcalcifications and mass.
2. To evaluate the performance of CAD in relation to age, breast density, BIRADS classification, stage of cancer, lesion type and size, histopathology results.
3. To evaluate the sensitivity and specificity of FFDM in detecting Breast cancer.

Subjects and Methods

Source of Data

This study is a prospective study done in Department Of Radio diagnosis, SVS Medical College & Hospital. All cases presenting for Mammography and fulfilling the below mentioned criteria were taken up for study.

Inclusion Criteria

a. Cases with lump breast with clinical suspicion of breast cancer

b. Post op recurrence of breast cancer

Exclusion Criteria

a. Pregnancy

b. Breast implants

c. Cases unable to bear the compression force of 4N due to breast tenderness.

Method of Collection of Data:

Total number of cases 30.

Study duration

From January 2017 to December 2019

Imaging protocols

a) Screening and diagnostic mammograms were performed with four standard views per case using Full Field Digital Mammography (Siemens Mammomat DS).

b) Each case included a craniocaudal (CC) and mediolateral oblique (MLO) view of the breast with cancer at the time of diagnosis.

c) Nondisplaced implant views; magnifcation and compression views; and images taken for biopsy with needles, wires, or other equipment were excluded.

d) Unilateral cases were accepted.

e) 30 cases of breast cancer were imaged with Full Field Digital Mammography (Siemens Mammomat DR)

f) CAD (Second Look,® Digital version 7.2) was also used to detect mass and microcalcifications in these cases. CAD sensitivity was assessed in relation to breast density, mammographic presentation, histopathology results, and lesion size.

Data Collection

a. As per proforma

b. MS database.

Statistical Analysis

1. Comparison was done in all the cases of masses and microcalcifications without the aid of CAD and with the aid of CAD.
2. Sensitivity, specificity and accuracy of CAD in detecting breast cancers using full field digital mammography as an imaging modality were calculated with histopatholgical examination as the gold standard.
3. In this study sensitivity, specificity and accuracy were calculated with presumption that if a mass / microcalcification is not detected on FFDM with / without use of CAD, then there is no breast cancer.
4. Also if a mass / microcalcification is detected with / without CAD on FFDM, then the mass / micro calcification is present and the diagnosis of breast cancer is made only following histopathology of resected specimen.

Results

Age Distribution of Study Population

In present study, the age range was 38-80 years. The maximum incidence was in 41-50 years and 51-60 years which was 13

Figure 1: Digitalmammo Diagnostic unit Model Mammo-mat Novation DR by Siemens

cases in each group (30 %). The incidence was minimum in < 40years.

Table 1: Age distribution of patients studied

Age in years	No. of patients	%
<40	2	5
41-50	13	30
51-60	13	30
61-70	8	20
71-80	4	10
Total	40	100.0

Clinical Background of Patients

The most common symptom was lump alone which was present in 35 patients (87.5%). 03 patient (7.5%) presented with nipple retraction, 01 patient (2.5%) presented with pus and blood stained nipple discharge and 01 patient (2.5%) had lump in breast with Ca cervix.

Breast Density

Table 2: Clinical background of patients

History	No. of patients	%
1.Lump only	35	87.5
2.Case of Ca cervix with lump breast	3	7.5
3.Nipple retraction	1	2.5
4.Pus and blood stained discharge	1	2.5
Total	40	100.0

Majority of patients had scattered fibro glandular density of breast. This was present in 19 patients (47.5%). 10 patients (20%) had heterogeneously dense breast, 07 patients (17.5%) had fatty breast and 04 patients (10%) had extremely dense breast.

Table 3: Breast density

Breast density	No. of patient (40)	%
1.Extremely dense breast	4	10
2.Fatty breast	7	17.5
3.Heterogeneously dense	10	20
4.Scattered Fibro glandular densities	19	47.5
Total	40	100

Lesion Detected Without the Aid of CAD

The number of cases in which lesions were detected without the aid of CAD was 38 (95%), out of which 32 (75%) cases had only single lesion and 04 (15%) cases had two lesions. The total number of lesions detected without the aid of CAD was 38 (95%).

Lesions marked by CAD

There were 25 cases out of 40 (62.5%) in which the lesion was marked by CAD. Out of which in 20 cases (50%) only one lesion was marked by CAD and in 4 cases (10%) two lesions were marked by CAD. The total number of lesions marked by CAD was 25 (62.5%)

Lesion Distribution in Quadrants of Breast

In majority of cases the distribution of lesion was in the upper outer quadrant of breast, which was seen in 18 cases (45%). In 14 cases (35%) the lesion was in lower inner, 04 cases (10%)

Table 4: No of lesion detected without the aid of CAD

No of lesion	No. of patients (n=40)	%
Detected	38	95
● One lesion breast	32	75
● Two lesion breast	6	15
Not detected	2	5

Table 5: Number of lesion marked by CAD

No. of lesion	No. of patients (n=40)	%
Not marked by CAD	12	30
Marked by CAD	25	62.5
● One lesion marked	20	50
● Two lesions marked by CAD	4	10

the lesion was retroareolar, 02 case (5%) the lesion was lower outer and 01 case (5%) the lesion was in upper inner quadrant of breast.

Table 6: Lesion distribution in quadrants of breast

Lesion quadrant	No. of patients	%
Lower inner	14	35
Lower outer	2	5
Retroareolar	4	10
Upper inner	2	5
Upper outer	18	45
Total	40	100.0

Lesion Type

In majority of cases the lesion type was mass alone which was present in 26 cases (60%). While 10 cases (25%) presented as mass with microcalcifications and 4 cases (10%) presented with microcalcifications alone.

Table 7: Lesion type

Lesion type	No. of patients	%
Mass alone	26	65
Microcalcifications alone	4	10
Mass with microcalcifications	10	25
Total	40	100.0

Size of Mass

In majority of cases the size of lesion was more than 20mm, the number of cases which presented with lesion size more than 20mm were 28 (70%). The number of cases which presented with lesion size of 10-20 mm was 7 (17.5%). The number of cases which presented with microcalcifications alone and no mass were 5 (12.5%). While no case presented with a lesion size of 21-30 mm.

Table 8: ?

Size	No. of patients	%
Nil	5	12.5
10-20 mm	7	17.5
>20 mm	28	70
Total	40	100.0

Spread of Cluster of Microcalcifications

In 24 cases there was no spread of cluster of microcalcification (60%). In 7 cases (17.5%) the spread of cluster of micro calcification was <10mm, in 4 cases (10%) the spread of cluster of micro calcification was 21-30 mm and in 5 cases (12.5%) the spread of cluster of micro calcification was > 40mm.

Table 9: Spread of cluster of micro calcification

Spread of cluster of micro calcification	No. of patients	%
Nil	24	60.0
<10	7	17.5
21-30	4	10
>40	5	12.5
Total	40	100

Architectural Distortion

In 18 cases there was no architectural distortion (60%). While in 12 cases (40%) there was architectural distortion.

Table 10: Architectural distortion

Architectural distortion	No. of patients	%
Nil	26	65
Present	14	35
Total	40	100

Histopathological Examination

Both FNAC and excision biopsy were performed in all the cases. On FNAC, in 06 cases reported as ductal hyperplasia with atypia and 02 case reported as fibromyxoid stroma with no epithelial cells the biopsy report confirmed a carcinoma. In

majority of cases the HPE revealed DCIS which was seen in 22 cases (55%), 08 cases (20%) were invasive ductal carcinoma and 02 case was invasive lobular carcinoma.

Table 11: ?

FNAC	No. of patients	%
1.Ductal carcinoma in situ	22	55
2.Invasive ductal carcinoma	8	20
3.Ductal hyperplasia with atypia	6	15
4.Fibromyxoid stroma with no epithelial cells	2	5
5.Invasive Lobular carcinoma	2	5
Total	40	100.0

Table 12: Final HPE report

Final HPE	No. of patients	%
1.Ductal carcinoma in situ	30	70.0
2.Invasive ductal carcinoma	9	26.7
5.Invasive Lobular carcinoma	1	3.3
Total	40	100.0

BIRADS Score

In 22 cases (55%) the BIRADS for the breast affected with cancer was BIRADS-V. While in 14 cases (35%) the score was BIRADS-IV, 04 cases (10%) the score was BIRADS-VI and in 02 case (5%) the score was BIRADS-III.

Stage of Breast Cancer

Both TNM and pathological stage of cancer was determined in all 30 cases.

Comparison of detecting breast cancer with CAD and without the aid of CAD and

correlation with lesion type

In the lesion type mass alone there were 18 cases and 22 lesions. In 16 cases there was solitary mass and in 04 cases there were two masses. All these 22 lesions (100%) were detected without the aid of CAD. There were 12 lesions (54.5%) marked by CAD while 10 lesions were not marked by CAD.

In the lesion type of mass with microcalcifications there were 08 cases with solitary lesions. All these 08 lesions (100%) were detected without the aid of CAD. All theses 08 lesions (100%) were marked by CAD.

Table 13: BIRADS score of both breasts

BIRADS	No. of patients (n=30)	%
Right		
● I	8	20.0
● II	14	33.3
● III	0	0.0
● IV	6	13.3
● V	10	26.7
● VI	2	6.7
Left		
● I	8	20.0
● II	8	20.0
● III	2	6.7
● IV	8	20.0
● V	12	30.0
● VI	2	3.3

Table 14: BIRADS scoring in the breast affected with cancer

Overall BIRAD	No. of patients (n=40)	%
● III	2	5
● IV	14	35
● V	22	55
● VI	2	5

Table 15: Stage of breast Cancer (TNM)

Stage of breast Cancer	No. of patients	%
T2N0M0	14	35
T2N1M0	8	20
T2N2M0	6	15
T2N3M0	2	5
T3N2M0	6	15
T3N3M0	2	5
T3N3M1	2	5
Total	40	100.0

Table 16: Stage of breast Cancer-based on Pathological Staging

Stage of breast Cancer	No. of patients	%
Stage IIA	12	30
Stage IIB	8	20
Stage IIIA	10	25
Stage IIIC	6	15
Stage IV	4	10
Total	40	100.0

In the lesion type microcalcifications alone there were 04 cases with solitary lesions. In these cases 2 out of 04 lesions (50%) were detected without the aid of CAD. All 04 lesions (100%) were marked correctly by CAD.

Discussion

Breast cancer begins in breast tissue, which is made up of glands for milk production, called lobules, and the ducts that connect the lobules to the nipple. The remainder of the breast is made up of fatty, connective, and lymphatic tissue. Most masses are benign; that is, they are not cancerous and are not life-threatening.

Breast cancer is the most common female malignancy and the second leading cause of cancer deaths. The incidence of breast cancer is rising in most countries of the world. India is a low resource country, where the healthcare workforce and infrastructure available for cancer care is limited or nonexistent. In the past decade there has been a dramatic increase in the incidence of breast cancer in India like the rest of the world.

The radiological examination of breast is an integral part of modern multidisciplinary approach for effective management of breast disease. The aim of breast imaging is to assess the probability of a lesion being benign or malignant. While multiple screening trials have shown the benefits of screening mammography, there are limitations to X-ray mammography. The overall sensitivity of X-ray mammography is only 85%. The sensitivity of the mammography varies with the breast density. In the fatty breast the sensitivity has been reported in the high nineties. In the dense breast however, the sensitivity has been reported to be much less, closer to 50%.

Detecting cancers using mammography when they are at a smaller size and earlier stage has been shown to reduce or delay mortality from breast cancer.

In the past two decades, mammography has become the most sensitive technique for detecting non-palpable lesions and characterizing palpable masses. It is a technique that utilizes low x-rays for examination of the breast tissues.

Mammography is acknowledged as the single most effective method of screening for breast cancer and is credited with helping to reduce breast cancer mortality by approximately 30%.

Methods suggested to decrease the number of missed cancers include training, experience, continuing education, prospective double reading, retrospective evaluation of missed cases, and computer-aided detection (CAD). CAD systems have proven to be quite sensitive in detecting breast cancers on screening mammograms. CAD programs are commercially available systems that use computer software to assist the mammographer in detecting or identifying potentially suspicious abnormalities on a mammogram. The CAD program identifies potential abnormalities on the images and marks areas on the study that the computer considers to be suspicious.

In the present study, 40 cases who presented with clinical features related to breast cancer were evaluated by Full Field Digital Mammography. Screening and diagnostic mammograms were performed with four standard views per case using Full Field Digital Mammography (Siemens Mammomat DS). Each case included a craniocaudal (CC) and mediolateral oblique (MLO) view of the breasts.

Symptoms of Patients

We observed the most common symptom was lump alone which was present in 35 patients (87.5%). 03 patients (7.5%) presented with nipple retraction, 01 patients (2.5%) presented with pus and blood stained nipple discharge and 01 patients (2.5%) had lump in breast with Ca cervix.

Age Distribution In Patients

In present study, the age range was 38-80 years. The maximum incidence was in 41-50 years and 51-60 years which was 13 cases in each group (30 %). The incidence was minimum in < 40years.

Breast Density

In this study, Majority of patients had scattered fibro glandular density of breast. This was present in 19 patients (47.5%). 10 patients (20%) had heterogeneously dense breast, 07 patients (17.5%) had fatty breast and 04 patients (10%) had extremely dense breast.

In the category of extremely dense breast there were 02 cases and 03 lesions. One case had solitary lesion while another breast had two lesions. 02 lesions (66.7%) were detected without the aid of CAD and 01 lesion was not detected without the aid CAD. In this category, CAD marked 01 lesion (33.3%) while 02 lesions were not marked.

In a study conducted by Bern, the CAD sensitivity with FFDM was six of six (100%) fatty breasts, in 63 of 66 (95%) breasts containing scattered fibroglandular densities, and in 43 of 46 (93%) heterogeneously dense breasts. Sensitivity in extremely dense breasts was only 60% (3/5). [6,7]

Lesion Size

In majority of cases the lesion type was mass alone which was present in 26 cases (60%). While 10 cases (25%) presented

Table 17: Comparison of detecting breast cancer with CAD and without the aid of CAD and correlation with lesion type

Lesion Type	No. of Cases	No. of lesions	Lesion detected with-out the aid of CAD	Lesion marked by CAD
Mass alone	24	22	22/22 (100%)	12/22 (54.5%)
Mass with microcalci-ficati ons	08	08	08/08 (100%)	08/08 (100%)
Microcalcificati ons alone	04	04	02/04 (50%)	04/04 (100%)
Total	30	34		

as mass with microcalcifications and 4 cases (10%) presented with microcalcifications alone.

The number of cases in which lesions were detected without the aid of CAD was 38 (95%), out of which 32 (75%) cases had only single lesion and 04 (15%) cases had two lesions. The total number of lesions detected without the aid of CAD was 38 (95%).

There were 25 cases out of 40 (62.5%) in which the lesion was marked by CAD. Out of which in 20 cases (50%) only one lesion was marked by CAD and in 4 cases (10%) two lesions were marked by CAD. The total number of lesions marked by CAD was 25 (62.5%)

In majority of cases the size of lesion was more than 20mm, the number of cases which presented with lesion size more than 20mm were 28 (70%). The number of cases which presented with lesion size of 10-20 mm was 7 (17.5%). The number of cases which presented with microcalcifications alone and no mass were 5 (12.5%). While no case presented with a lesion size of 21-30 mm.

In a study by Giger, [4] CAD with FFDM enhanced earlier detection by showing 89% of tumors that were 1–10 mm. Moreover, detection was fairly consistent among moderate to large tumors despite the fact that CAD systems are generally not designed to identify them, because large tumors are more readily identifiable by the radiologist without CAD. In this study, 93% (14/15) of tumors > 30 mm were detected by CAD. [6]

Lesion Type

In majority of cases the lesion type was mass alone which was present in 26 cases (60%). While 10 cases (25%) presented as mass with micro calcifications and 4 cases (10%) presented with microcalcifications alone.

Architectural Distortion

In the present study, in 18 cases there was no architectural distortion (60%). While in 12 cases (40%) there was architectural distortion.

Histopathological Examination

In the present study, both FNAC and excision biopsy were performed in all the cases. On FNAC, in 06 cases reported as ductal hyperplasia with atypia and 02 case reported as fibromyxoid stroma with no epithelial cells the biopsy report confirmed a carcinoma. In majority of cases the HPE revealed DCIS which was seen in 22 cases (55%), 08 cases (20%) were invasive ductal carcinoma and 02 case was invasive lobular carcinoma.

Brem and colleagues found that CAD sensitivity for invasive ductal carcinoma, invasive lobular carcinoma, and mixed and various invasive carcinomas and DCIS varied from 85% to 95%. [7]

Malich et al, [8] reported a sensitivity range of 90–97% for invasive ductal carcinoma, invasive lobular carcinoma, invasive tubular carcinoma and DCIS, whereas less common histopathologies with five or fewer cases in that study such as mucinoid and other invasive cancers showed CAD sensitivities of 75% and 80%, respectively.

Birads Score of the Breast

In 22 cases (55%) the BIRADS for the breast affected with cancer was BIRADS-V. While in 14 cases (35%) the score was BIRADS-IV, 04 cases (10%) the score was BIRADS-VI and in 02 case (5%) the score was BIRADS-III.

Pahological Stage of Breast Cancer

In this study, there were 12 cases of stage IIA, 08 cases of stage IIB, 10 cases of stage IIIA, 06 cases of stage IIIC and 04 cases of stage IV.

In the category of Stage IIA, there were 12 cases and 10 lesions. 07 cases had solitary lesion while one case had two lesions. There were 08 lesions (88.9%) detected without the aid of CAD and one lesion was not detected. CAD marked 04 lesions (44.4%) and 05 lesions were not marked by CAD.

Conclusion

This study was done to evaluate the performance of CAD in FFDM in detecting mass and micro calcifications in cases of breast cancer. The final diagnosis was based on histopathological examination (FNAC and Biopsy). The sensitivity, specificity and accuracy of FFDM without the aid of CAD for detection of mass were 100% respectively. Detection of lesion on FFDM was better without the aid of CAD as compared to detection of lesion with CAD alone. However detection of lesion improves if reading of mammogram is done both with and without CAD. Detection of masses on FFDM is better on FFDM without CAD than with CAD. Detection of microcalcification in FFDM is better with CAD than without CAD. Detection of lesion on FFDM is better both with and without CAD in less dense breast as compared to dense breast and detection of lesion is better in dense breast without CAD than with CAD.

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