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ORIGINAL ARTICLE

Microcalcification detection with and without CAD system (LIBCAD): A comparative study

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Classification

Abstract The objective of this research is to assess the performance of the LIBCAD as a recent prototype CAD in microcalcification detection, and compare it to the readings of an experienced radiologist.

Subject and methods: We used 100 normal cases (437 images) to calculate the False Positive (FP) results and 488 cases (1952 images) with abnormalities. All the images are digital mammography. Out of these 488 cases, only 38 cases (67 images) have malignant microcalcifications. Those 38 cases are used to calculate the True Positive findings (sensitivity).

Results: Malignant microcalcifications were detected by the radiologist in 100% (38/38) of cases: 86.8% (33/38) microcalcifications alone and 13.2% (5/38) microcalcifications with masses. The performance was tested at two threshold levels. At a threshold of 4 foci per cluster (an aggressive threshold) malignant microcalcifications were detected in 97.4% (37/38) of cases: 86.8% (33/38) microcalcifications alone and 10.5% (4/38) microcalcifications with masses. At a threshold of 8 foci per cluster (a less aggressive threshold) the detection rate was 92.1% (35/38) of cases: 84.2% (32/38) microcalcifications alone, and 7.9% (3/38) microcalcifications with masses.

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1. Background

Detection of breast cancer while it is still small and confined to the breast provides the best chance of effective treatment for women with the disease (1,2). Clusters of microcalcifications are an early sign of possible cancer and are in general not palpable. Benefits of early detection include increased survival rate, increased treatment options and improved quality of life. Currently, there is insufficient knowledge about the causes of

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Table 1 "Breast imaging reporting and data system" (BIRADS) scoring.

Category 0	mammographic assessment is incomplete
Category 1	negative
Category 2	benign finding(s)
Category 3	probably benign finding(s)
Category 4	suspicious abnormality
Category 5	highly suggestive of malignancy

breast cancer for primary prevention strategies to reduce incidence in the population.

Causes of missed breast cancer on mammography can be secondary to many factors including those related to the patient (whether inherent or acquired), the nature of the malignant mass itself, poor mammographic techniques, or provider factors or interpretive skills of radiologists and oncologists (including perception and interpretation errors) (3).

Perception error occurs when the lesion is included in the field of view and is evident but is not recognized by the radiologist. The lesion may or may not have subtle features of malignancy that cause it to be less visible. Small non-spiculated masses, areas of architectural distortion, asymmetry, and small clusters of amorphous or faint microcalcifications, all may be difficult to perceive (3).

Several factors may lead to misinterpretation, such as lack of experience, fatigue, or inattention. Misinterpretation may also occur if the radiologist fails to obtain all the views needed to assess the characteristics of a lesion or if the lesion is slow growing and prior images are not used for comparison (3,4).

The implementation of Computer aided detection (CAD) systems will help to reduce the human errors that lead to missing breast carcinoma, either related to poor perception or interpretation errors. CAD could increase the sensitivity of mammography interpretation (5).

The American Food and Drug Administration (FDA) had approved the use of Computer Aided Devices (Detection or Diagnosis) in 1998; since then many CAD systems have been developed. Despite the availability of such systems all over the world, and in the U.S. in particular, they have no existence in many countries for their exaggerated price which ranges from 50,000$ to 175,000$ (6). A computer-science based technical review on CAD systems and their development can be found, e.g., in (7,8).

In retrospect, developing a CAD system that is affordable to all laboratories, and individual radiologists on their desktops, is of great value to the field for early detection of breast cancer. LIBCAD (9) is CAD software that is recently developed, in the form of Dynamic Linked Library (DLL), to be affordable for all image viewers that do not support detection capabilities.

2. Objective

In the present article we measure the performance of microcalcification detection of this new software and compare it to the performance of an experienced radiologist.

3. Materials and methods

3.1. Working team and data collection

The working team comprises a multidisciplinary group of several backgrounds including statistics, computer science, and engineering, along with a trained, experienced and professional radiologist (10 years' experience, 6000 mammogram/year).

Mammograms are collected from two different institutions. All images are acquired from digital mammography. The radiologist reads the digital mammograms and then marks the lesions in the images. The marked lesions are also tagged according to the different radiological lexicons and then categorized by the radiologist according to the "Breast Imaging Reporting and Data System" (BIRADS) scoring system. Table 1 is the description of the international BIRADS scoring system for the diagnosis of breast lesions. We have implemented our protocol for reading and marking by designing software

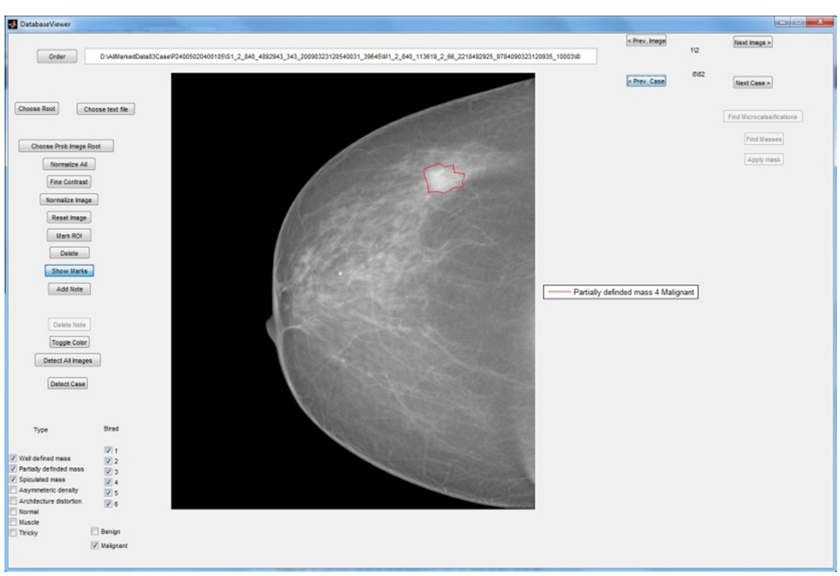

Fig. 1 A snapshot for software used by the radiologist to mark every lesion in a mammogram.