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Incidence and Clinical Significance of Incidentally Detected Breast Lesions on Contrast-Enhanced Chest Computed Tomography in Thammasat University Hospital

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ABSTRACT

Increased use of the contrast-enhanced chest computed tomography (CT) has resulted in increased detection of unexpected breast lesions unrelated to the primary diagnostic questions. However, the breasts are not the primary focus of most chest CT scans, breast lesions are usually overlooked. The purpose of this study was to evaluate the incidence, clinical significance and CT features of incidentally detected breast lesions from routine contrast-enhanced chest CT scans performed for reasons other than breast-related problems. A total of 1912 contrast-enhanced chest CT scans of female patients with no history of breast diseases performed between January 2013 and December 2014 were retrospectively reviewed. Incidental breast lesions were identified by two radiologists in consensus. The incidence, clinical significance, morphology and enhancement patterns of the incidentally detected breast lesions were evaluated. Forty-one (2.1%) patients had one or more incidentally detected breast lesions identified by chest CT scan. Of these, 12 (29.3%) patients had primary breast cancer, 19 (46.3%) patients had benign breast lesions and 10 (24.4%) patients had breast lesions with unknown pathology. The incidental detection rate of breast cancer was 0.6%. CT characteristic analysis showed a statistically significant difference between benign and malignant breast lesions in size, shape, margin and pattern of enhancement ($p<0.0001$). In conclusion, clinically unexpected breast cancer can be incidentally detected by contrast-enhanced chest CT scans. Careful interpretation of the breasts in these scans may improve early diagnosis and treatment of breast cancer.

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1. Introduction

Breast cancer is one of the most common malignancies in women worldwide and is also a common cause of cancer related death in women [1-3]. Although the main examination methods for the screening and characterization of breast disease are mammography, breast ultrasonography and magnetic resonance imaging (MRI) [4-5], new breast lesions can be incidentally found by chest computed tomography (CT) scans performed for reasons unrelated to breast conditions.

In recent years, chest CT has been increasingly used in the diagnosis and surveillance of various thoracic diseases including of the lung, mediastinum, heart, pleura, chest wall and diaphragm. Because the entire breast tissue is usually included in chest CT, greater use of chest CT has resulted in the increased detection of unexpected breast abnormalities unrelated to the primary diagnostic questions. For incidental breast lesions, chest CT is sometimes the first imaging modality to detect a new, potentially curable primary breast cancer and in some cases it can prompt a diagnosis or further work-up [6-14]. However, breasts are not the primary focus of most chest CT, breast lesions are usually overlooked.

The purpose of this study was to evaluate the incidence, clinical significance and CT features of incidentally detected breast lesions on routine contrast-enhanced chest CT scans performed for reasons other than breast-related problems.

2. Materials and Methods

2.1 Patients

Our study was approved by the institutional review board. All contrast-enhanced chest CT data was of female patients, gathered between January 2013 and December 2014 at Thammasat university hospital. Patients with a previous history of breast abnormalities including breast cancer, breast mass or breast surgery were excluded from the study. Chest CT images were retrospectively reviewed by two radiologists in consensus to identify incidental breast lesions. Clinical information, further imaging studies of the breast including mammography, ultrasonography, MRI, tissue pathology and follow-up results of the patients who had incidentally detected breasts lesions from chest CT were reviewed.

2.2 CT Technique

Chest CT was performed using a 256-slice CT scanner (Brilliance iCT, Philips healthcare). Both unenhanced and contrast-enhanced scans were obtained with patients lying in the supine position, from the lung apices through the adrenal glands, with breath-hold after deep inspiration. Regarding the contrast-enhanced CT, it was performed at 60 seconds after the injection of the contrast material, using 90 ml (300 mg iodine/ml) of non-ionic contrast material, with a mechanical power injector at a rate of 2.0-4.0 ml/sec. The CT images were obtained using a soft-tissue algorithm (window width, 360 HU; window level, 60 HU) with a 2.5 mm. or 5.0 mm. slice thickness. The exposure parameters were 120 kVp with a tube current of 100-250 mA.

2.3 Imaging interpretation

Contrast-enhanced chest CT images of breast lesions which had histopathologic diagnoses or stable follow-up imaging for at least two-years were included for CT characteristic analysis. Two radiologists, who were blinded to the pathology and follow-up results, were asked to describe the CT characteristics of each breast lesion including size (greatest axial diameter),

shape (round, oval, lobulated, irregular), margin (circumscribed, ill-defined, spiculated) and enhancement patterns (no enhancement, homogeneous enhancement, heterogeneous enhancement, rim enhancement). The reviewers were also asked to determine associated breast findings including breast edema, nipple retraction, skin thickening, chest wall or skin invasion and axillary lymphadenopathy and calcification.

2.4 Statistical analysis

Descriptive values were presented as number, percentages and mean ± standard deviation. The imaging features of malignant and benign lesions were compared with " Student t test" and "Fisher's exact test". A p-value of 0.05 or less was considered statistically significant.

3. Results and Discussion

3.1 Results

A total of 1970 female patients underwent routine contrast-enhanced chest CT scans at our institution during the period of January 2013 to December 2014. Fifty-eight patients were excluded from the study because of known breast diseases including invasive ductal carcinomas (IDC) (54 patients), phylloides tumors (2 patients), diffuse large B cell lymphoma (1 patient) and sarcoma (1 patient). For the remaining 1912 patients, 41 patients (2.1%) had one or more incidentally detected breast lesions identified by the chest CT. Of these, 12 patients (29.3%) had primary breast cancer, 19 patients (46.3%) had benign breast lesions and 10 patients (24.4%) had breast lesions with unknown pathology. The rate of incidental detection of breast cancer was 0.6% (12/ 1912). Clinical indications from the chest CT data of the 41 patients who had incidental detection of breast lesions are summarized in Table 1.

Among the 41 patients with incidentally detected breast lesions from contrast-enhanced chest CT, 10 patients were excluded from CT characteristic analysis because of unavailable final diagnosis of the breast lesions. Of the remaining 31 patients, 26 had a solitary lesion, 4 had two lesions and one had three breast lesions. For a total of 37 incidental breast lesions which were included for CT characteristic analysis, 15 lesions (40. 5%) were malignant lesions and 22 lesions (59.5%) were benign lesions (Table 2). The most common pathology of these 15 malignant lesions was IDC (14 lesions, 93.3%) and the most common pathology of the 22 benign lesions was fibroadenoma (18 lesions, 81. 8%). There was no significant difference in mean age between the patients with incidental malignant breast lesions (59.7±9.3 years; range, 42-73 years) and the patients with incidental benign breast lesions (61.4±12.9 years; range, 32-78 years, p = 0.70).

Table 1. Indications for chest CT of the patients with incidental breast lesions.

Indications	Malignant	Benign	Unknown
Staging work-up for non-pulmonary malignancy	2	8	
Chronic cough and dyspnea	4	2	1
Lung and pleural cancers	1	2	3
Prolonged fever or febrile neutropenia		2	2
Suspicious for mediastinal mass or hilar mass		2	1
Cervical or axillary lymphadenopathy	2		1
Others	3	3	2
Total (41 patients)	12	19	10

Table 2. Diagnosis of incidental breast lesions.

Diagnosis	Number of lesions (n=37)
Malignant (n=15)	
Invasive ductal carcinoma	14
Papillary carcinoma	1
Benign (n=22)	
Fibroadenoma	18
Cyst	2
Inflammatory lesion	1
Atypical ductal hyperplasia	1

CT characteristic analysis of the incidental breast lesions showed that the size of malignant breast lesions (mean±SD, 22.6±11.2 mm; range, 7-47 mm) were likely to be larger than benign breast lesions (mean±SD, 11.7±4.7 mm; range 4-24 mm; p=0.0002). For the shape of lesions, most malignant breast lesions were irregular in shape (14 lesions, 93.3%), while the majority of benign lesions were round in shape (11 lesions, 50.0%) or oval in shape (7 lesions, 31.8%). None of the benign lesions had an irregular shape. The incidental malignant breast lesions had either ill-defined margins (8 lesions, 53.3%) or spiculated margins (7 lesions, 46.7%), while all of the incidental benign breast lesions had well-circumscribed margins (22 lesions, 100%) (Figs. 1 and 2). All of the malignant breast lesions showed enhancement on post-contrast study and the most common enhancement pattern was heterogeneous enhancement (10 lesions, 66.7%). In contrast, more than half of the benign lesions showed no enhancement on post-contrast study (13 lesions, 59.1%). For the benign lesions which showed enhancement on post contrast study, the most common enhancement pattern was homogeneous enhancement (6 lesions, 27.3%). There were statistically significant differences between the malignant and benign groups in size, shape, margin and pattern of enhancement ($p < 0.001$) (Table 3).

Of the 12 patients with malignant breast lesions, associated breast findings including breast edema and skin thickening were observed in 6 patients (50.0%) and axillary lymphadenopathy was observed in 7 patients (58.3%). None of these findings were seen in patients with incidental benign breast lesions. Popcorn and coarse macrocalcification were found in 5 (22.7%) benign breast lesions. No calcification was detected in incidental malignant breast lesions. The reason for these findings might be the poor sensitivity of CT to microcalcification in breasts.

Among 37 incidental breast lesions, 13 (35.1%) lesions were not mentioned in the final radiologic reports. One of them was a malignant breast lesion (IDC) and was at stage T1 based on the TNM staging system for breast cancer at the time that particular chest CT scan was performed. The remaining 12 lesions were benign.

Table 3. CT characteristics of benign and malignant incidental breast lesions.

	Malignant	Benign	p-value
Size (mm)	22.6	11.7	0.0002
(Mean+/- SD)	+/-11.2	+/-4.7	
Shape			< 0.001
Round	1	11	
Oval	0	7	
Lobular	0	4	
Irregular	14	0	
Margin			< 0.001
Circumscribed	0	22	
Ill-defined	8	0	
Spiculated	7	0	
Enhancement			< 0.001
No	0	13	
Homogeneous	2	6	
Heterogenous	10	1	
Rim	3	2	

Note: Student t test and Fisher's exact test were used for statistical analysis.

3.2 Discussion

With increasing use of contrast-enhanced chest CT, a greater number of unexpected breast abnormalities unrelated to the primary diagnostic questions have been detected. Several studies have reported incidental breast lesions on chest CT scans with a considerable detection rate, ranging from 0.6-7.6% [7-8, 13-15]. In our study, 2.1% of female patients with no previous history of breast abnormalities had one or more incidental breast lesions identified by a contrast enhanced chest CT scan.

Chest CT can be the first imaging modality to detect clinically unexpected breast cancer. The reported detection rate of incidental breast cancer detected by chest CT vary from 0.4-1.9% [7-8, 13, 15].

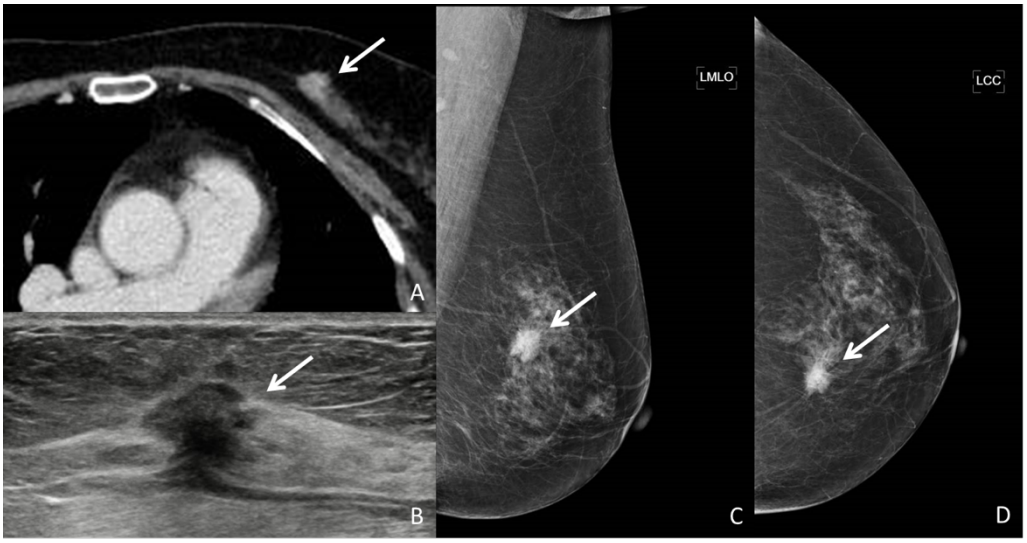

Fig. 1. A 62-year-old woman with invasive ductal carcinoma of the left breast. She presented with chronic cough and dyspnea and chest CT was performed for evaluation of interstitial lung disease. A: Contrast-enhanced chest CT shows an irregular shape mass with a spiculated margin and heterogeneous enhancement at upper-inner quadrant of left breast. B: Ultrasound of the same lesion shows an irregular hypoechoic mass. C and D: Mammography images of the same lesion show a spiculated mass at upper-inner quadrant of left breast.

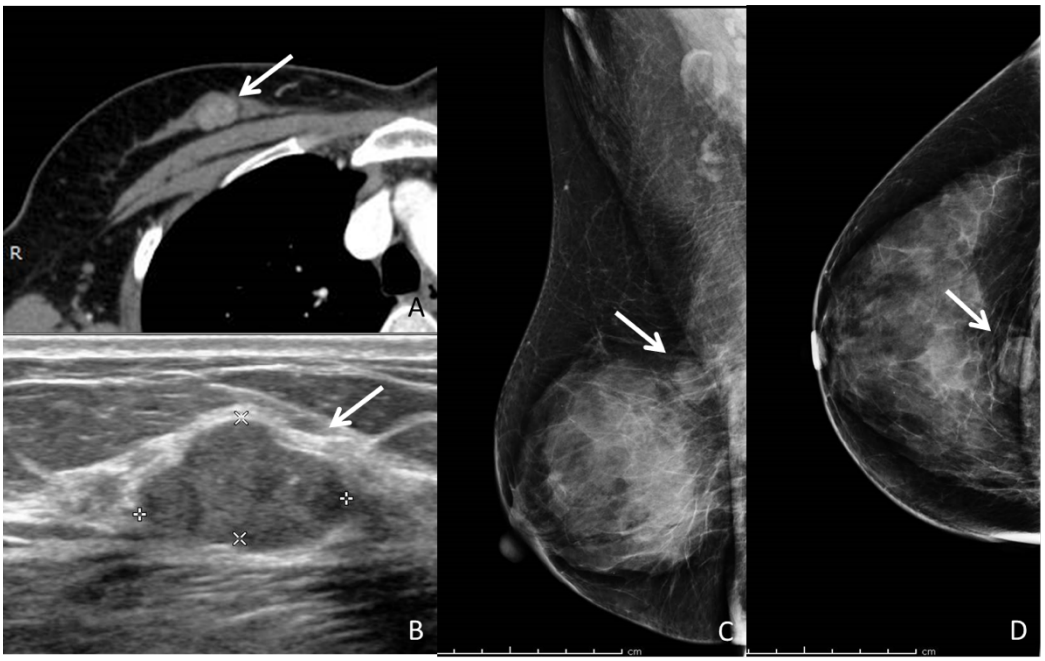

Fig. 2. A 57-year-old woman with fibroadenoma of the right breast. Chest CT was performed for evaluation of a small pulmonary nodule at left upper lung field seen on a chest radiograph. A: Contrast-enhanced chest CT shows a circumscribed lobulated mass with heterogeneous enhancement at 12 O'clock of right breast. B: Ultrasound of the same lesion shows a circumscribed lobulated hypoechoic mass. C and D: Mammography images of the same lesion show a circumscribed mass.

In our study, we found 12 patients with incidental primary breast cancer from contrast enhanced chest CT; here the primary breast cancer detection rate was 0.6%, comparable to other results reported in the literature.

In this study, 35.1% of the incidental breast lesions were not mentioned in the final radiological reports. Although most of them were benign breast lesions, one of them was early-stage malignant breast cancer (IDC). In this case, the mass was missed by the first CT study but was discovered by the follow up CT, unrelated to breast abnormalities, one year later. It had markedly increased in size since the first CT evaluation. This patient had delayed diagnosis and treatment for 1 year. Due to the fact that breasts are not the primary focus of chest CT, breast lesions may be missed or not reported by the radiologist, resulting in delayed diagnosis and management. Concerning breast evaluation in CT, performed for any indication, it is very important for radiologists to complete patient care.

Careful evaluation of CT characteristics of breast lesions might help to predict the nature of lesions be they benign or malignant, and help to suggest further management. In this study, we found a statistically significant difference of CT characteristics between benign and malignant breast lesions in size, shape, margin and pattern of enhancement. Moyle et al. and Bach et al. reported that malignant breast lesions were likely to be larger than benign lesions, concordant with the findings of our study [11-12]. Most malignant lesions had an irregular shape (93.3%), ill-defined or spiculated margins (100%) and heterogeneous enhancement patterns (66.7%), while the majority of benign lesions had a round or oval shape (81.8%), circumscribed margins (100%) and no enhancement pattern (59.1%). None of the benign lesions had an irregular shape, ill-defined or spiculated margins and none of the malignant lesions had circumscribed margins or enhancement pattern. Of these, an irregular shape, ill-defined or spiculated margin and a heterogeneous enhancement pattern were good CT predictors of malignant breast lesions; on the other hand, a round or oval shape, circumscribed margin and absence of enhancement pattern were characteristics predictive of benign lesions. Homogeneous enhancement was more frequently found in benign lesions. In this study, we detected 8 lesions with homogeneous enhancement, 2 were malignant and 6 were benign. However, 1 malignant incidental breast lesion in our study had round shape and homogeneous enhancement which are CT features that predict the legion to be benign in nature, but its histopathology was papillary carcinoma.

Inoue et al. reported that rim enhancement was a highly suggestive feature of malignancy [16]. In our study, there were 5 breast lesions with rim enhancement, 3 lesions were malignant and 2 lesions were benign. The histopathology of benign lesions with rim enhancement were atypical ductal hyperplasia and complicated cyst, and all 3 malignant lesions with rim enhancement were IDC. Therefore, breast lesions with rim enhancement were not always malignant.

Poyraz et al. reported that calcification was found in 4 of 21 incidental benign breast lesions (19.0%) and no calcification was found in incidental malignant breast lesions on chest CT scans [15]. These results are the same as in our study, in which all of the incidental breast lesions with internal calcification detected on chest CT scans were benign (fibroadenoma). The types of calcifications that were detected on chest CT scans were coarse or popcorn-like calcifications. This may be due to the low spatial resolution of CT images, insufficient to detect suspicious microcalcifications.

One limitation of our study was the small sample size, which may have effected

the results of CT feature evaluation. Another limitation was that some incidental breast lesions detected on chest CT scans had no final diagnosis, this may have resulted in a lower measured incidence of incidental breast cancer in this study.

4. Conclusion

Clinically unexpected breast cancer can be incidentally detected by contrast-enhanced chest CT. Careful interpretation of the breasts in chest CT data may provide early diagnosis and treatment of breast cancer.

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