

The significance of incidental breast findings on routine computed tomography of the chest

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Abstract:

Background: with the dramatic increase in the use of chest computed tomography (CT) for diagnostic or screening purposes, incidental breast lesions faced more frequently; while most of these incidental breast findings are benign; nevertheless, breast cancer be existing.

Objectives: to determine the imaging characteristic of incidentally detected breast lesions in routine chest computed tomography and to review the outcome of further assessment of these abnormalities.

Patients and methods: a prospective study performed on (33 patients) during the period from October 2014 to November 2015 in AL Shaheed Ghazi Al Hariri hospital, Baghdad teaching hospital, and Radiology Institute at Medical city complex, Baghdad. All patients were female and their ages ranging from (18-74) years. Then breast lesions found incidentally at CT scan identified and their CT features analyzed and include number of lesions, size, location, shape, margin characteristics, and density of the lesion and associated calcification. Most of these patients with incidental breast findings were followed up by performing breast ultrasound (US) and/or mammography in oncology teaching hospital (according to their age) and according to breast imaging and reporting data system (BIRADS); BIRAD- IV and V lesions followed by cytopathological examination and final results were recorded.

Results: during the study period, a total of 39 incidental breast lesions were identified on chest CT scan among those 33 patients because some patients had multiple lesions. The mean age of patients for malignant lesions was (53±6.1 years) and for benign lesions was (43.21±0.8years). 25.6%, of incidental, breast lesions found to be malignant and 74.4% found to be benign. Malignant incidental breast lesions tend to have an irregular shape, ill-defined margin and have soft tissue attenuation.

Conclusion: Although CT scan is not the primary procedure for the breast imaging, but it can show a significant complementary role in the evaluation of the breast with ultrasound and mammography. A careful review of the breast and accurate characterization of incidental breast lesions (IBL) would highlight the radiological reports, it would achieve appropriate management for the patients, and this would improve survival. Although some of the findings of benign and malignant breast lesions on CT scan do overlap to some degree, we can conclude that an irregular shape and ill-defined margin are important features that go with malignant breast lesions.

Key words: incidental, breast, computed tomography.

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Introduction:

Incidental findings are a common feature in computed tomographic examinations of the chest, most of them are classified as clinically non-significant like coronary artery calcifications, degenerative changes of the spinal column and others. In contrast, breast incidental findings described only sporadically. (1, 2) Chest CT is not routinely used for breast imaging. However, the entire breast tissue usually appears on a chest CT. (3) with the increased use of chest CT, incidental breast lesions are recognized more frequently. In some cases, CT may be the first imaging modality to demonstrate a breast lesion on unenhanced or contrast- enhanced CT of the chest. (4, 5) Three conditions are probable in incidental breast findings

on CT: primary breast cancer, intramammary metastasis from non-breast cancer and benign breast lesion or combined. (6) Even though dedicated breast imaging will often be essential for conclusive diagnosis. It stays vital for radiologists to distinguish breast lesions incidentally found at CT as benign or suspicious to warrant further work. (7)

The main purposes of this study are to determine the imaging characteristics of incidentally detected breast lesions on routine chest computed tomography and to review the outcome of further assessment of these abnormalities.

Patients and methods:

A prospective study performed during the period from October 2014 to November 2015 at medical city complex hospitals including AL Shaheed Ghazi Al Hariri hospital, Baghdad teaching hospital, and Radiology Institute. During the study

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period 40 patients with incidental breast lesions were identified, of these 40 patients, seven are excluded and only 33 patients (with 39 lesions) are followed up. All patients were female and their ages ranging from (18-74) years.

Inclusion criteria includes: (patients referred for chest CT scan for indications other than breast disease, and then incidental breast lesions were identified, patients with known non-breast cancer referred for chest CT scan for staging or searching for recurrence and patients with metastatic disease referred for CT scan searching for primary malignancy); whereas, exclusion criteria includes: (male patients, patients with known breast cancer and postoperative follow up of breast cancer.

The chest CT was performed in the supine position, using one of the multidetector CT machines: Siemens (Somatom) of Al Shaheed Ghazi AL Hariri as definition of 64 multislice (120 KV, 200-300 mAs, slice thickness 6mm), Toshiba (Aquilion) of Radiology institute as definition of 64 multislice (120 KV, 250 mAs, slice thickness 5 mm), Philips and Toshiba of Baghdad teaching hospital as definition(Philips 64-multislice ,120 KV, 200 mAs, slice thickness 3mm[0.8-5mm]) and (Toshiba 64-multislice, 120 KV, 250 mAs, slice thickness 5mm). CT examination was carried out from lower neck through the adrenal glands with scan time of (12sec). Intravenous iodinated contrast media were given according to the primary indication for doing chest CT scan and their findings. Multiplaner reconstructions (axial, sagittal and coronal) were used for the assessment of breast lesions and their localization by routine chest CT scan. The images were obtained by using a standard soft tissue algorithm [window width, 400 Hounsfield units (HU); level, 40 HU]. All CT scan sections were evaluated by radiologist on call and supervisor radiologist. Then breast lesions found incidentally at CT scan were identified and their CT features were analyzed and include: number of the lesion, size, location, shape, margin characteristics, attenuation of the lesion whether soft tissue attenuation (more than 30 HU), less than 30 HU, and if there is calcification described as (density and distribution in the breast). The shape of the incidental breast lesion was described as irregular, a round/ ovoid and lobulated. The margin of the incidental breast lesion was described as well circumscribed and non-circumscribed (ill defined). Breast tissue architecture was evaluated also at CT scan whether there is asymmetry between both breasts. Skin thickness of breast also assessed. The presence of ipsilateral axillary lymphadenopathy and their size were recorded. An abnormal axillary lymph node was defined as a node with a short axis greater than 10mm. Other important findings of bone, lung, and liver were also recorded.

Most of these patients with incidental breast findings were followed up by performing ultrasound of breast under the supervision of an expert radiologist or sending for ultrasound and/or mammography (according to their age) in the Oncology Teaching Hospital for further characterization of the lesion and

correlation and the findings were recorded and categorized using BIRADS category system. If there were suspicious findings on breast ultrasound and /or mammography (BIRAD IV or V), fine needle aspiration or biopsy was performed and the cytopathological or histopathological results were recorded.

In this study we use two terms for description of incidental breast CT findings which are: incidental breast mass (IBM) and incidental breast lesion (IBL). The IBL include (incidental breast mass, breast calcification and focal asymmetry).

Limitations: A total of 40 patients with incidental breast lesions were identified on routine chest CT scan. We exclude (7patients) from the study from those 40 patients because these seven patients either refused to be examined by breast US and/or performing mammography or because of difficulty in following up them and collect their information, so statistical analysis applied only on (the 33patients) who underwent further evaluation and complete follow up.

Statistical analysis: Each patient assigned a serial identification number. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 20. The continuous data were represented by mean, and standard deviation. The categorical data presented as frequency and percentage tables. The independent t-test was used for assessing the mean differences between continuous variables. The Chi square was used to assess the association between categorical variables. P – Value less than 0.05 was used as the alpha level of significance.

Results:

During the study period, 40 patients reported incidental breast lesions (IBLs) including the axilla while performing routine chest CT scan. Of these 40 patients, seven patients are excluded because they were not available for sonographic and/or pathological correlation. The remaining 33 patients were all female. Those 33 patients had 39 lesions because some patients had more than one lesion.

Those 33 patients were followed up; 19 patients by breast ultrasound only, 12 patients by breast ultrasound and mammography, two patients by mammography only.

Cytopathological and/or histopathological study confirmed the diagnosis in 13 patients (which include all patients found to have BIRAD IV and BIRAD V on US &/or mammography) except one patient with wide spread metastatic lung cancer and had incidental breast lesion and therefore only breast ultrasound was performed for her and showed malignant criteria (BIRAD V) and Cytopathological study was not feasible.

Indication of chest CT: All chest CT scan were for indications other than breast, such as staging of other malignancy (n=6), follow up of leukemia & or lymphoma (n=3) pulmonary angiography (n=3), SOB (n=7), chronic cough (n=4), interstitial lung disease (n=4), bronchiectasis (n=3), chest pain (n=1), chest trauma (n=1), hemoptysis (n=1).

Age of the patients: The age of the patients in our study was ranging from 18 to 74 years with the mean age of patients for malignant lesions was (53±6.1 years) which was higher than the mean age for benign lesions (43.21±0.8 years) with significant difference reported (p value = 0.012).

CT findings of incidental breast lesions (IBLs):

A total of 39 IBLs were identified on chest CT scan among those 33 patients were summarized in (table 1) and (figure 1).

Table 1: distribution of incidental breast lesions including the axilla.

	CT findings	Number	Percentage
	Breast mass	33	84.6
Non-mass	Focal asymmetrical tissue	1	2.56
	Breast calcification alone	4	10.25
	Enlarged axillary LN lone	1	2.56
	Total	39	100

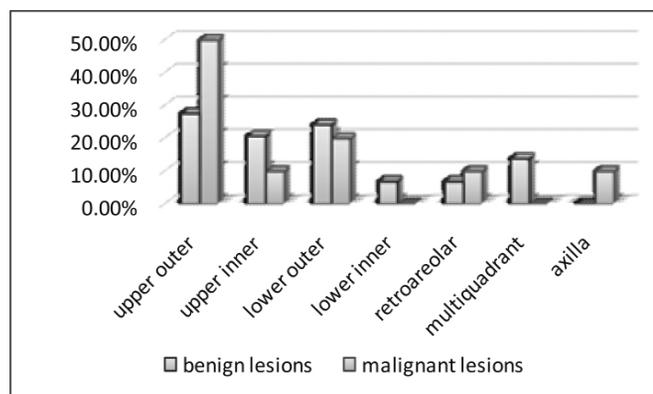


Figure 1: distribution of incidental breast lesions on routine chest CT scan according to their location.

Characteristic findings of incidental breast masses (IBMs): Several variable imaging characteristics of incidental breast masses were summarized in (table 2).

Table 2: characteristic findings of incidental breast masses on routine chest CT (total No. =33)

Characteristic findings	Benign masses		Malignant masses		P value	
	no.=24	%	No.=9	%		
shape	Irregular	0	0	5	55.5	<0.001*
	Round/oval	16	66.6	2	22.2	
	Lobular	8	33.3	2	22.2	
margin	Non-circumscribed	2	8	7	77.8	<0.001*
	Well circumscribed	22	92	2	22.2	
	Size(M±SD)	5.6	7.2	5.9	6.8	0.918
attenuation of mass	more than 30 HU	17	70.8	9	100	0.081
	Less than 30HU	6	25	0	0	
	Less than -50 HU	1	4.1	0	0	
	mass with calcification	4	16.7	1	11.1	0.62
	mass with enlarged axillary LN	5	20.8	8	88.9	<0.001*
	mass with skin thickening	0	0	3	33.3	<0.001*

* Significant p value

Malignant rate: Ten lesions (25.6%) were confirmed to be malignant and 29 lesions (74.4%) were confirmed to be benign. Those malignant lesions were found to be primary breast cancer in six lesions (15.4%) and four lesions (10.2%) were secondary involvement as shown in (figure 2).

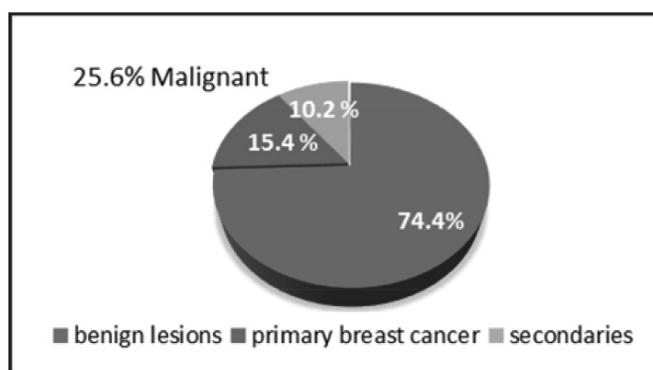


Figure 2: Percentage of incidental malignant breast lesions in relation to the total incidental breast lesions in routine chest CT scan, (total No.=39)

Final pathological outcome: Regarding the final diagnosis of these IBLs (as confirmed by cytopathological study in 13 lesions and depend on ultrasound and/or mammography in most lesions with BIRAD II and III), we found that fibroadenoma was the most common incidental breast lesion identified on chest CT scan with reported frequency of (46.1%) and primary breast cancer was

the second most common incidental breast lesion with reported frequency of (15.4%). Of these patients with primary incidental breast cancer, one patient was at stage I, one patient was at stage II, two patients were at stage IV (one of them had bone metastasis and the other had pleural metastasis) and the other 2 patients cannot be staged due to lack of recommended information.

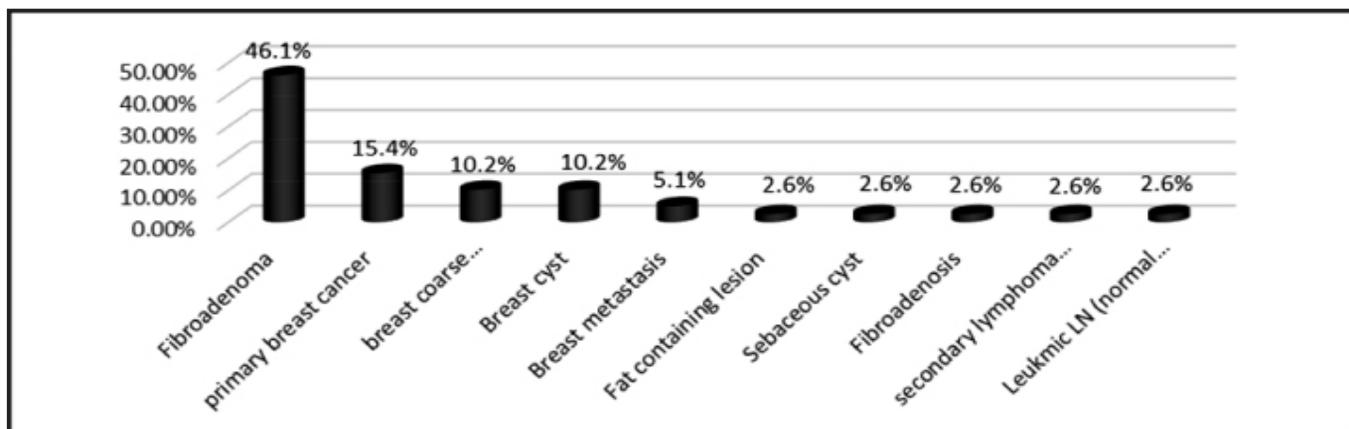


Figure 3: Percentage of incidental breast and axillary lesions according to frequency of pathology (N=39).

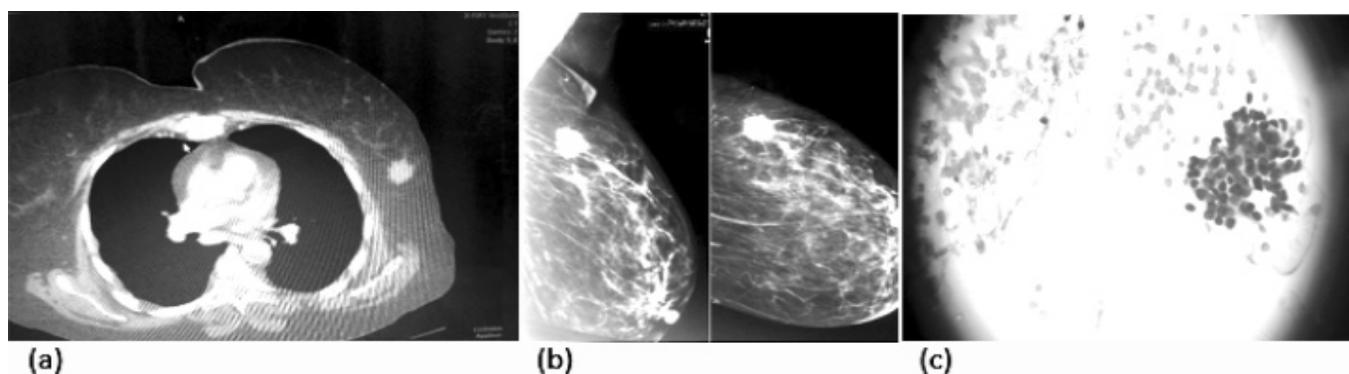


Figure 4: 40 years age female presented with chronic cough. Axial chest CT scan, mediastinal window (a), show irregular soft tissue mass incidentally noted in the left breast. Follow up mammogram (b) reveal this dense mass with speculated margin in the upper outer quadrant of left breast (c) Cytological study of left breast of the same patient above showed features of malignancy with cluster of malignant epithelial mammary cells with large pleomorphic hyper chromatic vesicular nucleus (picture of breast cancer).

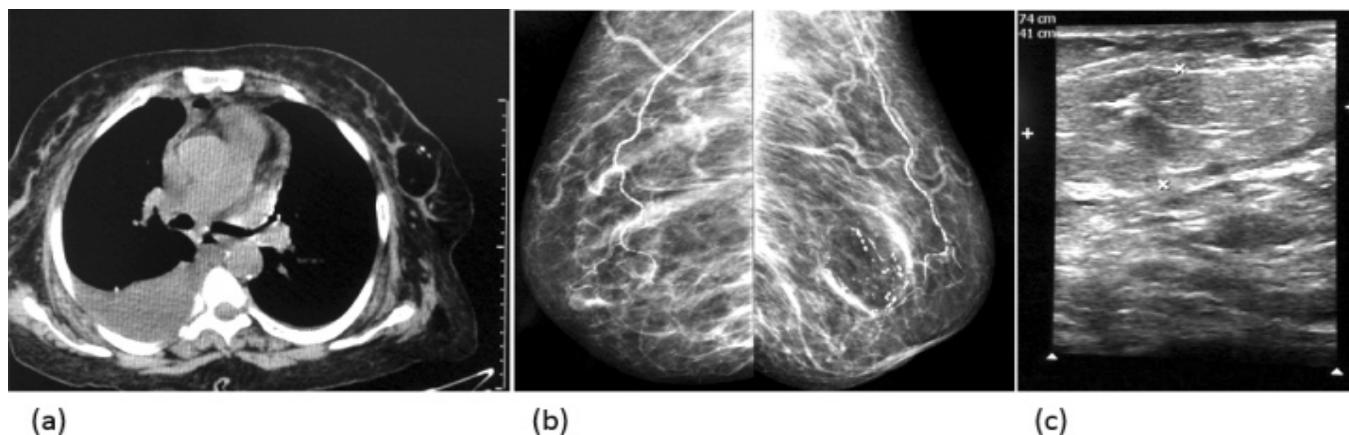


Figure 5: 62 years old female presented with dyspnea. Axial chest CT scan mediastinal window (a) shows right pleural effusion and incidentally noted a fat containing lesion in the left breast with foci of calcification. Left breast ultrasound (b) shows large hyperechoic well defined mass (BIRAD II). (c) mediolateral oblique view mammogram of both breasts of the same patient above shows well defined lucent fat containing lesion in left breast with macro calcification inside (lipoma is suggested) BIRAD II.

Discussion:

The majority of breast lesions are diagnosed through the breast screening programs and clinical breast examinations; however, breast lesions can be detected incidentally on CT scan. (7) CT scan is not only sensitive for the detection of small breast lesions within dense breasts but also it allows for better visualization of some breast lesions adjacent to the chest wall. (7, 8, 9) Usually, chest CT scans are reported by radiologists who are not specialized in breast imaging, As a result breast lesions may be missed or may not be mentioned in the radiological reports, subsequently such cases would not be referred for further assessment and management. (10) Although the prevalence of breast cancer on CT is very low, the risk of a primary breast malignancy does exist. (2) Furthermore, other breast malignancies, such as breast metastases from non-mammary tumors or lymphomas can also occur (2, 4). Breast metastasis can be the first sign of an unknown tumor or the first sign of a tumor recurrence. (11)

Age of the patients : In our study, The age of the patients in our study was ranging from 18 to 74 years with the mean age of patients for malignant lesions was (53± 6.1 years) and for benign lesions was (43.2±10.8 years) with significant difference reported (p value =0.012) where the older age group have higher incidence of malignant lesions. This goes with the fact that risk of breast cancer increases with increasing age .These results were comparable to Lin et al who noted that the age of patients with incidental primary breast cancer was higher than that of patients with benign incidental breast lesions. (8) In contrast to Porter et al who reported no significant difference in the mean age of patient between benign and malignant IBLs (the mean age was 68.8years for benign and malignant IBLs). (12)

CT findings of IBLs

Multiplicity and bilaterality: We found that the bilaterality and multiplicity favor benignity in patients with negative history of primary tumor where (12.12%) of our patients had bilateral involvement and all these were found to have benign lesions and also 12.12% of our patients had more than one lesion (multiple lesions) and all these lesions confirmed to be benign and no malignant lesions were multiple in our study. Porter et al reported that multiplicity was found in 10% of malignant lesions and in 13% of benign lesions. (12) In the study of Lin et al there were three patients with a known primary malignancy other than breast cancer and showed multiple, well-circumscribed breast tumors. These tumors were confirmed as breast metastases. So the possibility of breast metastases should be considered in patients with multiple well-defined breast nodules and non-mammary malignancy. (8).

Location of IBLs: We found that the higher percentage of IBLs was in the upper outer quadrant where 50% of malignant

IBLs and 27.6% of benign IBLs located in the upper outer quadrant. Twenty percent (20%) of malignant IBLs were in the lower outer quadrant and 10% in the retro-areolar region. in the study of Bach et al 40% of malignant and 54% of benign lesions were in the upper outer quadrant and 20% of malignant lesions were in the retro areolar region. (13)

Incidental breast mass (IBM) characterization

Shape and margin of IBMs: Significant statistical difference between malignant and benign IBMs regarding the shape and the margin was found in our study; with the malignant masses tend to have irregular shape and non-circumscribed margin. This was in agree with Harish et al, Surov et al , Lin et at and Kim et al which all demonstrated that irregular shapes and ill-defined margins were suggestive CT features of malignancy. (5, 6, 8, 10) In contrast to Bach et al who showed that there was no significant difference regarding the shape or margin characteristics between malignant and benign masses (13). We found that 55.5% of malignant IBMs have irregular shapes and all these were incidental primary breast cancer. This results was comparable to that was reported by Porter et al who found that 60% of malignant IBLs were irregular in shape. (12) In contrast to the study of Bach et al 2013 who found that only 13.1% of IBLs were irregular in shape. (13) We found that 66.6% of benign IBMs were round &/or oval in shape and 33.3% were lobulated in shape. This results was comparable to what reported by Kim et al who found that 70% of benign lesions were round/oval in shape.(10) Also our result was near the results of Bach et al who found 62.4% of benign lesions have round/oval shape and 25.8% were lobulated. (13) In the study of Surov et al, 48% of incidental benign lesions were round/oval and 52% had lobular shape. (6) In our study about 77.8% of malignant masses have non-circumscribed or ill- defined margin. This result was slightly lower than that reported by Kim et al and Porter et al. They found that 100% of malignant masses had ill-defined margins. (10,12) This may be explained by that two of the malignant lesions (22.2%) in our study which had well defined margins were indeed found to be metastasis rather than primary tumors; one of them was from a malignant melanoma of the vulva and the other was from a lung carcinoma. This was also correlated with Surov et al and Lin et al who found that breast metastasis were most frequently rounded or oval in shape with well circumscribed margins when compared with benign or primary malignant masses. (6, 8) Therefore any patient with a known primary malignancy other than breast carcinoma and presented to us with a well-defined incidental breast lesion, this may represent either a benign lesion or a breast metastasis and those patients should be referred for further assessment.

Size of IBMs: Our study revealed that there is no statistical difference between benign and malignant IBMs regarding the

size (the mean size of malignant IBMs was 5.9 ± 6.8 cm and for benign IBMs was 5.67 ± 2.2 cm with p value = 0.0918). This was in agreement with what was reported by Surov et al, Porter et al and Lin et al. (6, 8, 12) They found that the size of incidental breast lesions was not a reliable feature to distinguish malignancy from benignity. In the study of Harish et al, the breast abnormalities presented are all larger than 1 cm in size, this may reflect that these lesions were discovered incidentally, and there is a high likelihood that smaller breast lesions may have been overlooked. (5) Also in our study most of the lesions were larger than 1 cm.

Attenuation of IBMs: In our study we found that all malignant IBMs (100%) have attenuation (more than 30 HU) which is soft tissue attenuation that all these when correlated with ultrasound appear solid. This was comparable to Surov et al and Bach et al. They reported that malignant lesions showed higher density in comparison to benign masses. However, the range of densities was very wide in both groups. (6, 13) We found that the benign masses that had attenuation more than 30 HU were 17 (70.8%), one benign mass (4.1 %) had fat attenuation less than -50 HU (fatty lesion) and six benign masses (25%) had attenuation from 0 to 30 HU. We noted that all IBMs with attenuation from 0 to 30 HU were benign, but when correlated with US one of these lesions was solid and the others were cystic. As a result, IBMs with this attenuation range cannot be confirmed to be cystic from their CT attenuation due to volume averaging from background glandular tissue of breast especially if the lesion was small and should be correlated with US which has high sensitivity in distinguishing cystic from solid lesions.

Mass with associated features: The present study showed that incidental masses with associated calcification were reported more in benign pathologies which was four (16.7%) and the calcification was dense and large in size while we found only one malignant mass out of 9 IBMs (11.1%) had associated calcification that was punctuate, very faint and measured about 2 mm on HRCT. Bach et al demonstrated that calcification found in 14.5% of benign lesions and in 1.3% of malignant lesion. (13) Surov et al reported that calcification was noted in 23% of benign IBMs and no malignant lesion showed calcification with significant p value of 0.001. (6) Also we noted that one patient with incidental primary breast cancer which was not associated with calcification on CT scan when followed up and mammography done for her; we observed fine pleomorphic calcification on mammography and this reflects the limited spatial resolution of CT scan in detecting micro-calcification less than 0.5 mm in comparison with mammography. In the study of Harish et al, they stated that CT is very sensitive for the detection of coarse calcification and nearly all calcifications currently seen at CT are benign, on the basis of size alone,

due to the limited spatial resolution. (5) Other studies stated that Uniform large, round calcifications are more likely benign, whereas fine pleomorphic calcifications had a higher probability of indicating malignancy and are rarely visualized at CT. (14, 15) The present study showed that (20.8%) of benign and (88.9%) of malignant masses had associated enlarged axillary lymphadenopathy (more than 10 mm in short axis) with significant difference (p value less than 0.01). This result was much higher than that of Porter et al who showed that abnormal axillary LAP was found in 33% of malignant IBMs and no benign IBMs had axillary LAP with significant statistical difference (P value of 0.03). (12) Also Bach et al stated that statistically axillary LAP occurred more frequently in malignant lesions. (13) In contrast to the study of Surov et al who stated that there was no statistical difference in presence of lymphadenopathy. (6) In the study of Lin et al there was no case demonstrating axillary lymphadenopathy, however; this may be due to early stage of disease where all of the incidentally detected breast cancer in his study were at the T1 stage of breast cancer. (8) While in our study one case was at stage I breast cancer, another case was at stage II, two cases were at stage IV with bone &/or pleural metastasis and the other two cases with primary breast cancer cannot be staged due to insufficient data. The other malignant IBMs were breast metastasis with abnormal axillary LAP, one leukemic infiltration of axillary LN and one case was secondary lymphoma of breast with abnormal axillary lymphadenopathy. Other studies revealed that CT is better than clinical examination in detecting axillary lymphadenopathy, but its overall accuracy is mainly limited by its inability to detect micro metastases. (16) We found that skin thickening when associated with IBMs are suggestive CT features of malignancy. Skin thickening associated with (33.3%) of malignant IBMs while not associated with any benign pathology with significant P value of less than 0.001. Harish et al 2007 stated that, in advanced cases, associated skin thickening, lymphadenopathy, or pleural effusions may be seen. (5)

Contrast enhancement: In our study, twenty one examinations were native chest CT scan and only twelve thoracic CT examinations were with contrast media. Of these twelve examinations, three were CT pulmonary angiography and the other were routine contrast enhanced chest CT. This was because the contrast media was given according to the primary indications of thoracic CT scan which were mentioned previously. However; even in these contrast enhanced CT examinations, the enhancement pattern of IBMs cannot be analyzed properly because the process was routine enhanced chest CT scan for lesions other than breast and not dynamic CT scan for breast lesions.

Malignant rate and final pathological outcome: We found that

25.6% of IBLs were malignant and 74.4% lesions were benign. This result was nearly similar to that reported by Moyle et al who found that 28.2% of lesions were malignant and slightly lower than what reported by Porter et al who demonstrated that 31.4% of incidental breast lesions were malignant. (12, 17) While Lin et al found that 69.6% of incidental breast lesions were malignant. This may be explained by that Lin et al studied only enhancing incidental breast lesions and therefore some benign incidental breast lesions which were not enhanced on chest CT may not be included. (8) The malignant IBLs in this study were primary breast cancer in 15.4% and secondary in (10.2%). Secondary breast lesions were breast metastasis in 5.1% (one from malignant melanoma and other from a lung cancer), secondary lymphoma of breast was (2.56%) and leukemic infiltration of axillary lymphadenopathy with normal breast was (2.56%). This was in contrast to the results of Surov et al who reported only 9% of IBLs were primary breast cancer and 58% was breast metastasis. (6) This was because Surov et al had studied IBLs in staging CT scan of other malignancies and already metastasis would be encountered more than primary tumor. (6) Regarding the final diagnosis of IBLs, we found that fibroadenoma was the most common incidental breast lesion identified on chest CT scan with reported frequency of (46.1%) and primary breast cancer was the second most common incidental breast lesion with reported frequency of (15.4%). This result was slightly lower than that of Porter et al and Moyle et al who reported primary breast cancer in 22.9% and 25.6% respectively. (12, 17)

Conclusions:

Like other breast imaging techniques, ultrasound and mammography, CT findings of incidental breast lesions can be classified into two category: benign or suspicious lesion according to the shape, margin, attenuation, associated calcification, skin thickening and abnormal enlarged axillary LN and others. This would make the dealing with incidental breast lesions easier and can achieve satisfied practicable approach. Although some of the findings of benign and malignant breast lesions on CT scan do overlap to some degree, we can conclude that an irregular shape and ill-defined margin are important features that go with malignant breast lesions. Skin thickening and abnormal enlarged axillary lymph node are other features that when observed on CT scan are considered suggestive features of malignancy. Patients with the aforementioned features should be referred for further assessment to reach final diagnosis. Breast lesions with fat attenuation on CT scan and coarse calcification can be considered benign and breast lesions with suspicious morphology on CT scan should be referred for further assessment. The bilaterality and multiplicity of IBLs in our study in favor of benignity particularly in patients with

negative history of primary tumor. In contrast to primary breast cancer, breast metastasis tend to have well defined margin, so when we encountered well defined IBMs on chest CT scan in patient with primary tumor, they should be referred for further assessment as it may be breast metastasis and can potentially alter treatment strategies.

Author contributions

Hiba Mohammed, Abdullateef Aliasghar: Authors make substantial contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data and drafting the article.

Mohammed Al-Hilli, Abdullateef Aliasghar: Authors participate in drafting the article or revising it critically for important intellectual content.

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