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MINIREVIEWS

Imaging of the treated breast post breast conservation surgery/oncoplasty: Pictorial review

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Abstract

Mammographic appearance of the normal breast is altered in the post-operative setting. It is essential to be aware of the normal findings as well as to identify features of recurrent disease with particular emphasis on radiological-pathological concordance. Digital breast tomosynthesis and volumetric breast density add incremental value in this clinical setting. We present a pictorial review of various cases to illustrate normal post-operative findings as well as mammographic features suspicious for recurrent disease.

Key words: Mammography; Digital breast tomosynthesis; Breast conservation surgery; Post breast-conserving therapy imaging; Breast cancer

Core tip: Mammographic imaging in patients after breast conservation surgery is challenging because surgery alters the normal breast architecture. The distinction of normal post-operative changes from true findings of recurrence becomes demanding even for a breast imager making it essential to update our knowledge in the subject. In the recent times digital breast tomosynthesis and volumetric breast density are adding an incremental value in this clinical setting.

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INTRODUCTION

Breast conservation surgery (BCS) is the most commonly employed management of breast cancer in current practice and aims at surgical excision of the tumor while conserving the patient's breast appearance and form. Breast radiologists need to update their knowledge of typical and atypical appearances of the treated breast in order to detect abnormalities signifying recurrence as well as to not raise unnecessary concern over benign course of post-operative change.

The expected changes on mammography after breast conservative surgery include skin thickening or edema, parenchymal edema, post-operative fluid collection, scar, fat necrosis and dystrophic calcifications which are more marked up to six months after therapy. Recurrence on mammographic imaging may be observed as a mass or microcalcifications, increase in skin thickening, increase in breast density, scar enlargement, axillary nodal recurrence or Paget's disease. We present various mammography images to illustrate findings which may be left alone and those which require further intervention.

LEAVE-ME-ALONE FEATURES

Skin thickening and parenchymal edema

Normal skin thickness of the breast as seen on mammogram is 2 mm[1,2]. Skin thickening (more than 2 mm) is the most common finding after breast-conserving therapy (BCT), reported in up to 90% of patients[3]. On imaging it manifests as skin and trabecular thickening or overall increased breast density due to parenchymal edema which decrease on follow up studies and return to normal by 2 to 3 years (Figure 1)[2]. Post radiation edema occurs more commonly after external beam radiotherapy (EBRT) than intraoperative radiotherapy[4,5]. Less commonly the skin thickening and parenchymal edema may be a consequence of lymphedema (secondary to axillary node dissection) or mastitis[3].

Post-operative collection

Fluid with or without blood which collects in the post-operative cavity appears as an oval or round circumscribed mass on mammography. When viewed on ultrasound, a mixed echogenic collection with variable fluid (anechoic) and haemorrhagic (echogenic) contents is observed. Post-operative fluid collections are seen in about half the patients at 1 mo after surgery and may remain in up to a fourth of cases till 6 mo[2] though in a few patients these may persist for years[6]. On sequential

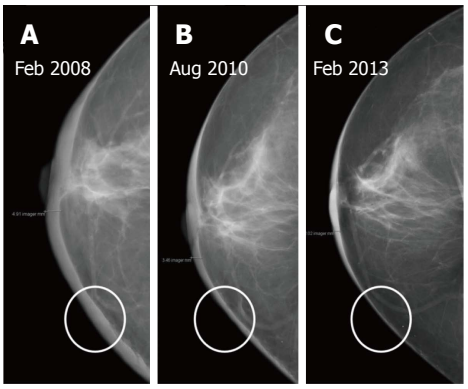

Figure 1 Patient underwent lumpectomy followed by radiation therapy. A-C: (A) Diffuse increase in skin thickness is seen in first post therapy mammogram which decreased on subsequent mammograms at two (B) and five (C) years respectively.

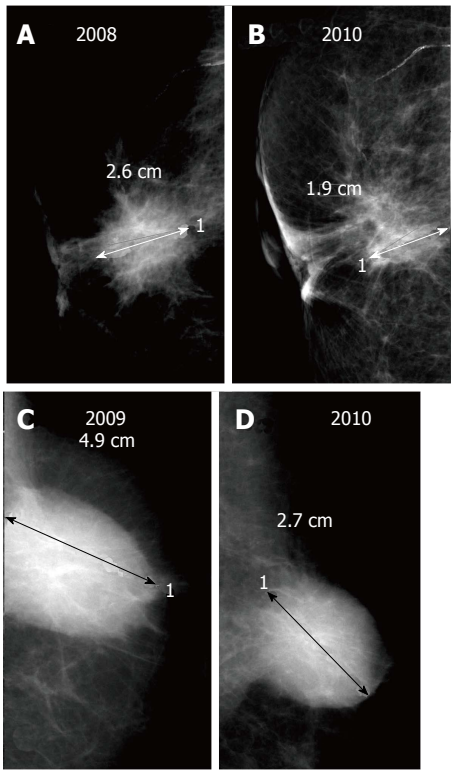

Figure 2 Two different patients post breast conservation. A and B demonstrate retraction of scar in right breast on follow up while C and D reveal serial decrease in size of a post-operative collection (seroma) in left breast.

mammograms, the lesion becomes smaller, irregular and denser as the seroma retracts and is replaced by fibrous tissue (Figure 2). However an increase in size on follow-up merits further evaluation to exclude a recurrent mass.

Post-surgical scar

A post-surgical scar appears as an area of architectural distortion contiguous with contour deformity of surgery. In comparison to a true recurrence which appears same on all mammographic views and has a dense centre; on different projections a scar has varied appearances (appearing less distorted on one) and demonstrates

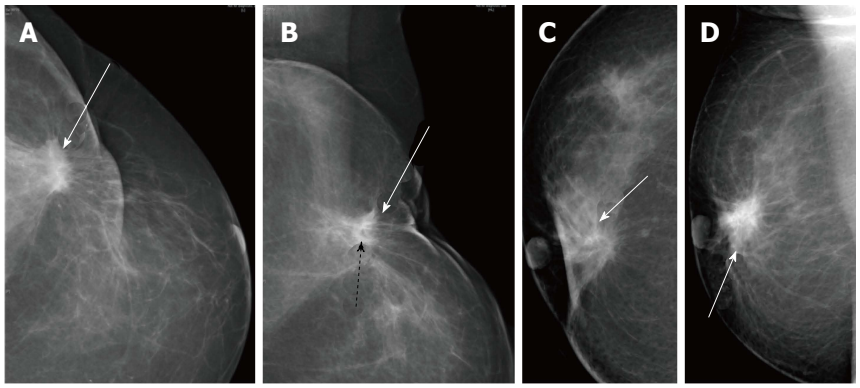

Figure 3 The scar usually decreases in density and/or size on serial imaging. A and B demonstrate a post-surgical scar in left breast which is contiguous with the skin contour deformity. Fat lucency (black dashed arrow) within the scar is seen on the MLO view in (B); C and D show the post-surgery scar (white arrow) on CC and MLO views having different morphology respectively; it opens up on CC view (C).

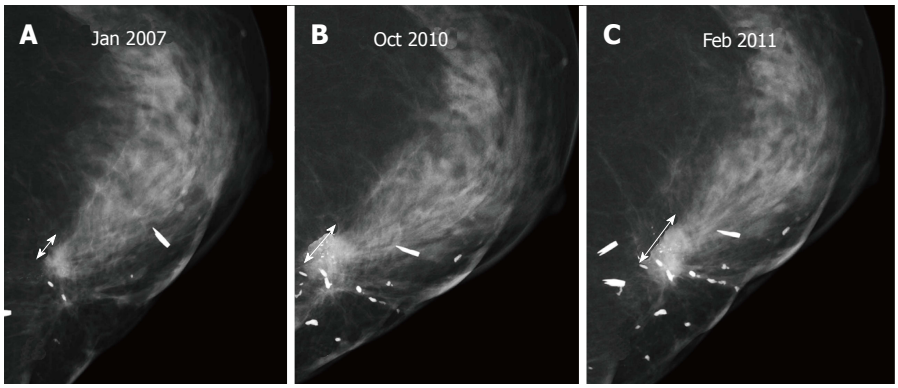

Figure 4 In a patient post breast-conserving therapy, scar (double headed arrow) is seen to increase in size at three (B) and four (C) years as compared to the initial mammogram shown in (A) which suggests recurrence.

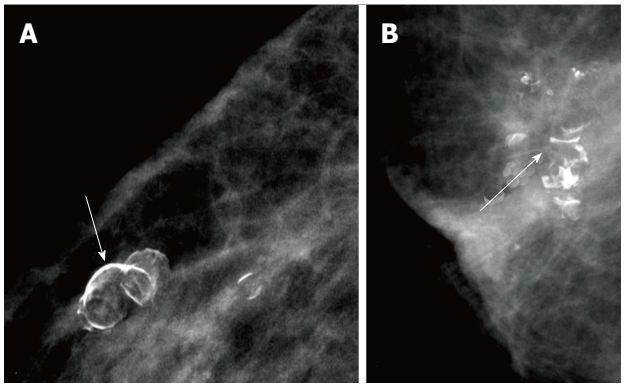

Figure 5 Calcifications associated with fat necrosis demonstrate a typical curvilinear or arc-like (arrows) morphology (A and B).

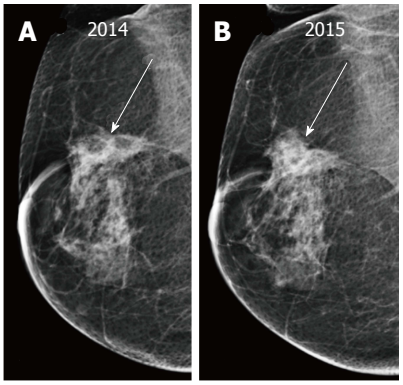

Figure 6 (A) Post breast-conserving therapy scar is seen in the right breast which appears to have increased in size on follow up mammogram after one year seen in (B). However fat lucencies are still seen within the lesion (which was better appreciated on tomography images). Patient underwent biopsy because of clinical suspicion of recurrence.

fat lucencies within[3]. These features may be better imaged on spot compression or magnification views. As with a seroma, the scar usually decreases in density and/or size on serial imaging (Figure 3) or remains stable while an increase in size or density is suspicious for recurrence (Figure 4).

Dystrophic calcifications and fat necrosis

Benign calcifications are seen on mammography in about a third of treated breasts beginning 2 to 3 years after completion of therapy due to a combination of surgical trauma and radiation. Morphologically these calcifications are large (> 5 mm) and irregular in outline with central lucencies, with no associated mass/density and always occur at the site of surgery[7].

Fat necrosis is tissue necrosis resulting from damage to the intima of arteries from surgery and radiation. It more commonly manifests as an oval or round lucency with curvilinear or arc-like peripheral calcifications which are characteristic for the same (Figure 5). It is a common complication of myocutaneous flaps usually seen after 6-12 mo of treatment[3] and may clinically present as a palpable mass that is firm or hard[8]. When it presents as a palpable lesion with atypical appearance on mammography, sonography followed by biopsy may become requisite to confirm the diagnosis (Figure 6)[9].

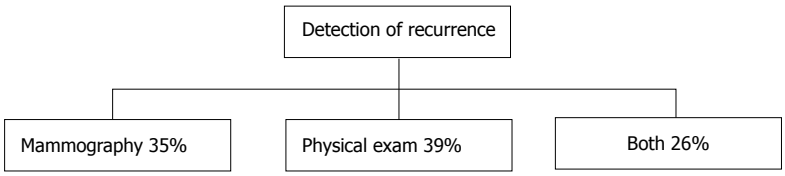

Figure 7 How are recurrences detected on follow up.

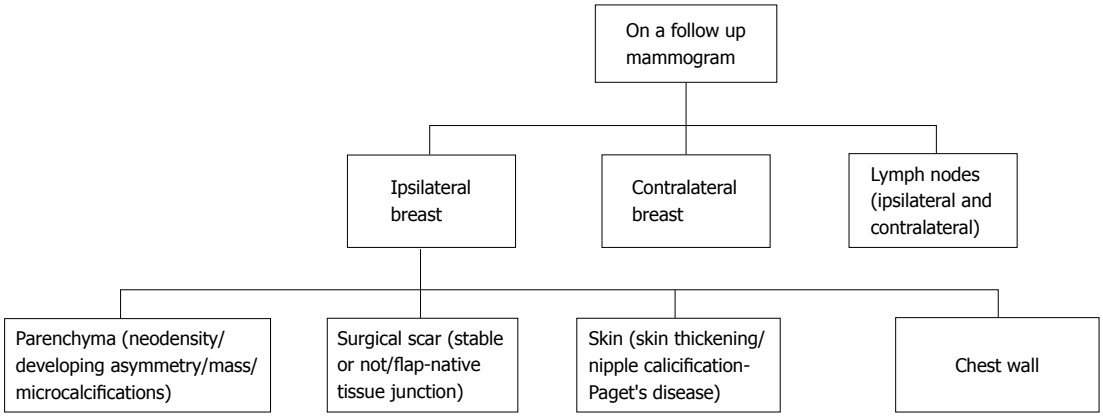

Figure 8 Sites for recurrent lesions.

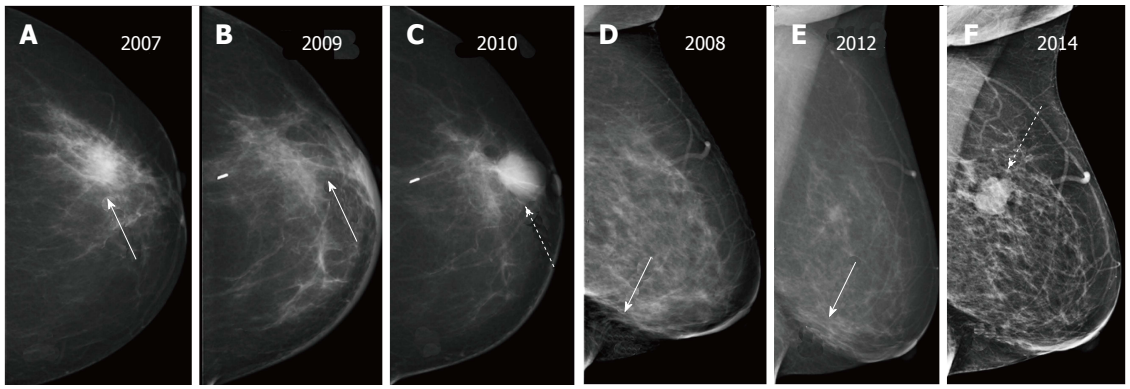

Figure 9 Two patients post breast-conserving therapy with recurrent masses. A-C show a recurrent mass (dashed arrow in C) appearing at the scar site (solid arrow in A and B) two years after surgery; D-F demonstrate a post-surgical scar in the lower aspect (arrow in D and E) and a recurrent mass (dashed arrow in F) in upper aspect - different quadrant than the primary.

WORRISOME MAMMOGRAPHY FINDINGS, *I.E.*, "RED FLAGS"

Recurrences may present at clinical examination or, may be detected only on mammography (Figure 7) as suspicious microcalcifications or masses. The rate of local recurrence after breast cancer surgery is 1%-2% per year[10]. Stability is defined as no interval change on two successive mammographic studies[7] and is generally observed at around 2-3 years after the completion of radiation therapy. Any retrograde change in imaging findings such as a new mass, microcalcifications, architectural distortion or an area of increased density at the scar site post stability should raise suspicion for tumor recurrence. Figure 8 lists the sites of recurrences to be looked for in conservatively treated breast on follow up.

Masses

Palpable recurrences usually manifest as masses and even when seen as microcalcifications on a mammogram, they have associated densities. The temporal changes from prior mammogram determine the approach to patients[11]. Recurrences may be perceived as an increasing asymmetry or an enlarging mass within the operative bed or a new mass (neodensity) away from operative site[10] (Figure 9). Any neodensity at mammography should be evaluated on ultrasound to determine whether it is solid or cystic (Figure 10), and solid lesions should be biopsied (Figure 11).

Up to 65% of early recurrences occur at or within a few centimetres of the site of original tumor, usually

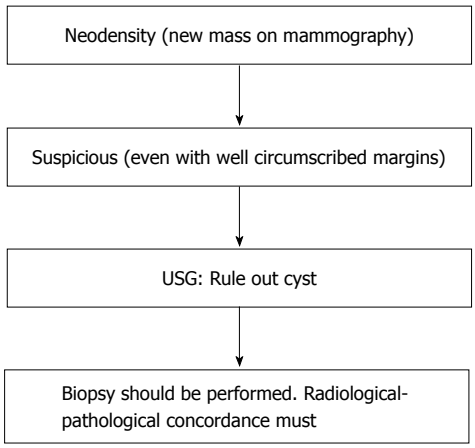

Figure 10 Approach to a neodensity.

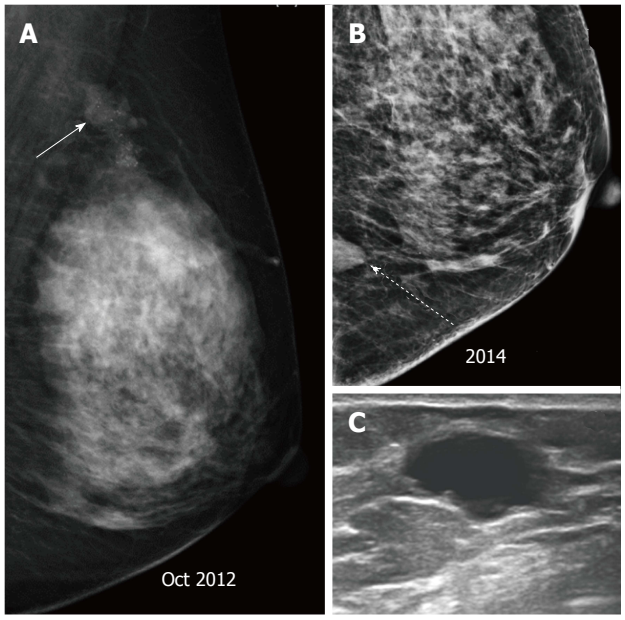

Figure 11 Patient with a left breast mass (arrow), who underwent breast-conserving therapy (A), (B) follow up mammogram at 2 years revealed a neodensity (dashed arrow) which on ultrasound (C) was found to be a cyst.

within 6-7 years of treatment[1]. At follow up imaging, it is essential to ensure that scar site is visible in two views (CC and MLO or additional views), at least in the first decade after surgery[6]. A new lesion or a neodensity which is suspicious may remain stable due to ongoing hormonal treatment, and stability does not indicate benign finding. Morphology is the most important criteria, and it is necessary to achieve a radiological-pathological concordance (Figure 12). Recurrence in the form of a developing asymmetry (Figure 13) has a 27% likelihood of cancer post BCT[12]. Post-oncoplastic or breast reconstruction, locoregional tumor recurrence is seen in 2.3%. The most common site of tumor recurrence is the contact line, at the junction of the flap with the native tissue[13] (Figure 14).

Microcalcifications

Microcalcifications that are casting, fine linear or

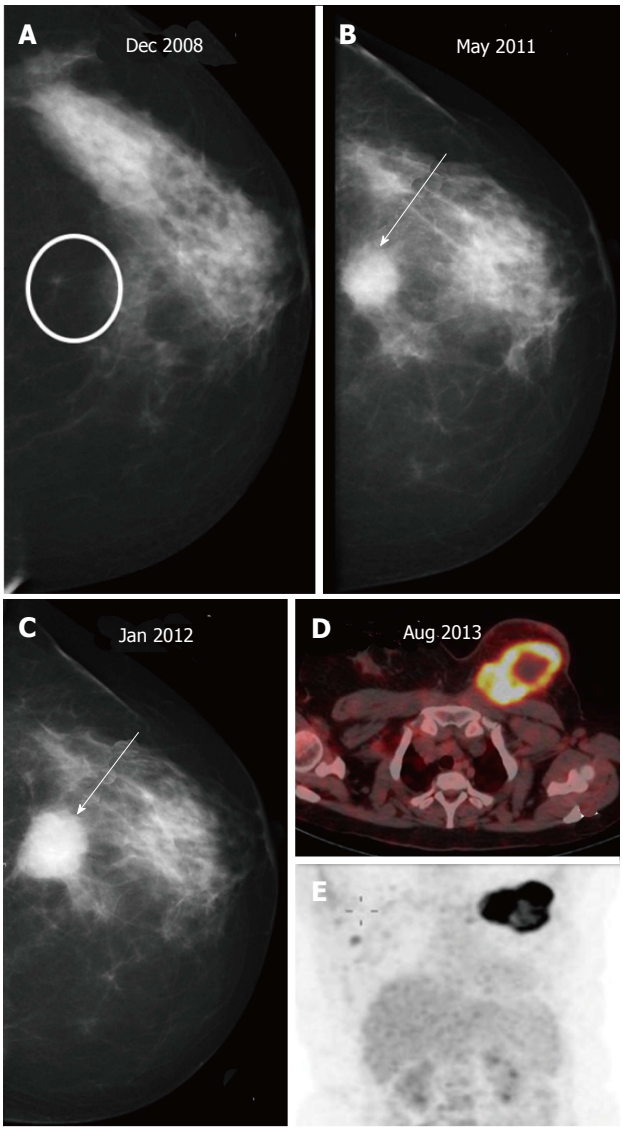

Figure 12 Morphology is the most important criteria, and it is necessary to achieve a radiological-pathological concordance. A-C: Patient underwent breast-conserving therapy for left breast carcinoma and on follow up imaging was found to have a developing asymmetry (circle in A) progressing to a mass (arrows in B and C). Biopsy and histopathology showed no evidence of malignancy however there was radiological and pathological discordance; D and E: Patient presented a year later with a large necrotic FDG-avid mass in the left breast. FDG: Fluoro-2-deoxyglucose.

linear branching and not typical of fat necrosis are suspicious. They are frequently similar in morphology to the primary cancer[7] (Figure 15). In an area of fat necrosis, fat like lucency is noted around or within the calcific densities, while in calcifications associated with recurrence, an associated mass density is seen in the region (Figure 16).

Skin thickening

Progression of breast edema or skin thickening after the first post-surgical, post radiation therapy mammogram is abnormal and should be investigated[14]. Increasing skin thickening is better appreciated on digital mammography as compared to screen film mammography.

Radiation induced sarcoma is a rare complication

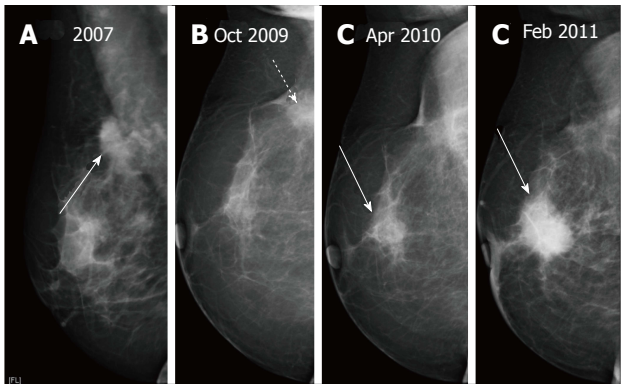

Figure 13 Patient with a right breast mass (arrow in A) who underwent breast-conserving therapy shows a normal post therapy mammogram at two years (B) with a post-surgical scar (dashed arrow), follow up imaging demonstrates a developing asymmetry in the retro-areolar region at three (C) years post therapy which subsequently developed into a frank mass (D).

which manifests as thickening of the skin or prominent trabecular pattern[15]. Angiosarcoma presents as a painless mass that may be associated with overlying blue or purplish discoloration of the skin (Figure 17).

Paget's disease: Incidence of Paget's disease in ipsilateral breast tumor recurrences ranges from 3.1% to 10.6%. Paget's disease following BCT or subcutaneous mastectomy and reconstruction in patients presenting with nipple changes is not uncommon and should prompt early biopsy of what could be considered post-RT nipple changes[16]. Microcalcifications in the nipple-areola region may be seen on the mammogram (Figure 18).

Axillary recurrence

Axillary nodal recurrence is relatively rare after adequate nodal dissection (of level Ⅰ and Ⅱ) has been done, occurring in 1%-3% of women[17]. Patients who present with axillary recurrence have metastatic disease at other sites in about fifty percent. On mammogram enlarged nodes may be seen (Figure 19).

ROLE OF DIGITAL BREAST TOMOSYNTHESIS AND VOLUMETRIC BREAST DENSITY

Digital breast tomosynthesis (DBT) as a technique entails imaging of the breast tissue in multiple sections (at varied angles) instead of a two-dimensional image as with conventional mammography. The overlap of parenchymal tissues is resolved thus reducing the false positives as well as adequately identifying true lesions thus increasing the sensitivity of a mammogram. DBT not only helps in triangulation of a lesion but also reduces the requirement for additional views and lowers the patient call-back rate. Studies related to digital breast tomosynthesis to date have primarily focussed on screening with fewer reports on its utility in diagnostic mammography. Most studies have concluded a definite advantage of DBT in dense breasts (*i.e.*, patients who have types 3 and 4 breast parenchymal

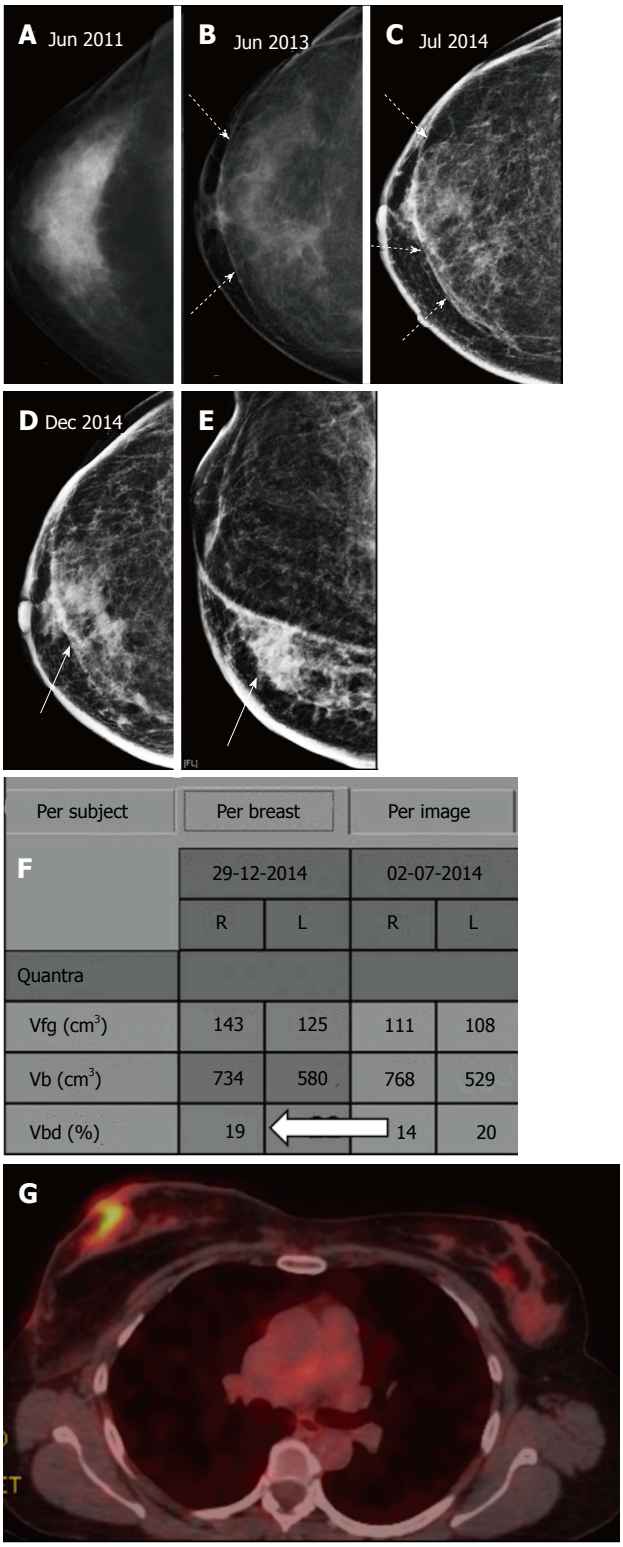

Figure 14 The most common site of tumor recurrence is the contact line, at the junction of the flap with the native tissue. A-C: Patient post right lumpectomy (A) underwent subcutaneous mastectomy with LD flap (dashed arrows in B and C); D-F: At three year follow up patient presented with a skin nodule which was seen as an asymmetric density at the junction of flap with native breast tissue (arrows in D and E) and an increase in volumetric density of right breast (F); FDG-PET study (G) showed that the nodule was FDG avid. Histology - IDC grade 3. FDG-PET: Fluoro-2-deoxyglucose-positron emission tomography.

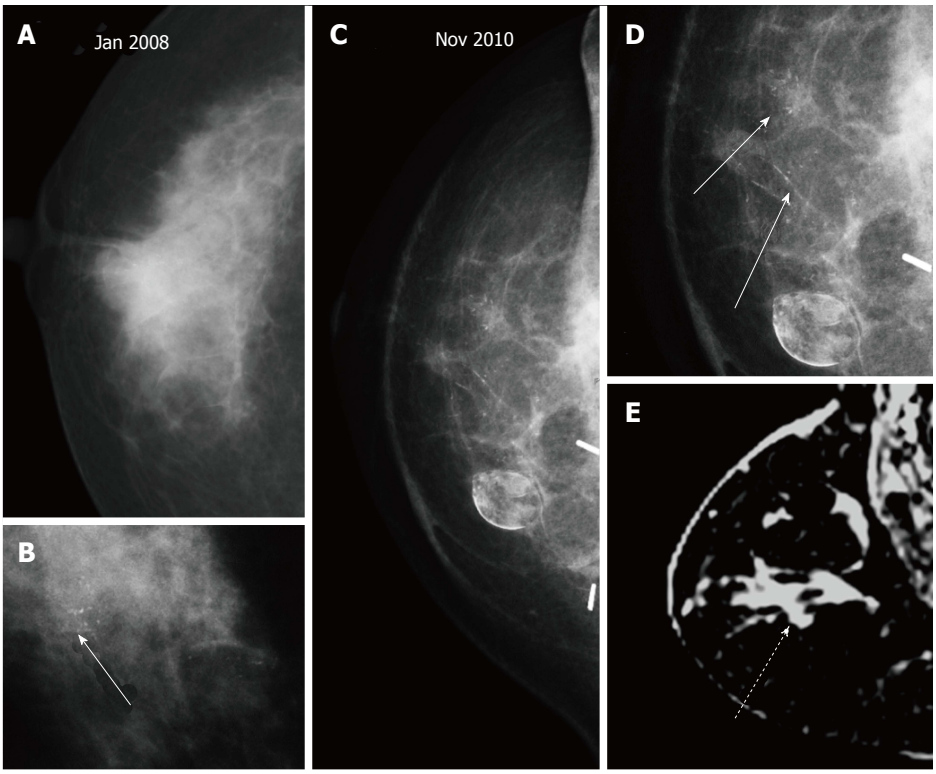

Figure 15 Microcalcifications. A, B: Patient presented with a right breast mass with microcalcifications (arrow in B) and underwent right breast-conserving therapy with latissimus dorsi flap; C, D: At two years post treatment casting microcalcifications developed similar to the index lesion, better appreciated on magnified view (arrows in D) are seen around the scar site; E: Breast MRI revealed non-mass enhancement (dashed arrow) in the right breast. Histopathology of the recurrence showed DCIS. MRI: Magnetic resonance imaging.

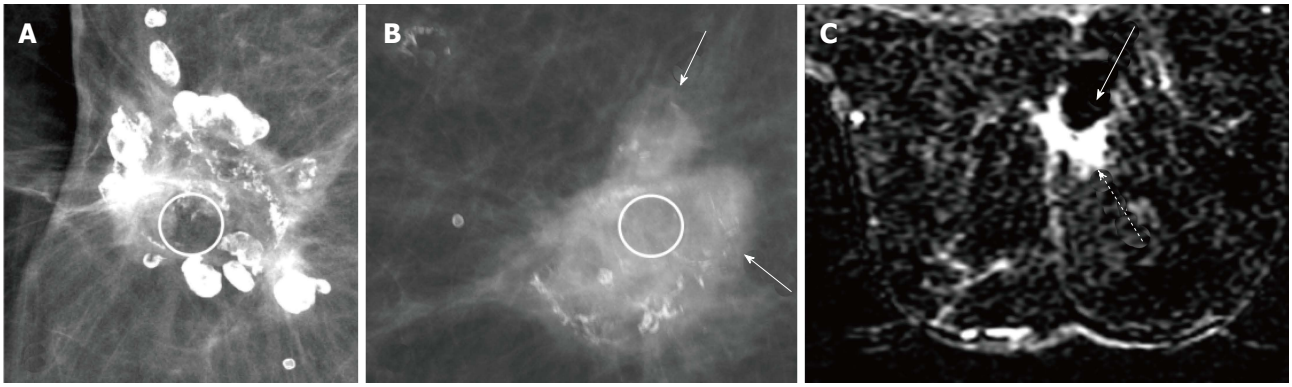

Figure 16 In dystrophic or benign calcifications, fat lucency (circle) is present within as seen in (A) while in calcifications associated with recurrence (arrows), the centre appears dense (circle) as shown in (B), (C) subtracted post contrast MRI image of the patient in (B) shows a seroma cavity (solid arrow) with an enhancing solid component (dashed arrow) in the periphery anteriorly.

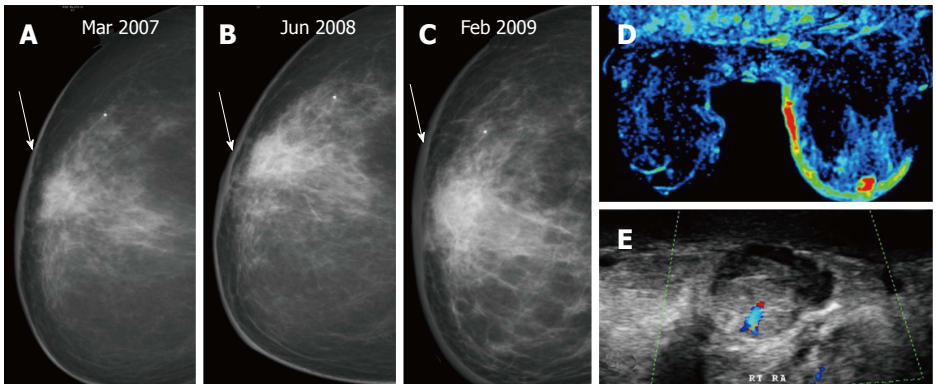

Figure 17 (A) In a post breast-conserving therapy patient, the skin thickness increases at one-year (B) and two-year (C) follow up mammograms; (D) dynamic MR perfusion reveals increased perfusion along the skin of the right breast and an enhancing focus, on ultrasound (E) an oval hypoechoic mass with increased vascularity is seen in the retroareolar region corresponding to the enhancing focus on breast MRI. Histopathology: Angiosarcoma. MRI: Magnetic resonance imaging.

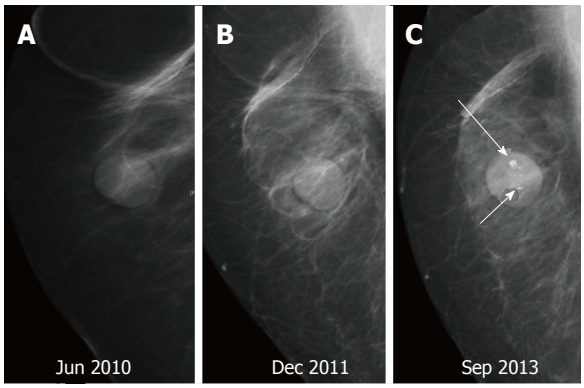

Figure 18 Microcalcifications in the nipple-areola region may be seen on the mammogram. A: Three year post breast-conserving therapy mammogram - normal. Patient presented with unilateral yellowish nipple discharge and no clinically palpable abnormality at five year follow up. MMG revealed microcalcification (arrows in C) in the nipple-areola region. Histopathology: Paget's disease of nipple; B: On retrospective evaluation, a tiny speck of calcification is seen in the nipple-areola region.

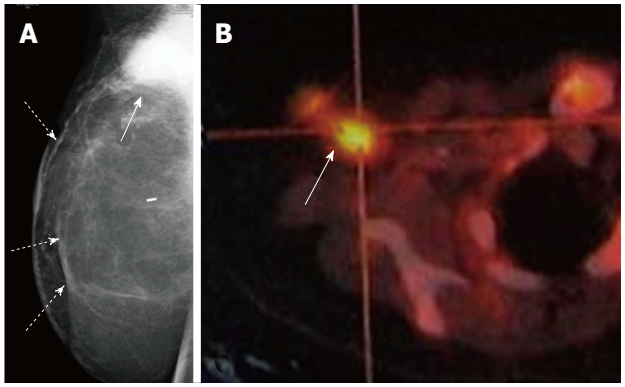

Figure 19 Patient underwent right skin sparing mastectomy with Deep Inferior Epigastric Perforator Flap (dashed arrows in A) and axillary and apical clearance, one year later she presented with right axillary nodes (arrow) on mammogram (A) which were FDG-avid on PET (B).

density) in terms of lesion characterisation[18].

Similar to screening mammography, DBT also helps resolve post conservation changes such as a scar or other asymmetric densities due to parenchymal edema from a true recurrence[19]. A recent study by Sia *et al*[20] also reported that DBT decreases the rate of indeterminate findings in surveillance imaging of conservatively treated breasts. The fat density within the scar and that associated with benign calcification is better appreciated on DBT (Figure 20) whereas a true recurrence would demonstrate a mass. Increase in the volumetric breast density (Vbd) allows for a quantitative assessment for recurrences particularly where the presentation is without a definite mass (Figure 21).

CONCLUSION

To conclude, mammographic appearance of the breast is altered in the post-operative setting and breast radiologists should be cognisant of features suggestive

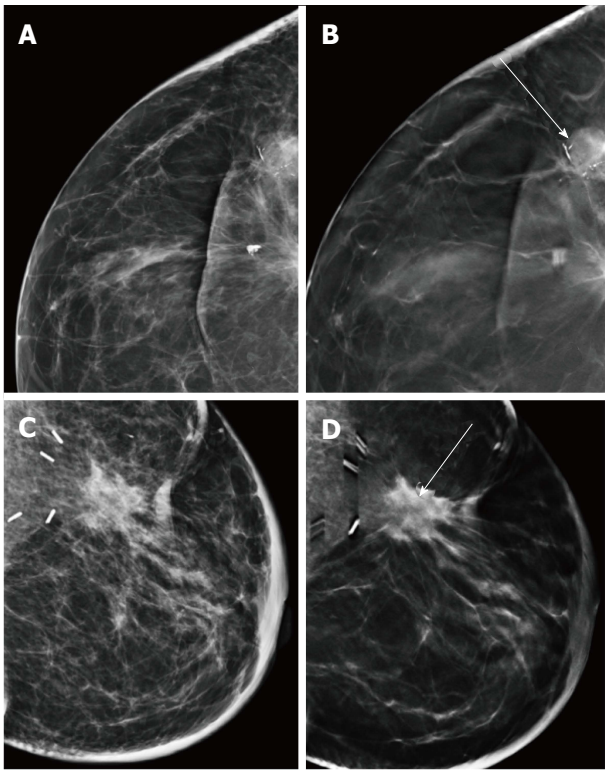

Figure 20 (A) and (B) represent conventional or 2D mammographic (A) and digital breast tomosynthesis (B) views of the scar site recurrence wherein mass density within the lesion is better appreciated on digital breast tomosynthesis (arrow); (C) and (D) show appearance of a scar on conventional or 2D mammogram (C) and digital breast tomosynthesis (D) where the fat lucency at the scar site is confirmed (arrow) on digital breast tomosynthesis.

of recurrent disease to identify it early. It is just as essential to be aware of the normal evolution of post therapy changes to avoid unnecessary further workup and stress to the patient. DBT and Vbd add incremental value in characterising normal and abnormal findings in this clinical setting. Not many studies have assessed the value of DBT over digital mammography with scope for research in this area in future.

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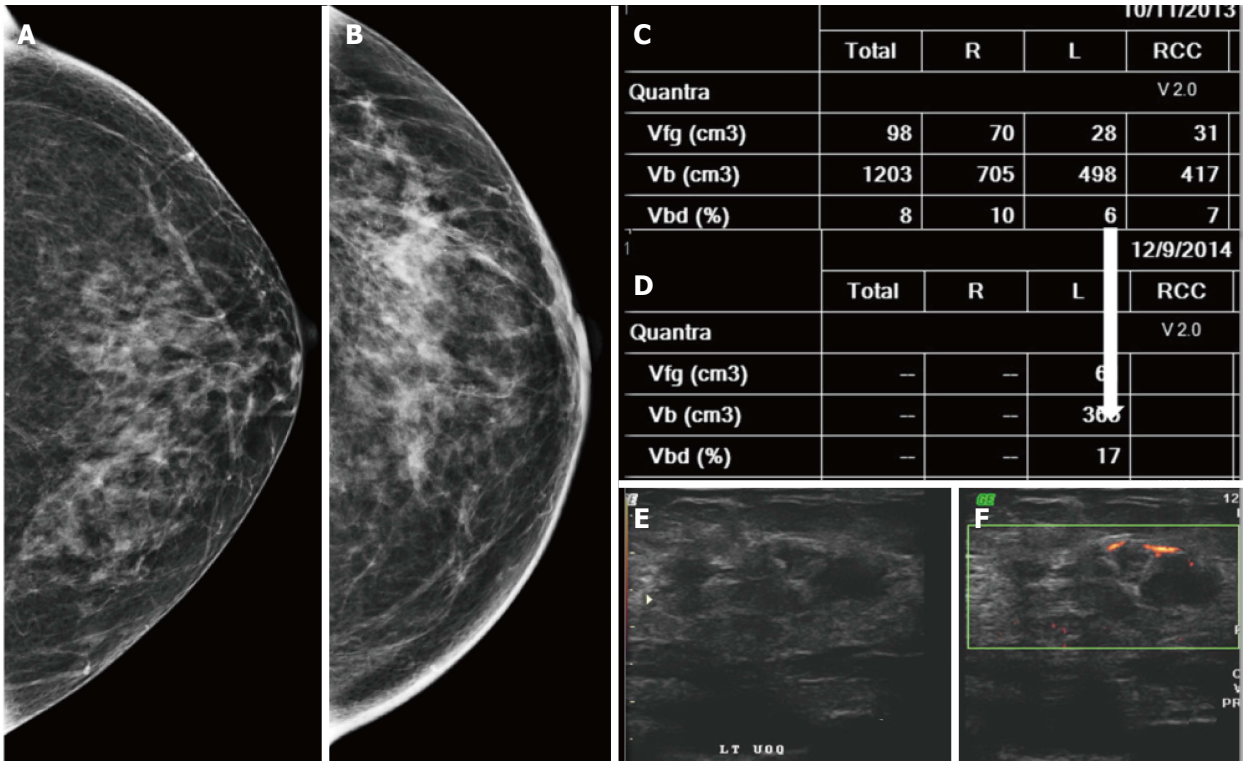

Figure 21 Patient underwent left breast-conserving therapy. On follow-up mammograms at five (A) and six (B) years a subtle increase in density is noted. On volumetric assessment (C and D), the left breast density increased from 6 to 17; E and F: Ultrasound and color Doppler revealed a heterogeneously hypoechoic mass in left upper outer quadrant with peripheral vascularity. Histology: IDC.

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