Signs of Benign Breast disease in 3D Tomosynthesis.

Poster No.: C-1860
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Pathology, Computer Applications-3D, Mammography, Breast
DOI: 10.1594/ecr2013/C-1860

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Learning objectives

To illustrate and analyse signs, specific for benign breast lesions in 3D Tomosynthesis.

The conventional primary mammographic features for diagnosing a benign breast lesion like mass, calcification and other secondary features (reference 1) are analysed with signs specific to 3D tomosynthesis without using additional imaging.

Background

The role of three dimensional tomosynthesis in margin analysis especially for malignant lesions is well known (reference 2). Three dimensional tomosynthesis has specific signs in lesions for categorization of Benign & Malignant pathology resulting in efficient & effective diagnosis. Three dimensional Tomosynthesis has been found to reduce recall rates (reference 3, 4) because of better assessment and categorisation of breast lesions.

In a setting of Screening mammograms it is very important to identify the benign lesions correctly and the various signs help us in doing this. In two dimensional mammography breast lesions are analysed for Primary features like masses & calcification. However due to overlap of tissue even palpable masses can be missed. And Secondary features of asymmetry & architectural distortion are invariably recalled for additional evaluation. Spot and magnification views are needed to resolve calcification whilst tangential views are needed for skin lesions (reference 2).

However in a setting of screening mammograms where bulk of the lesions are benign or normal it is very important to identify them correctly and the various signs help us in doing this.

Imaging findings OR Procedure details

The study was conducted in the Department of Radiology, Apollo Speciality Hospital over a period of 7 months. All patients who were referred to our department for mammography over a period of 7 months (1st June 2011 to 31st December 2011) underwent combined view mammography (2D FFDM + 3D Tomosynthesis) in CC and MLO views. Informed consent was obtained for the same, after explaining the details of the procedure including
the incremental radiation dosage (reference 5) during the combo mode as opposed to a conventional 2-view mammogram. These patients were further subjected to either image guided trucut core tissue biopsy or FNAC (in case of cystic lesions).

Totally 1340 combo view mammograms were studied over a period of 7 months. Out of these 189 patients with 200 abnormalities in 2D full field digital mammogram which were biopsy proved were included in the study. Of the 200 abnormalities there were 164 mass lesions.

A total of 119 cases of focal asymmetry and architectural distortion were analysed during the entire duration of our study. Of these in 63 cases (53 %) were resolved as normal glandular parenchyma in 3D tomosynthesis slices and this was confirmed by ultrasound or were follow-up studies therefore did not require any additional imaging or histopathological evaluation. The remaining 56 cases (47%) underwent histopathological evaluation.

The 3D tomosynthesis unit used in our study is capable of dual functionality. The mammographic technique involves a combination of 2D FFDM with 3D tomosynthesis which takes a total acquisition time of 13 seconds. This is immediately followed by the 2D Full Field Digital mammogram in the same compression thus eliminating the need to re-position the breast. Typical exposure parameters are 25- 30 kVp and 55-76 mAs . Combo mode (2D +3D) has a dose of 2.5 to 2.8 mGy whereas 2D full field digital mammogram has a dose of 1.7 - 2.0 mGy with an incremental radiation dosage of 0.5 - 0.8 mGy for tomosynthesis per view for a single breast of average thickness.

After acquisition, the data from the projection images are used to reconstruct between 50 and 90 parallel 1-mm-thick slices (i.e., the 3D Digital Breast Tomosynthesis data set), depending on the thickness of the breast in ≤ 2 seconds.

Interpretation of combo mode mammogram images of the patients in the study was done by two Senior Radiologists with more than 10 years’ experience in reading mammograms who were trained in interpreting 3 D tomosynthesis . The workstation, which is PC based, includes two 5-megapixel LCD displays with a mammography workflow keypad. Images could be magnified to full acquisition resolution by a free-moving magnification box with additional provisions for contrast adjustment and measurement.

The operator can view the images one at a time or display them in a ciné loop. As the 2D and 3D mammograms were acquired in the same compression, images from these two modalities are completely co-registered.

2D Digital Mammogram and 3D Tomosynthesis images were analysed for the following features (Fig1 ):
PRIMARY

1. Masses or opacities were analysed for

Margin

Internal architecture / Content

Plane of mass

2. Calcification

Mach effect - calcification seen in the single slice with a tiny halo

Localised - to one or two, 1-2 mm slices

Association with a benign mass.

SECONDARY

3. Asymmetric density & Architectural distortion

Vanishing margin sign - prominent glandular parenchyma

Sign of linear densities - duct ectasia.

Three dimensional tomosynthesis is able to resolve overlapping margins and correctly categorise the lesions as malignant (reference 7, 2) by identifying the spiculated or microlobulated margin. In benign lesions the "mach" effect or the surrounding lucency or the complete 'halo' helped in correctly categorising the lesion (reference 2) Halo sign-fine radiolucency (1-2 mm) that surrounds circumscribed masses and is highly predictive of a benign mass (Fig 2) and this can be seen in the individual slices obviating the need for spot views. Incomplete halo sign should raise the possibility of a malignant lesion especially in a high risk patient and should be ruled out by histopathological evaluation.

The internal contents of mass lesion in conventional two dimensional could not be assessed especially in parenchymal patterns 3 & 4 or if they were overlapped by glandular tissue. Analysis of individual slices shows the density of the mass better which can be assessed and compared with the adjoining parenchyma. The presence of a pseudo capsule & 'mixed density', glandular and lipomatous elements within the lesion are indicative of a fibroadenolipoma. (Fig 3 ).Ill-defined 'dirty lucent areas' in the mass are highly suggestive of an infective pathology ( Fig 4).
Lesions in the superficial plane like skin or subcutaneous plane can be correctly diagnosed in by identifying the plane of the lesion using the proximity to the skin or from the slice locator. (Fig 5).

Calcifications were categorised into macro and micro calcifications. Macro calcifications were confidently detected with 2D FFDM alone. However the smaller micro calcifications posed a challenge in 2D where tomosynthesis provided additional information. Calcifications classified as benign, indeterminate or malignant.

The pattern of micro-calcifications in breast lesions have were analysed and categorised as malignant if their morphology was typically pleomorphic, fine, linear, branching, with a linear / segmental distribution & associated with a malignant lesion (Fig 6).

Benign calcifications have a typical morphology and are dependent on their location and distribution in the tissue (dermal, vascular) and pathology (fat necrosis plasma cell mastitis) for diagnosis. The tiny dermal calcifications can be identified by their proximity to the skin from the slice locator (Fig 7). Morphological analysis of rounded calcifications of fibrocystic disease with their tiny 'halo' and fat necrosis with the central lucencies can be made out in the individual slices. If the calcification is associated with a mass, the margin analysis of the mass gives a good idea of the nature of the calcification (Fig 8).

Indeterminate calcifications are diffuse, sometimes clustered in distribution and amorphous coarse heterogeneous (Fig 9) were difficult to categorise by tomosynthesis and however required additional views like spot compression and magnified views followed by biopsy. Out of 14 cases of indeterminate calcifications biopsied 10 turned out to be benign while 4 were malignant.

In 63 cases this sign of 'vanishing' margins in three dimensional tomosynthesis categorised the lesion as Birads 1 or 2 without additional imaging or biopsy. This presence of asymmetrical density in benign lesions is due to tissue overlap and requires spot compression views to assess the margin. Analysis of the slices correctly predicted the absence of a definite margin. The characteristic distribution of lucent & dense tissue within the asymmetry with absence of convex margins (Fig 10) confirms the presence of normal fibro glandular parenchyma. Studying the looped images of the 1 mm slices of 3D tomosynthesis (Fig 11) can resolve the density as a prominent glandular tissue if the margins in the individual slices are not convex or spiculated.

Linear densities of duct ectasia also present as asymmetric density or architectural distortion (Fig 12).

Images for this section:
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**Fig. 1:** Feature analysis of BENIGN SIGNS.

![Feature analysis of BENIGN SIGNS](image1)

**Fig. 2:** There is a complete halo sign around an ovoid opacity with a speck of calcification, which in 2D is obscured by the overlapping dense parenchyma.

![Fig. 2: Halo sign around an ovoid opacity with calcification](image2)
Fig. 3: 2D and 3D MLO views of the right breast, in a 43 year old female who presented with a malignant mass in the left breast also, had a vaguely palpable lesion in the right breast. The fibroadenolipoma which is faintly appreciated in 2D image is well seen in the in 3D tomo slice, with the thin pseudocapsule and mixed density of glandular lipomatous elements within.
Fig. 4: Poorly defined mass in the MLO in a 42 year old woman who presented with a hard, palpable abnormality in her right breast. On Tomosynthesis slice, ‘dirty’ lucencies were appreciated within the mass, which were more in favour of an inflammatory pathology than malignancy.
**Fig. 5:** Ovoid opacity in the inner aspect of left breast which in tomo slice is seen in the superficial plane. This is confirmed by the appearance of skin pores and the position of the slice in the locator bar at the 'F' foot end is a flat wart in the inferior surface of the breast.
Fig. 6: Clusters of pleomorphic microcalcifications associated with a spiculated lesion in right superior aspect.

Fig. 7: Left breast shows few calcifications in the medial aspect (top). On tomo slices they are localised in the dermal layer where the skin pores are visualised (bottom)
Fig. 8: Peripherally placed benign calcifications within a fibroadenoma shows “halo” around the calcifications and mass due to the mach effect in 3D slices (bottom and left)
Fig. 9: Clusters of indeterminate microcalcifications in retromammary zone on 2D (right) identified by CAD (triangle marker). Morphology of these calcifications is better appreciated in 3D tomo slice. However the calcifications with associated lesion was more obvious in ultrasound (bottom) and HPE was fibroadenoma.

Fig. 10: Focal asymmetry in the upper quadrant of left breast which on tomo slices does not show any definite convex margin and is therefore suggestive of normal dense glandular parenchyma.
**Fig. 11:** Cine loop clip shows the resolution of the focal asymmetry as normal glandular parenchyma with vanishing margins.

**Fig. 12:** Duct ectasia in two different patients. Linear densities representing ectatic ducts in the 2D MLO view, is better appreciated in 3D slice (arrows). Ovoid opacity in the upper quadrant (in the 2nd set of images) is seen in line with a linear density on 3D tomosynthesis slices and is cystic dilation of the duct. Note the speck of benign calcification with "halo" in the same image.
Conclusion

A comparative analysis of the various signs in benign breast lesions showed 3D tomosynthesis to have a higher pick-up rate than 2D FFD for almost all the signs (Fig 13).

Two dimension FFD mammography overlap of tissue can obscure the margin of a mass rendering it invisible or difficult to categorise as benign or malignant (Birads 0, 3, 4). This entails recalling the patient for additional tests like ultrasound or additional views to reconfirm. The ability to scroll through the three dimensional data set for a particular view helps in eliminating the overlap of tissues seen in two dimensional images and better resolution of the internal contents, leading to better diagnostic capabilities.

In a tropical country like India non-lactational breast abscess is a diagnostic dilemma and can occur in diabetics (reference 8) and in tuberculosis (reference 9) which is prevalent in our population. Both these lesions clinically and in the 2D mammogram present as non-tender mass and mimic a malignant lesion.

In our series, secondary features of asymmetry & architectural distortion were seen in 119 cases. Of these in 63 cases (53%) were resolved as normal glandular parenchyma in 3D tomosynthesis slices and did not require any additional imaging or histopathological evaluation. The remaining 56 cases (47%) underwent histopathological evaluation and of these 61% turned out to be malignant after 3 dimensional tomosynthesis (Fig 14).

Three dimensional tomosynthesis was able to assess the microcalcifications in individual slices and the slab thickness also can be altered and this feature increased the level of confidence in diagnosing benign breast calcifications. However indeterminate calcification can be a problem. Calcification were detected in the 2D images and CAD was very useful in locating them.

Though the primary role of screening mammography is early detection of breast cancer it also involves effectively ruling out the presence of malignancy and reassuring the vast majority of the women who come for screening mammogram. In this context, these signs which are specific for benign breast lesions in 3D tomosynthesis have the potential to become invaluable tools for the radiologist to categorise benign versus malignant lesions as they improve the confidence level.

It also reduces the need for time consuming additional imaging such as special mammographic views or sonomammography, thereby increasing the efficacy of the test by reducing the additional radiation dose, time and money. At the same time it alleviates patient's anxiety, by avoiding unnecessary recalls and increasing patient throughput.
Fig. 13: Histogram depicting the comparative distribution of various signs in 2D full field digital mammogram and 3D tomosynthesis
Fig. 14: Analysis of asymmetry and architectural distortion by 3D Tomosynthesis.
References

1. Sickles EA. Mammographic features of 300 consecutive non-palpable breast cancers. AJR 1986; 146: 661-676.

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