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RESEARCH ARTICLE

A STUDY OF MAMMOGRAPHY AND HIGH RESOLUTION ULTRASONOGRAPHY IN VARIOUS BREAST LESIONS

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Abstract

Sonography was used in Breast Imaging as it had an advantage in Breast Cancer Imaging. The functional unit of Breast is the terminal ductolobular unit (TDLU) , which of the site of origin of most breast pathology and abberations of normal development and involution(ANDI).Mammary gland projects as a triangle in mammogram.Mammographic patterns of normal breast and its relationship with carcinoma are described as N1,P1,P2 and DY. P2 and DY show higher risk of developing carcinoma than N1 and P1.Mammographic compression pulls a lesion away from the chest wall and Sonographic compression pushes close to it.BIRADS helps in standardising sonographic, mammographic clinical abnormalities.The combined use of X ray Mammography, High resolution Ultrasonography and use of BIRADS categorisation helps in diagnosing breast lesions effectively.sonography helps in evaluating palpable lumps when there is dense tissue in the area of palpable lump on mammography.sonography helps in preventing biopsy by showing a normal or a definitively benign findings.mammogram is an effective non invasive means of searching for breast cancer.this study is done to increase the awareness among women population to go in for early screening of breast lesions.

INTRODUCTION

Breasts form an important secondary sexual feature of females and are the source of nutrition for the newborn and hence the mankind. They have also got a lot of aesthetic significance in the modern perceptions.

Like any other organ system, breasts harbour a spectrum of diseases of diverse etiologies like infective, developmental, neoplastic etc. Of these breast cancer is the most dreaded one, since it remains the chief contributor to female mortality worldwide. Hence it is imperative to detect the cancer at the earliest, i.e., in the preinvasive stage and treat them promptly. Expeditious diagnosis and management of other breast conditions is also essential for female well being. Herein comes the vital role of diagnostic imaging.

First in 1913, Albert Solomon, a surgeon at the Berlin University demonstrated the usefulness of radiography in the study of breast cancer. Since then mammography as an imaging tool has evolved a great deal in the technological aspects as well as in clinical applications.

Today's high-end, fully dedicated mammographic equipments feature effective compression device, suitable target material producing x-rays of optimal energy, automatic exposure control, small focal spot for magnification views, high tube output, etc. These have resulted in better quality images of high resolution and high contrast at a reduced exposure and reasonable cost.

On the clinical front, the eight great randomized screening trials have shown that mammographic screening substantially reduces breast cancer mortality. Hence, mammography is now firmly established as a screening tool for breast cancer and also as a problem solving one for various breast conditions, termed as Screening and Diagnostic Mammography respectively.

Sonography, though introduced in breast imaging only in 1950s, has earned itself a prominent status in today's breast imaging, thanks to the rapid improvement in technology and clinical utility. Among the imaging methods, US is second to mammography in most cases because of long experience with its use, accessibility and relatively low cost of the equipment, and the opportunity it affords for real-time guidance of aspiration or needle biopsy. It will be particularly useful in heterogeneous and extremely dense breasts, painful breasts and in the evaluation of palpable but mammographically negative masses.

It is also pertinent to note that multimodality imaging works better in the diagnosis and management of breast lesions than the use of mammography or physical examination alone. In our country, mammography and US are the two widely available and affordable modalities. This is especially true in hospital set up like ours.

To put all technological advances and clinico-radiological know-how accumulated so far, into effective use in our day to day practice is a real challenge. Hence this study is taken up to find out the role for Sonography and mammography in breast imaging. Sonography doesn't have a proven role in primary breast cancer screening, but its role after mammography is promising. The proven and approved role for breast ultrasound is diagnosis. Specific role for ultrasound are to prevent biopsies and to find malignancies missed by mammography.

OBJECTIVES

- To evaluate the diagnostic role of Mammography and High Resolution Ultrasonography in various breast conditions.
- To evaluate the imaging findings with serial clinical follow up and Histopathological examination of appropriate lesions.

REVIEW OF LITERATURE

HISTORY OF BREAST IMAGING:

In 1913, Albert Solomon, a surgeon at the Berlin University demonstrated the usefulness of radiography in the study of breast cancer. Further interest in X-ray imaging of breast was shown in Europe and U.S in the thirties of the last century. Notable workers in the field during this period include Stafford Warren, Paul Seabold, Ira Lockwood and Jacob Gershon. But mammography didn't find widespread clinical application since the breast images produced by conventional X-ray machines lacked in quality and diagnostic accuracy. Hegan attempted to design a special equipment for breast imaging in the early 60's of last century. But only in 1965, dedicated mammographic equipment was introduced by Charles Gros of France. This X-ray unit contained two innovations: a molybdenum target to produce low energy X-rays and a built in cone compression device to decrease the thickness of breast and immobilize it during exposure.

From then on, rapid strides made in the technological arena have resulted in the proliferation of high-end, fully dedicated mammographic equipments. Notable improvements include, effective compression device, suitable target material producing X-rays of optimal energy, automatic exposure control, small focal spot for magnification views, high tube output, etc. These have resulted in better quality images of high resolution and high contrast at a reduced exposure and reasonable cost.

Ultrasound refers to waves that have a frequency higher than 20,000 Hertz and are therefore outside our hearing range. It is a mechanical disturbance that moves as a pressure wave through a medium.

In 1880, French Physicists Pierre and Jacques Curie discovered the Piezo electric effect when they were 21 and 24 years old. French physicist Paul Langevin attempted to develop piezo electric materials as senders and receivers of high frequency mechanical disturbances (Ultra sound waves) through materials.

A number of piezo electric crystals occur in nature like Quartz, Rochelle Salts, Lithium sulfate, Tourmaline and Ammonium Dihydrogen phosphate. Common man made crystals are Barium Titanate, Lead Metaniobate and Lead Zirconate Titanate (PZT). The standard Piezo electric materials for medical imaging process has been lead Zirconate titanate.

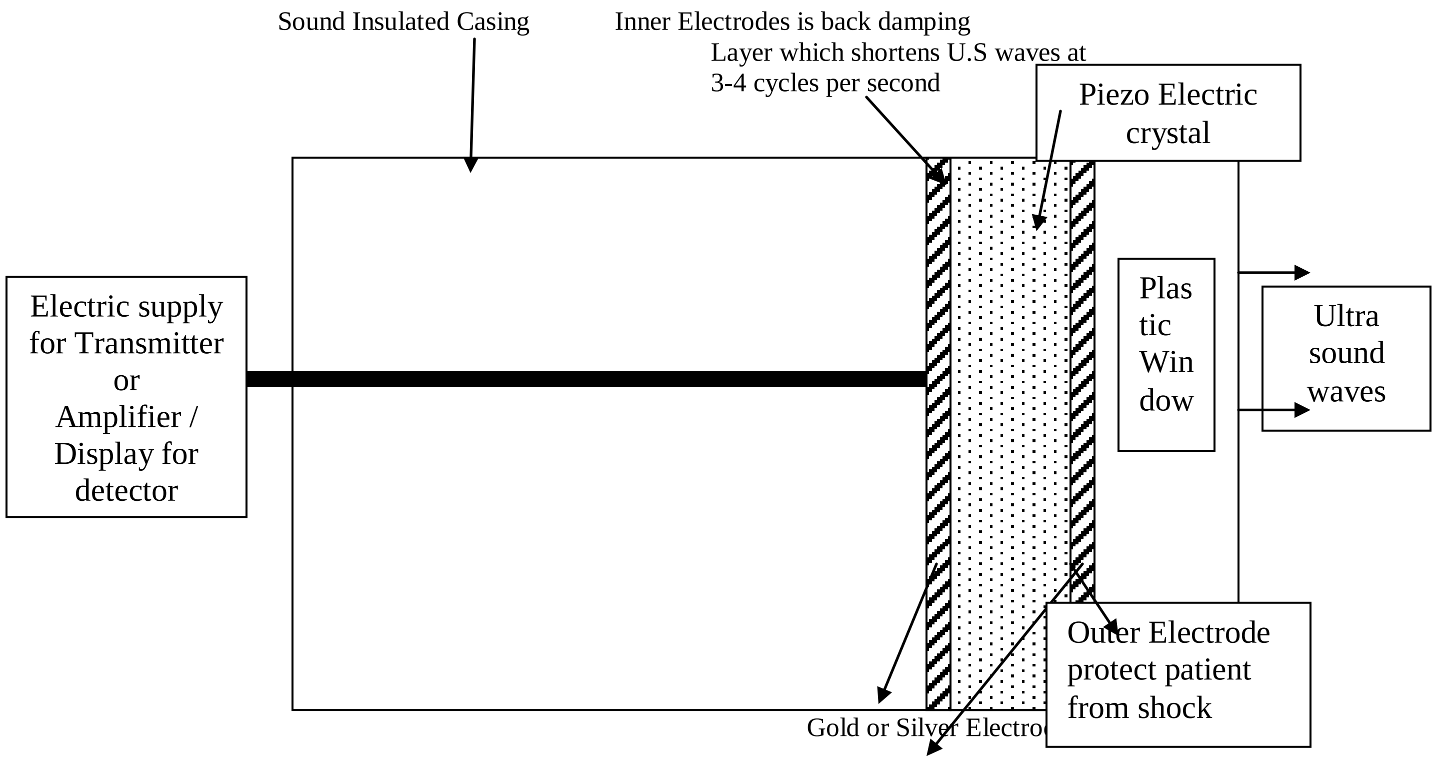
Ultra sound used for medical purposes is from 1 MHz (1 million cycles per second) to 20 MHz. Higher the frequency of ultrasound, shorter the wavelength. Ultrasound has a wavelength of about 1.5 mm.

The speed of ultrasound depends on what material or tissue it is travelling in. In soft tissues, sound travels at 1500 m / sec, in bone about 3400 m/sec, and in air 330 m / sec.

Ultra sound waves are produced by a Transducer. The transducer converts electrical signals to ultrasound waves and picks up the reflected waves converting them back into electrical signals. These signals are used to form pictures on a television screen.

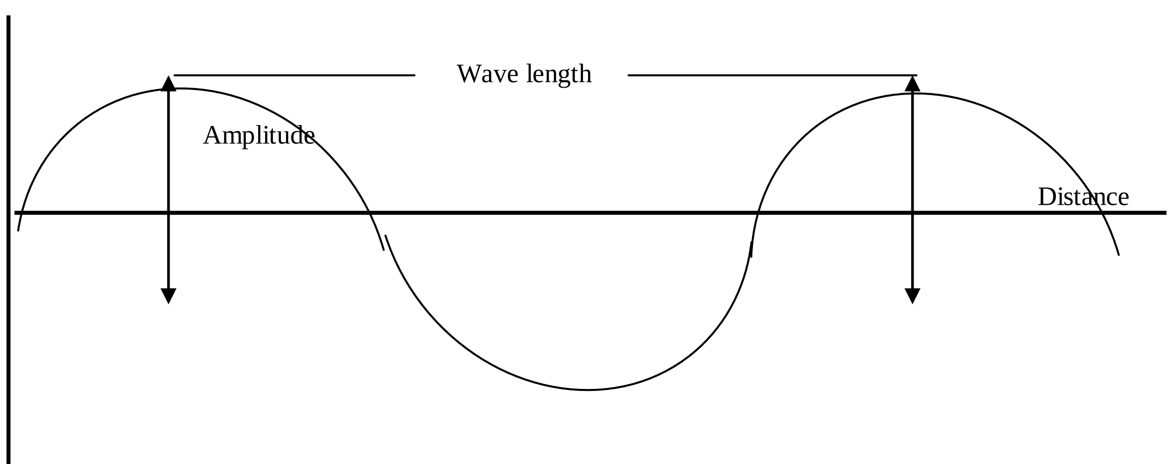
Ultrasound intensity is measured in Watts per square centimeter. Decibels are used to express the difference between ultrasound intensities.

ULTRA SOUND TRANSDUCER



Characterization of an ultra sound beam :

A zone of compression and an adjacent zone of rarefaction constitute one cycle of an ultrasound wave. The distance covered by one cycle is the wave length of the ultrasound wave. The number of cycles per unit time is referred to as the frequency of the wave, expressed in units of Hertz, kilo hertz, or mega Hertz where 1 Hz equals to 1 Cps.

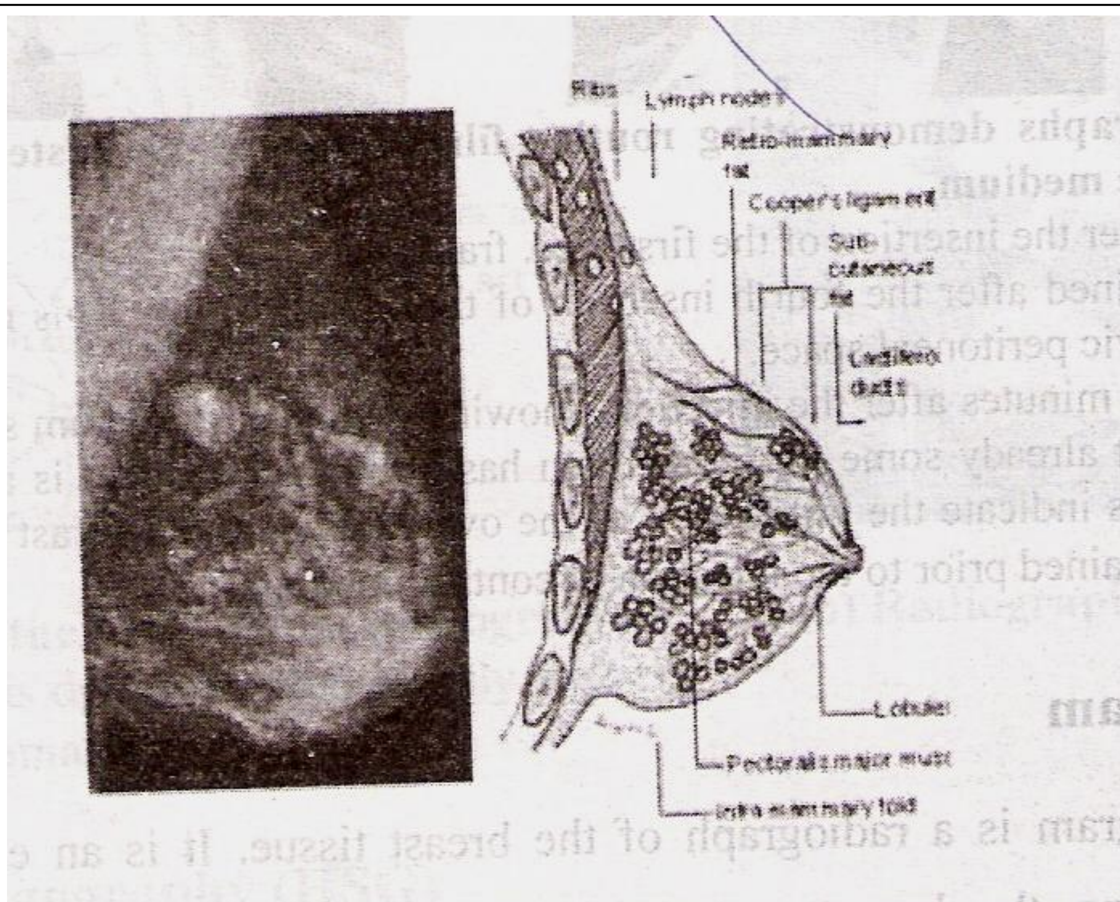


Sonography was used in breast imaging first by Toshio Wagai and his colleagues in Japan in 1951. Soon investigators around the world recognized the potential advantages of sonography in breast cancer detection; better techniques and equipments were developed. Diagnostic criteria for various breast lesions also evolved. Controversies also erupted over the ability of sonography as a screening tool. Various clinical studies conducted in 1980's showed that sonographic screening was far less effective than screen-film mammographic screening of asymptomatic women.

More recently, transducer devolopments, systems improvements and user experience have advanced US depiction of masses sufficiently to attempt classifying solid masses into categories defined by likelihood of malignancy.

NORMAL ANATOMY

The breast is a modified sweat gland that is composed of 15 to 20 lobules that are not well delineated from each other, that overlap and that vary greatly in size and distribution. Each lobe consists of parenchymal elements (lobar duct, smaller branch ducts, and lobules).and supporting stromal tissues (compact interlobular stromal fibrous tissue, loose periductal and intralobular stromal fibrous tissue, and fat), The functional unit of the breast is the terminal ductolobular Unit (TDLU), which consists of a lobule and its extralobular terminal duct. Each lobule consists of the intralobular segment of the terminal duct, ductules, and intralobular stromal fibrous tissue.TDLUs are important because they are the site of origin of most breast pathology and of aberrations of normal development and involution (ANDI) . Each fully developed lobule consists of 10-100 alveoli which open into ductules. The ductules in turn unite to form larger tributaries of lactiferous ducts.



MAMMOGRAPHIC ANATOMY

The mammary gland projects as a triangle on the mammograms. Within this triangle and separated from the skin by varying amounts of the more radiolucent adipose tissues lies the dense triangle pattern with the base towards the chest, composed of glandular tissue and lactiferous ducts with their connective tissue sheaths extending to the nipple.

There are 3 major types of breast tissues seen on breast imaging- fibrous, glandular and adipose tissues. Since the fibrous and glandular tissues have nearly the same Z number, they cannot be separated adequately on the mammogram and therefore the term “fibro glandular tissue” best describes these structures. Adipose tissue is more radiolucent than fibro glandular tissue and provides the necessary contrast on the mammograms.

Between the superficial layer of superficial fascia and the skin lies a definite layer of subcutaneous adipose tissue which appears radiolucent on a mammogram and varies from a thin layer in the young virginal breast to a thickness about 1 cm in a woman approaching menopause.

On the cranio caudal view the denser inner triangle composed of glandular tissue, possess varying degrees of diffuse opacity, the contrast being dependent upon the amount of fat present. A reticular appearance is caused by the stroma or connective tissue frame work which may be nearly homogeneous in the very dense virginal breast. In the less dense breast, intermediate degree of fatty deposition, ducts and trabeculae are clearly outlined. The fatty atrophic gland may have a nearly homogeneous ground glass appearance, with few ducts and trabeculae obvious or it may have a prominent trabecular pattern superimposed on the fatty background.

On the mediolateral or oblique view the reticular pattern is almost entirely replaced by gross striation composed of the duct, their associated connective tissues and trabeculae. These supporting structures course fairly straight towards the nipple in the upper portion of the breast but are concave upwards in the lower portion of the breast. In this projection, the lower border of the glandular tissue has a smooth convex outline, caused by the weight of the gland on the supporting strands, perhaps with a lobulated appearance. The upper border of the glandular tissue is less distinctly outlined against the subcutaneous fat. A saw tooth pattern is often produced if the glandular tissue is supported at unequal levels by the suspensory ligaments. The suspensory ligaments may not be well developed and may end as thin prolongations in the skin.

MAMMOGRAPHIC PATTERNS OF THE NORMAL BREAST (MODIFIED WOLFE)

It is worth while to mention the 15 years study of John N. Wolfe in which he described the various mammographic breast patterns and their relationship to risk for developing carcinoma.

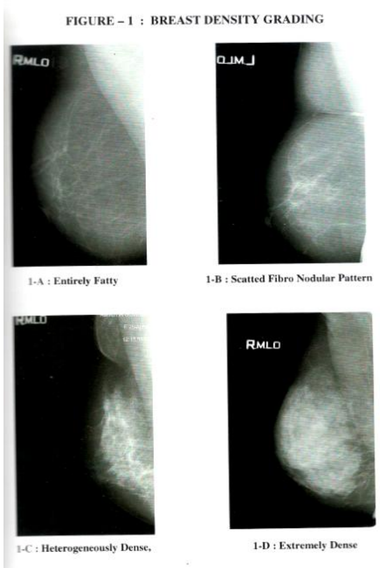
N1: The breast is composed primarily of fat often with a trabeculated appearance.

P1 : Prominent ducts occupy one fourth or less of the volume of the breast.

P2 : Prominent ducts occupy more than one fourth of the volume of the breast.

DY : Mammary dysplasia is severe.

P2 and DY patterns of breast show a significantly higher risk of developing carcinoma than N1 or P1.



APPROACH TO EVALUATION OF MAMMOGRAMS

When evaluating a mammogram one should look for masses, areas of asymmetry or architectural distortion and microcalcifications. When a parenchymal mass is identified, one should concentrate on certain important features, namely: shape of the lesion, the margin characteristics, the radiographic density, and the location of the lesion as well as the number and sizes of the masses.

These features help to guide development of a reasonable differential diagnosis and appropriate management. Malignant masses tend to be, typically, irregular in shape, higher in density with spiculated margins, although exceptions to this can occur.

Pleomorphic microcalcifications occurring in clusters suggest the presence of suspicious mass lesions. Areas of asymmetry or architectural distortions frequently require additional views and/ or biopsy for further evaluation.

ULTRA SONOGRAPHIC ANATOMY

For adequate performance and interpretation of breast Ultrasonography, normal breast anatomy and landmarks must be understood thoroughly and certain unique features must be kept in mind.

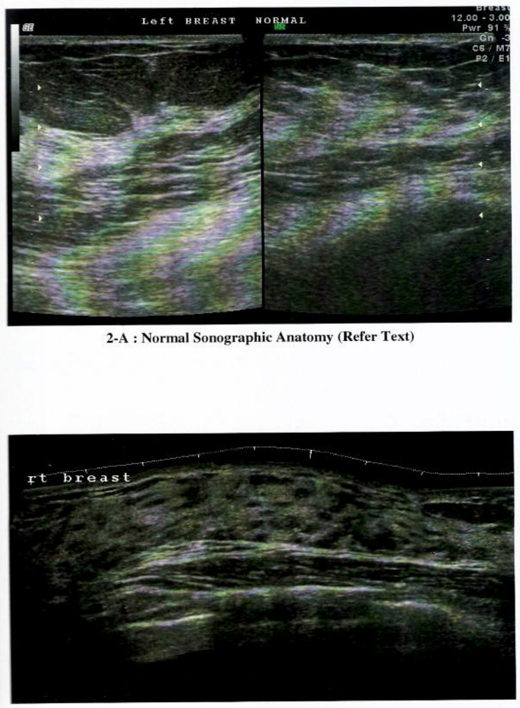
Unlike in other areas of the body, fat within the breast tends to be relatively hypoechoic, whereas the parenchymal or fibroglandular tissue is more echogenic or of fixed echogenicity.

The skin of breast, usually 1 to 3 mm thick, is imaged as echogenic lines with a very thin hypoechoic zone between them. This is best appreciated with whole breast scans or when a fluid offset is used.

Immediately beneath the skin are prominent rounded or oval fat lobules, which appear as relatively homogeneous, hypoechoic structures. These may be demarcated or interrupted by echogenic Cooper's ligaments that are believed to insert on the undersurface of the dermis.

The actual breast parenchyma is a cone of tissue that is demarcated by fascial planes. It is relatively echogenic or of mixed echogenicity, with thin curvilinear bands of connective tissue or

FIGURE – 2 : NORMAL SONOGRAPHIC ANATOMY



2-A : Normal Sonographic Anatomy (Refer Text)

2-B : "Extended View" of Breast

Cooper's ligaments extending through it. The fibrous tissue gives rise to stronger echoes than does the glandular tissue.

In the retroareolar region, branching ducts can occasionally be seen that are hypoechoic or anechoic. These are usually not visible when they are of normal caliber, but can be seen when they are dilated.

Beneath the breast parenchyma is a zone of hyper echoic retro mammary fat, posterior to which are hypoechoic sheets of pectoral muscle fibres, enveloped in discrete echogenic fascial planes seen as bright lines. The hypoechoic costal cartilages can be seen medially as either well defined oval structures or curvilinear hypoechoic bands, depending on transducer orientation. The calcified ribs are similarly imaged laterally, but unlike the cartilages, show posterior shadowing. Beneath the thoracic wall is the linear echogenic chest wall/pleura/lung interface.

LOCATION OR POSITION CORRELATION:

Because mammographic compression pulls a lesion away from the chest wall and sonographic compression pushes the lesion closer to the chest wall, lesions usually appear much closer to the chest wall on sonography than they do on mammography. Lesions that appear to lie several centimeters from the chest wall on mammography may appear to lie very close to, adjacent to, or might even indent the chest wall musculature on sonography. Lesions that would be considered in the B zone in depth on mammograms often lie within the C zone sonographically. If this routine apparent difference in depth of lesions on mammography and sonography is not understood, one might falsely conclude that the sonographic lesion lies too deep to correspond to the mammographic lesion.. Mammographic sonographic correlation of size, shape, location, and surrounding tissue density can be best made between the cranial-caudal (CC) mammographic view and the transverse sonographic view because there is little rotation and obliquity of the x-ray beam on the mammographic CC view.

NORMAL TISSUES AND ABERRATIONS OF NORMAL DEVELOPMENT AND INVOLUTION

Normal breast tissues and variations of normal tissues that include duct ectasia, fibrocystic change, or benign proliferative disorders can cause both mammographic and sonographic abnormalities. Some have termed these changes as ANDIs, aberrations of normal developments and involution.

BIRADS Nomenclature and Lexicon:

An official breast imaging reporting and data system (BIRADS) ultrasound lexicon is being developed by the ACR in hopes of standardizing reporting and data.

The sonographic BIRADS I category corresponds to sonographically normal tissues that cause mammographic or clinical abnormalities.

The sonographic BIRADS 2 category corresponds to benign entities and includes intramammary lymph nodes, ectatic ducts,simple cysts, and definitively benign solid nodules, such as lipomas.

The BIRADS 3 category corresponds to probably benign lesions that have a 2% or less chance of being malignant and includes some complex cysts, small intraductal papillomas, and a subset of fibroadenoma.

We divide the ACR BIRADS 4 category that is termed suspicious into two subcategories because it is so large, extending from > 2% risk to < 90% risk of malignancy.

The BIRADS 5 category is termed malignant and indicates a risk of malignancy of 90% or greater.

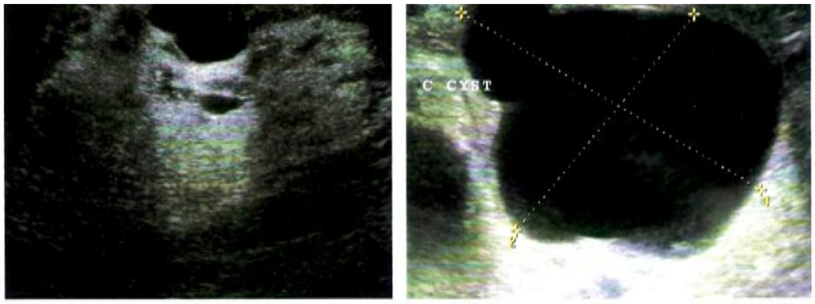
RADIOGRAPHIC & SONOGRAPHIC APPEARANCES OF SELECTED BREAST MASSES

i. SIMPLE CYSTS

On mammography, breast cysts usually appear as round or oval well defined masses. However their margins may be well defined or may be partly or completely obscured by adjacent fibro glandular tissue. On USG cysts as small as 2-3 mm can be diagnosed. A simple cyst is round or oval with very well defined borders, is totally anechoic, has an echogenic posterior acoustic enhancement. One or two thin internal linear septations may be allowed.

FIGURE –13: BREAST CYSTS – AN ULTRASONOGRAPHIC PROFILE

3-A : Small cysts 3 B : Large cyst with internal echoes



13-A : Small cysts 13-B : Large cyst with internal echoes

3 C : Cyst with mass within

A cyst may occasionally be confused with a very hypoechoic solid lesions. These lesions typically fill in rather uniformly with echoes as the gain setting is increased, whereas true cystic lesions will fill in from the periphery towards the center. If strict criteria for a simple cyst are met, the lesion is BIRADS2 and no biopsy aspiration, or follow up is necessary.

ii. COMPLICATED CYSTS

Usually present on USG as Hypoechoic lesions with posterior acoustic enhancement, but with multiple lower level echoes within the cyst fluid.

These may be due to thick proteinaceous material, debris or blood within the cyst. When these lesions do not show posterior acoustic enhancement they can be confused easily with solid abnormalities. Therefore, aspiration is often necessary. Complex and complicated cysts create a spectrum of lesions that can be characterized as BIRADS 2, 3or 4.

iii. INTRACYSTIC PAPILLARY LESIONS:

Intra-cystic carcinomas comprises less than 1% of all breast cancers, however, they have an excellent prognosis that is not related to their size. On mammography it appears as a well circumscribed dense lesion which may have a fuzzy posterior margin. On USG, it presents as cystic lesion with a solid protrusion from the wall of the cyst into the cyst fluid. Occasionally it may be present as diffuse irregular wall thickening with central fluid created as a result of necrosis. In most of these lesions aspiration cytology alone fails to yield malignant lesions.

iv. GALACTOCELE

It is usually found in lactating or pregnant women as a palpable doughy mass. On mammography, depending on the percentage of fat and its milk like content:

(i) It may not be radiolucent, appearing as a simple cyst.
(ii) It may be radiolucent with its thin wall clearly outlined.
(iii) There may be layering of the fat over the milk.

On USG a cystic or hypoehoic, oval or rounded structure can be seen with multiple floating internal echoes.

v. HAEMATOMA AND SEROMA

On mammography breast haematoma may appear as well defined or poorly defined masses. Spiculation and tumour calcification are absent. Ultrasonographically they appear as well defined or ill defined fluid collections with multiple internal septations and mixed echoes due to coagulation. In the post lumpectomy patients USG can usually differentiate between a post surgical fluid collection and a tumour recurrence, Seromas, on the other hand, are usually seen as totally anechoic area in or near a surgical site.

vi) BREAST ABSCESS :

It is usually found in lactating young women. USG is the usual procedure of choice in the evaluation of a possible breast abscess. Mammography is limited in these situations often due to the young age of the patient, marked breast density, or the inability to provide adequate compression due to severe pain and tenderness. Compression may also spread infection if a contained abscess is ruptured. Sonographically a breast abscess usually presents as a hypoechoic lesion with multiple internal echoes and increase internal echoes thorough transmission. The debris within the abscess may layer out in a dependent fashion, forming a fluid / debris level. On mammography, breast abscess appears as a poorly defined or spiculated mass mimicking cancer.

viii) TUBERCULOSIS OF THE BREAST

The disease presents in 3 forms : Nodular, diffuse and sclerosing. The nodular form presents on mammography as a dense round area with indistinct margins, closely resembling a carcinoma.

The diffuse form consists of multiple intercommunicating foci of tuberculosis within the breast associated with skin thickening. Mammographically one may see findings simulating inflammatory carcinoma with diffuse skin thickening. In an uniformly dense breast, Mammography may demonstrate increase density on the affected side. Sonographic findings are consistent with that of a breast abscess.

BREAST TUBERCULOSIS

4 A : Mixed echogenic loculated collection in the breast

4 B : shows irregular tracking of the abscess towards surface

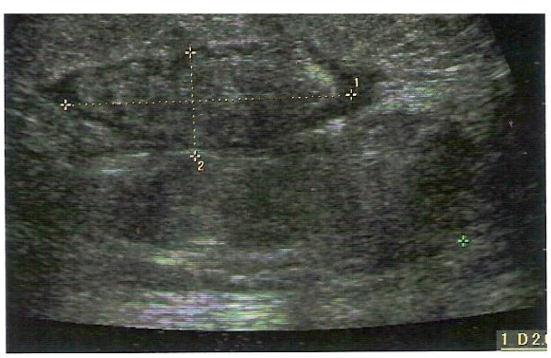


Figure 10A : Mixed echogemic loculated collection in the breast

Figure 10B: Shows irregular tracking of the abscess towards surface

viii) FIBRO ADENOMA

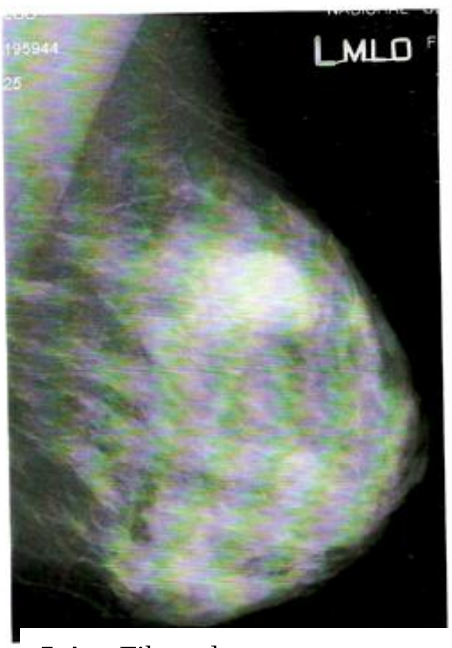
On mammograms, fibroadenomas seen are well circumscribed masses with a round, oval or nodular borders. Their margins may be well defined or partially obscured by surrounding fibroglandular tissues.

Calcification may be seen within the mass, which is coarse, or primarily distributed at the periphery of the mass. Fibroadenomas with diffusely distributed calcification may need to be biopsied as intraductal carcinoma may have a similar appearance.

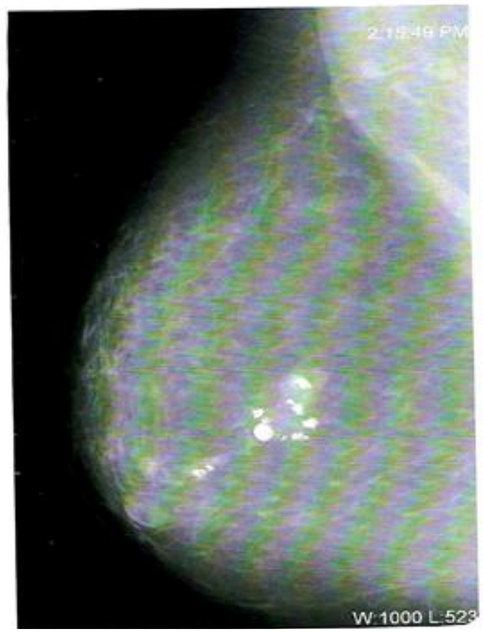
On USG, fibroadenomas have smooth well defined margins, although the lesions can be lobulated or even have irregular contours.

Most are hypo echoic in nature with homogenous internal echoes. Fibroadenomas may show posterior acoustic enhancement, though the commonest findings is no posterior acoustic change. Posterior acoustic shadowing may also be seen due to diffuse calcification, hyalinization or high proportion of fibrous component. Adenomas may be more superficial in location than carcinomas.

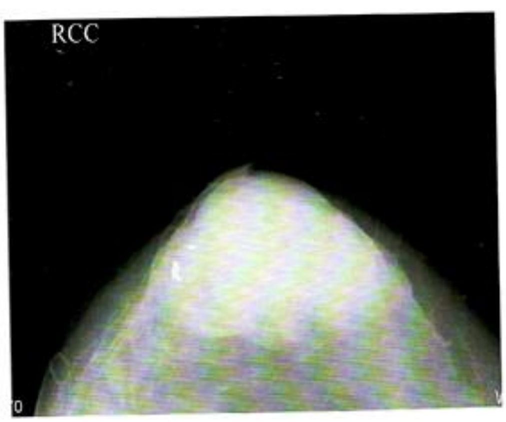
Figure – 5 : FIBROADENOMAS – A PICTORIAL PROFILE



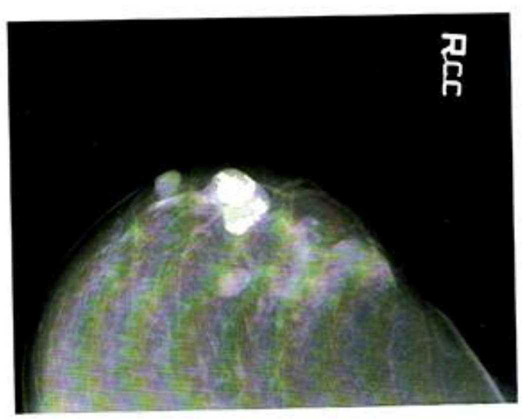
5 A : Fibroadenoma



5B : Calcifying Fibroadenoma



5 C : Giant Fibroadenoma



5 D : Involuting Fibroadenoma

ix) FIBROCYSTIC DISEASE :

Fibrocystic diseases can be divided into the following categories.

i) Predominantly cystic
ii) Predominantly fibrous
iii) Ductal hyperplasia
iv) Lobular hyperplasia
v) Sclerosing adenosis

Any localized form of fibrocystic disease may mimic malignant disease on the x-ray mammography. However USG usually permits a more accurate and detailed description of the lesion and is capable of detecting cysts as small as 0.2 cm in diameter.

x) CYSTO SARCOMA PHYLLOIDES

On mammography the tumour is smooth bordered, round or oval, polylobulated and usually sharply outlined. Because it is often large and rapidly growing the possibility of cystosarcoma should be considered for any circumscribed mass that is larger than 6-8 cm or that is rapidly enlarging.

On ultrasonography fluid filled clefts may be seen within this usually large, well defined solid mass. In other cases it may appear as a well defined solid mass resembling a giant fibroadenoma.

xi) CARCINOMA

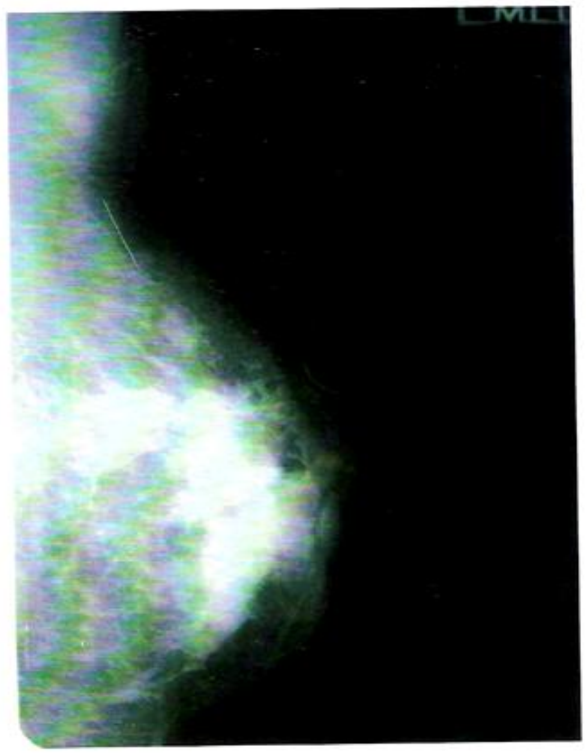
It is not an uniform disease, but rather a spectrum of diseases ranging from quite innocent to very malignant lesion. Carcinoma of breast on mammography can be subdivided into carcinoma in situ, Intra ductal carcinoma, Invasive ductal and lobular carcinomas and Circumscribed carcinoma. Invasive carcinoma usually appears as a spiculated or stellate mass with any or all of the following secondary signs.

i) Inhomogenous density
ii) Architectural distortion
iii) Skin changes
iv) Asymmetric prominent ducts
v) Asymmetric vessels
vi) Adenopathy
vii) Pleomorphic micro calcifications.

Edge shadows from Cooper’s ligament must not be mistaken from the attenuative shadowing of a schirrous carcinoma.

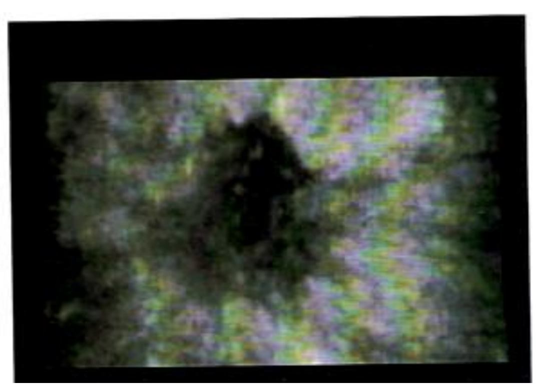
FIGURE – 6 - MALIGNANT MASS

6A



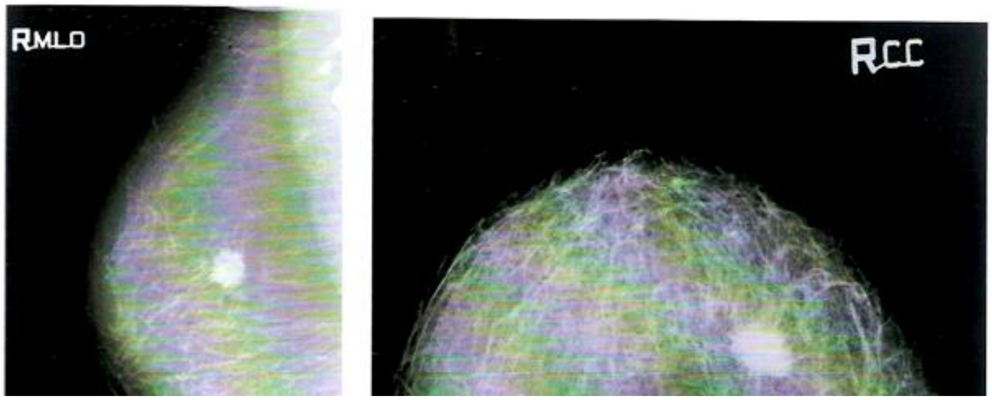
4A : MLO View of mammogram shows large irregular mass

6B : Typical Hypoechoic Mass with Posterior shadowing



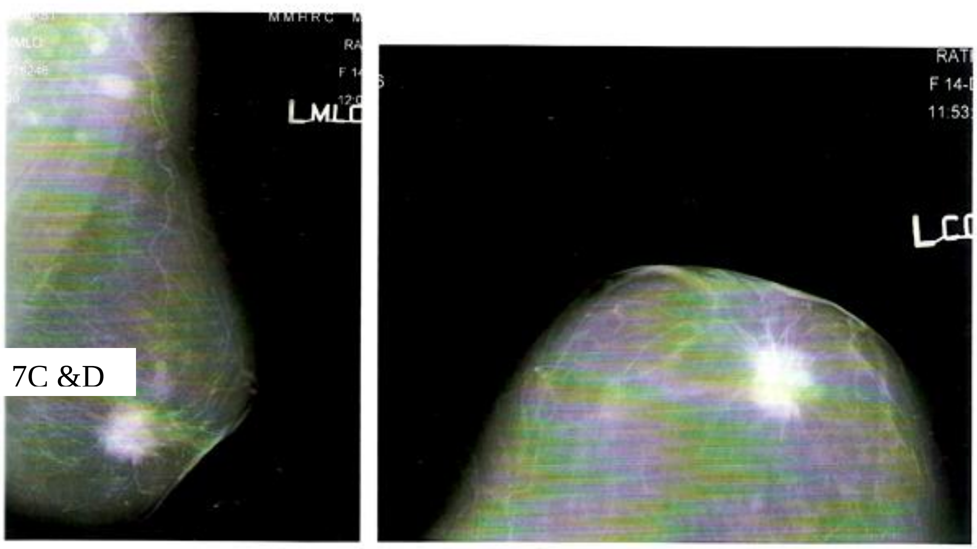
6C : 'C-Plane' depiction of spiculated margins

FIGURE-7 : CARCINOMA IN OLDER WOMEN (> 50 YEARS)



MLO and CC views in this 51 year old woman demonstrating typical spiculated mass. Note the smaller size of the mass at detection

5A & B : MLO and CC views in this 56 year old woman demonstrating typical spiculated mass. Note the smaller size of the mass at detection.



5 C & D : MLO and CC views showing spiculated mass in a fatty background. Note the thickening of overlying skin indicating infiltration; also note the axillary nodes in the MLO view.

Robert A. Smith PhD et al, (2004) reviewed the results of the 8 grand randomized trials of breast cancer screening and concluded that the practice of screening mammography is associated with significant and substantial reduction in breast cancer mortality.

But the Canadian National Breast Screening study-1, a randomized screening trial of mammography in women aged 40 to 49 years, analyzed breast cancer mortality after 11 to 16 years of follow up. It concluded that after 11 to 16 years of follow up, four or five annual screenings with mammography, breast physical examination, and breast self-examination had not reduced breast cancer mortality compared with usual community care, in this age group.

Steven P. Poplack, MD et al, (2000) analyzed the mammographic data from the New Hampshire Mammography Network, to assess performance parameters and evaluate the consistency of BIRADS recommendations. They found that screening mammography had a sensitivity of 72.4%, specificity of 97.3% and positive predictive value of 10.6%. Diagnostic mammography had higher sensitivity, 78.1% lower specificity, 89.3% and better positive predictive value, 17.1% BI-RADS recommendations were generally consistent, except for probably benign assessments.

Lawrence W. Bassett, MD et al (1991) reviewed the records of a series of 1,016 women in < 35 yrs age group who had undergone mammography, in order to determine the usefulness of mammography in women of this age group. They concluded that younger women with persistent localized breast symptoms should undergo a tailored mammographic examination, but negative findings or findings of a benign lesion should not preclude biopsy of a palpable solid mass.

An earlier study (1983) by Jack E. Meyer, M.D. et al involving a smaller number (31) of patients under 35 years had concluded that mammography can play a significant role in studies of the breast in women in this age group.

Richard E. Bird, MD et al. (1992) analyzed the cancers missed at Screening Mammography and found that missed lesions tend to occur in dense breasts, often presented as developing opacities, and were frequently found in the retro glandular region.

Robyn L. Birdwell, MD et al, (2002) conducted a multicenter retrospective study to determine the mammographic characteristics of cancers missed at screening mammography and assess the ability of computer – aided detection (CAD) to mark the missed cancers. Detection errors affected cases with calcifications and masses. For calcifications and masses, the most frequently suggested reasons for possible miss were dense breasts and distracting lesions, respectively. CAD marked most (77%; 88 of 115) cancers missed at screening mammography that radiologists retrospectively judged to merit recall.

The article on Diagnostic Mammography by Valerie P. Jackson, M.D., in Radiol Clin. N. Am 42 (2004), 853-870, described in detail the approach to the evaluation of mammograms. The article discusses the imaging evaluation and the management of lesion found on screening and diagnostic mammography and answers commonly encountered questions and dilemmas.

Edward A. Sickles M.D. et al, studied the role of microfocal spot magnification mammography in the assessment of clustered micro calcifications. The study involving 429 patients showed that the superior image quality of the additional magnification mammogram resulted in improved visualization of microcalcifications.

A retrospective Radiological – Pathologic correlation study by Christophe Frage M.D et al examined whether microcalcification with polyhedral shape could be found at mammography. They concluded that, if found, the polyhedral shaped microcalcifications represented calcium oxalate dehydrate (weddelite) crystals and were associated with benign lesions.

Lawrence W. Basset et al, in a study analyzed the labeling practice of 390 facilities in the U.S. The study found that labeling practice, information provided and methods used varied considerably from one site to another. Adoption of ACR guidelines for labeling mammography films is encouraged by the authors.

Catherine Cole-Beuglet and others (1981) evaluated Ultrasound Mammography in comparison with X ray Mammography. There was no significant difference in sensitivity on initial readings of USM and XRM. The sensitivity for USM cancer readings was higher when it was done with knowledge of the history, age, physical breast examination, and mammogram interpretation, when available.

Thomas M. Kolb, MD, et al, analyzed 27,825 Patient Evaluations to compare the performance of Screening Mammography, physical examination, and breast US and to evaluate the factors that influenced the same. Their conclusion was that mammographic sensitivity for breast cancer declined significantly with increasing breast density and was independently higher in older women with dense breasts. Addition of screening US significantly increases detection of small cancers and depicts significantly more cancers and at smaller size and lower stage than does Physical Examination, which detects independently extremely few cancers.

William E. Barlow et al (2002) analyzed data from six registries participating in the Breast Cancer Surveillance Consortium and linked them to cancer outcome data to assess the performance parameters of the diagnostic mammography. They concluded that Diagnostic Mammography in women with signs or symptoms of breast cancer shows higher sensitivity and lower specificity than screening mammography does. Higher breast density and previous mammographic examination appear to impair performance.

Virginia L. Ernster pooled data from seven regional mammography registries to determine the percentage of mammographically detected cancers that are Ductal Carcinoma In Situ (DCIS) and the rate of DCIS per 1000 mammograms. They found that approximately 1 in every 1300 screening mammography examinations leads to a diagnosis of DCIS. They opined that given the uncertainty about the natural history of DCIS, the clinical significance of screen detected DCIS needed further investigation. Paul C. Stomper, MD while analyzing Clinically Occult Ductal Carcinoma in Situ Detected with Mammography concluded that there is a wide spectrum of mammographic appearance of clinically occult DCIS.

Phan T. Huynh, MD, et al analysed the patterns of dilated ducts in mammography. They concluded that mammographic asymmetrically dilated ducts in a nonsubareolar area that are associated with interval change, suspicious microcalcifications, or both warrant biopsy.

Puneet et al (2005) analyzed the problem of breast tuberculosis in Indian population. They observed that breast tuberculosis is still prevalent in developing countries. Presentation may mimic benign lesion or malignancy of breast. Diagnosis is made on high index of suspicion in endemic area. FNAC or biopsy is required for definitive diagnosis. The anti-tubercular chemotherapy is the sheet anchor of treatment of breast tuberculosis. As early as 1968 Dubey MM, Agarwal S. gave detailed clinical account of the Tuberculosis of the breast in India. But clinical and laboratory findings were the mainstay of diagnosis then.

MATERIALS AND METHODS

A prospective study was conducted at Meenakshi Mission Hospital and Research Centre during August 2008 to April 2009. A total of 50 patients including those with various breast complaints and those who came for screening were evaluated with X-ray mammography and High resolution ultrasonography of both the breasts.

Demographic and Clinical profile including relevant laboratories investigations of all patients were collected and documented. Biopsy was done whenever required based on clinical and imaging findings and in patients who volunteered.

Ultrasonogram was the initial investigation done. Only patients with suspicious findings were subjected to diagnostic mammography.

Patients who already had histopathologically proven malignant breast conditions were excluded from the study.

MAMMOGRAPHY TECHNIQUE AND PROTOCOL

. **EQUIPMENT**

- Senographe DMR unit of GE Medical Systems was used for mammography.

Mammography Tube :

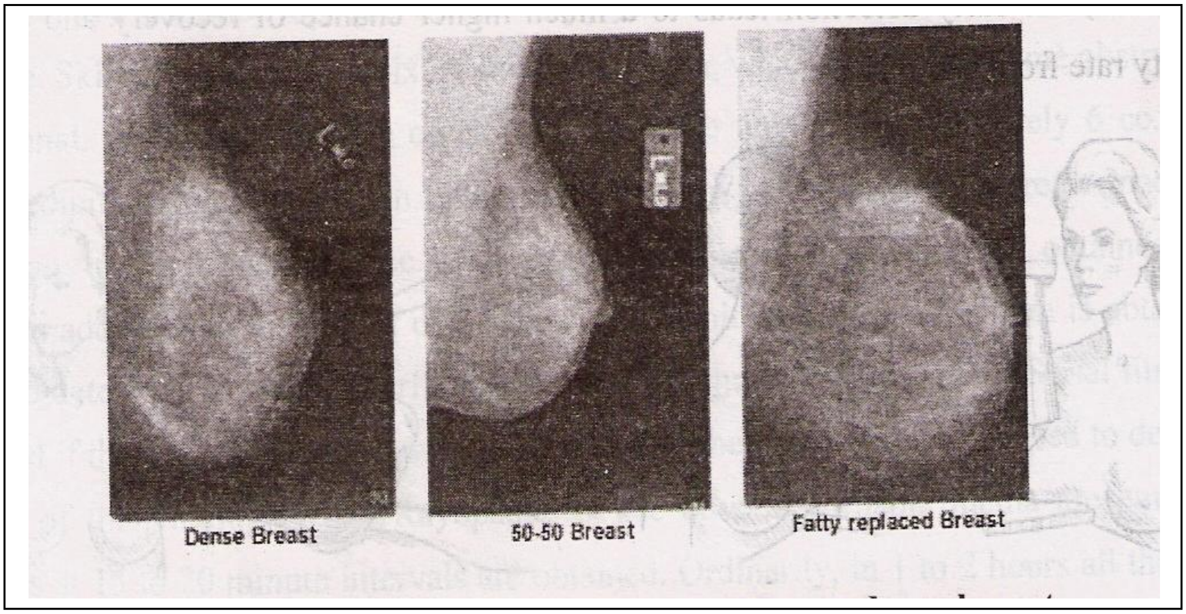
Some mammography technique requires the use of soft radiation ; such radiation is best produced by tube operating a low KV and preferably within a molybdenum anode in place of more commonly used Tungsten. The cathode end of the beam is limited by means of a diaphragm so that the radiation dose to the patients chest wall is minimized during exposure.

The tube has a Beryllium window, as this is less absorbent than glass and molybdenum filter. Unlike Aluminium, molybdenum filter is translucent to the characteristic radiation emitted by molybdenum target and it therefore allows the radiation, particularly required to pass through the filter with minimal absorption. A proximal diaphragm reduces the effect of extra focal radiation. The filament of mammotube is set much closer to Anode than that of the conventional tube. As there is no danger of breakdown of the tube due to vaporization, it is possible to heat the filament to higher temperature. This leads to an improved rating.

It also makes it possible to use higher milli ampere seconds value at lower KVP potential about 24 to 30 than previously possible. The metal tube is fitted with a large diameter compound anode, which may contain slits to allow for expansion and contraction of the metal without distortion of the anode. The anode would normally be capable of high speed rotation, the oil would be water cooled and tube used in conjuction with a 6-12 pulse generator, for diagnostic examination requiring short exposure time and sustained high loading.

Absorbed dose in breast tissue during mammography should be kept as low as reasonably achievable without sacrificing necessary diagnostic information. Currently, the preferred mammography techniques use either a molybdenum target and filter with a rare earth intensifying screen and matching radiographic film, or a tungsten target and aluminium filter with a Xerographic plate.

Mammography should be carried out with dedicated mammography X ray equipments. Under no circumstances should the total permanent filtrations be less than 0.03 mm of molybdenum for screen film mammography or 0.5 mm aluminium for Xero mammography.



Generally,

A younger woman has denser or fibro-glandular breasts. Her mammogram will look very white or 'cloudy' (figure 1 dense breast).

Middle aged women have a mixture of fibrous and glandular tissues. (figure 2 breast). Their mammograms look black and white.

In a mature breast, most of the fibrous tissue is replaced with fatty tissue. The mammogram tend to look black or gray (figure 3 – fatty replaced breast)

Film sizes

6 ½" x 8 ½" used for small to average sized breasts and

12" x 15" used for large sizes

2. IMAGING PROTOCOL

- All the patients above 25 yrs were subjected to mammography.
- In < 35 yrs age group only women with suspicious clinical or sonographic findings were examined by mammography.
- Medio-Lateral Oblique (MLO) and Cranio-Caudal views were the routine initial views taken for all patients. Additional spot compressions and magnification views were taken whenever deemed necessary.

Mammography procedure :

- The woman is escorted to the changing room, where she undresses from the waist up and changes into the screening center gowns.
- She is asked to wipe off any deodorants, perfumes or powders that she may have used that day, as these can mimic micro calcifications on the film.
- Mammography procedure explained this opens communication channels and the women feeds free to voice her concerns, thus increasing her comfort level.

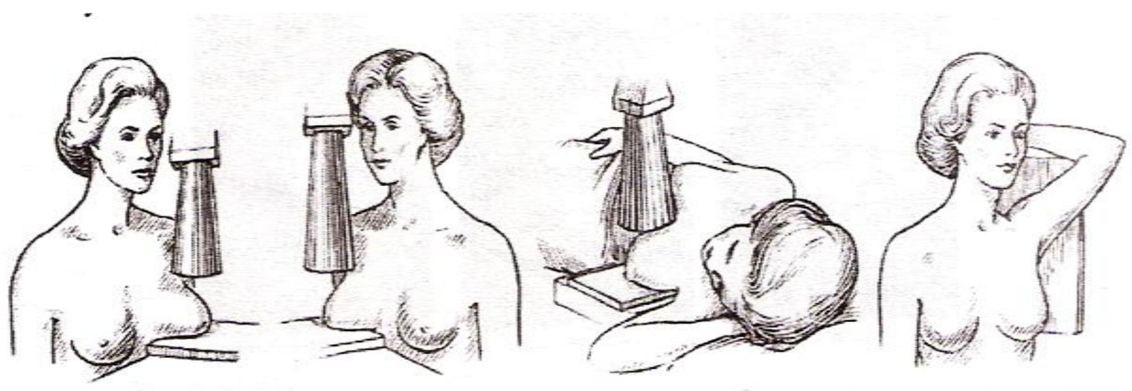


Figure-8 **Diagram illustrating positioning of patient for soft tissue mammography.**

Breast tissue composition varies with age and hormone levels in a woman.

- It is important to prepare the woman for the compression that would be used for imaging. This device causes discomfort, but should not hurt the woman. A compression paddle is a device used to compress the breast tissue. This helps to spread out and separate breast tissue, enabling the Radiologist to get an unobscured view of possible pathology. Compression also lowers radiation dose and prevents patient motion.
- The required views are performed and the woman is dismissed with instructions that she might feel sore for a day or so from the compression.

- The filter to make the beam hard and more penetrable used, is 0.03 mm molybdenum.
- Film processing is done under specific conditions. The two ways to develop an exposed film are (1) standard processing and (2) Extended processing. The choice depends on the type of film used.
- The films used for mammography are single emulsion fast films to enhance image sharpness by eliminating geometric distortion. Films commonly used are : Kodak Min-RE, Agfa, Fuji, Konica.
- Markers are used to indicate the side and view demonstrated on that particular film. Markers are placed on the side of the axilla (armpit) of the patient. This acts as a reference point to understand the orientation of the breast, especially in the CC view.

- Mammographic films were studied in view-boxes with optimal luminance. Hand lens was used for magnification.
- Final impression of the mammographic study was given based on the BIRADS classification.
- For all the patients, mammographic features were correlated with sonographic features before giving the final impression.

ULTRASONOGRAPHY TECHNIQUE AND PROTOCOL

EQUIPMENT

- Voluson 730 Expert of GE Medical Systems.
- High frequency linear transducer of frequency range 6-12 MHz was used for routine examination. Transducers used for breast sonography are usually electronically focussed at 1.5 to 2.0 cms for minimizing volume averaging.
- Another linear, volume probe with frequency range of 5-12 MHz was utilized for detailed evaluation of masses and architectural alterations. This had special attributes like 2-D imaging, C-plane and A-plane imaging.
- Colour flow mapping and spectral analysis were used whenever felt necessary, in the evaluation of masses and suspicious areas.

FINAL IMPRESSION OF IMAGING WORKUP

- Final impression of imaging workup was given after complete analysis of mammographic films and the ultra sonographic examination.
- BIRADS classification was used to categorize patients after imaging workup.

RESULTS & ANALYSIS

Table – 1 Age wise Distribution

Age / Yrs	Cases	Control
21 – 30	9	6
31 – 40	11	14
41 – 50	4	3
51 – 60	1	2
Mean	33.8	35.4
SD	8.16	8.24

Sample volume of study comprised of 50 patients. Of these, women in 31-40 years of age group constituted the largest sample.

Mean age in Control group - 35.4
Study group - 33.8

Table – 2 Clinical Presentation

Indication	Cases	Control
Screening	25	5
Palpable mass	9	-
Tenderness	7	13
Lumpiness	5	2
Adenopathy	3	5
Discharge	1	-

Study population consisted of those coming for screening as well as those presenting with various breast symptoms. Of these, palpable mass was the most common reason for opting for Imaging work up. Other clinical presentation were Tenderness, Lump, Adenopathy & Discharge.

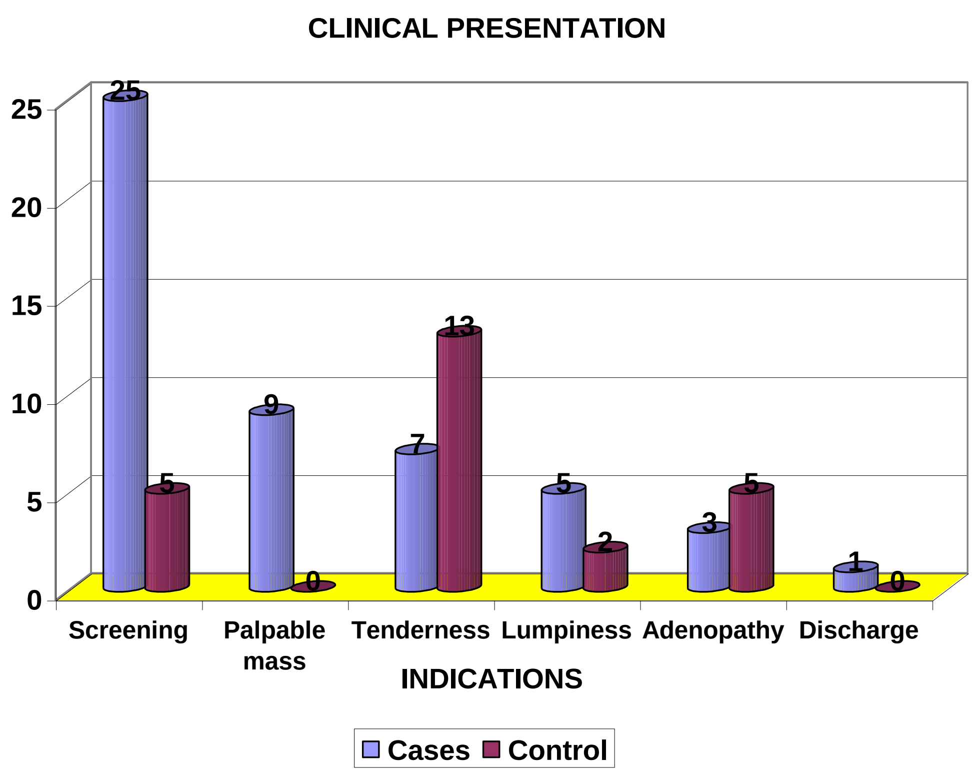


Table – 3 Results of Imaging work up based on BIRADS Categorisation

Birads Gr.	Cases		Control
	25		25
	Benign	Malignancy	
I	2		25
II	19		
III	2		
IV	0	2	
V	0		

After complete mammographic and sonographic evaluation, patients were classified into one of the BIRADs categories. Significantly more number of persons fell in to negative, benign categories with few % in malignant categories.

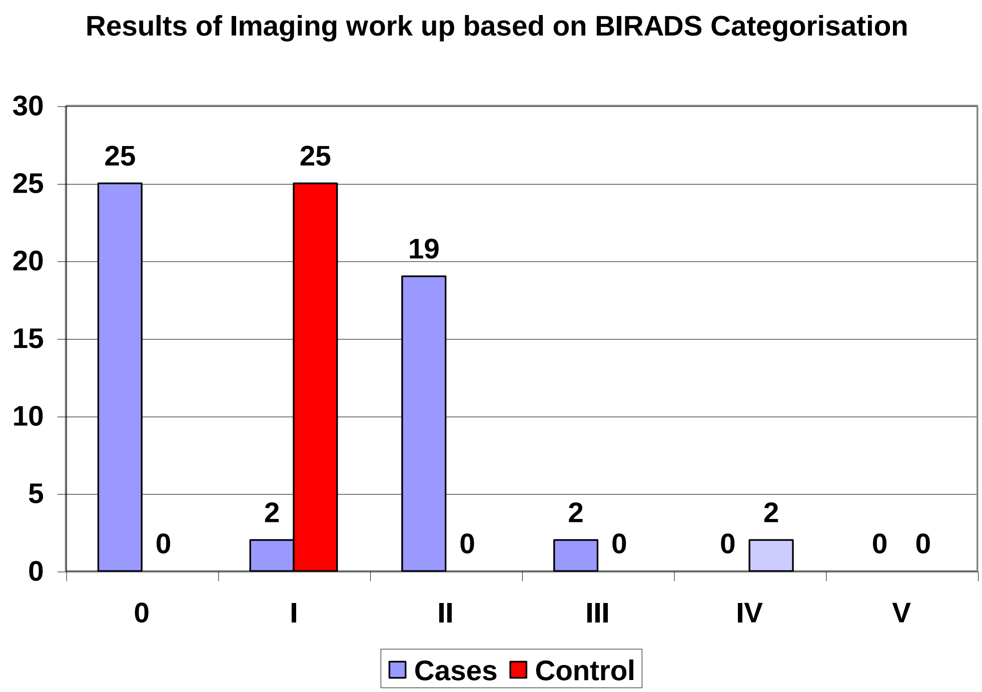


Table – 4 Age wise BIRADs classification

Age Group	0	I	II	III	IV	V
21 – 30		1(4%)	8(32%)			
31 – 40			10(40%)	1(4%)		
41 – 50		1(4%)		3(12%)		
51 – 60					1(4%)	

This table gives the BIRADS categorization in each age group. Figures within the brackets indicate the percentage of women in each BIRADs category, within each age group.

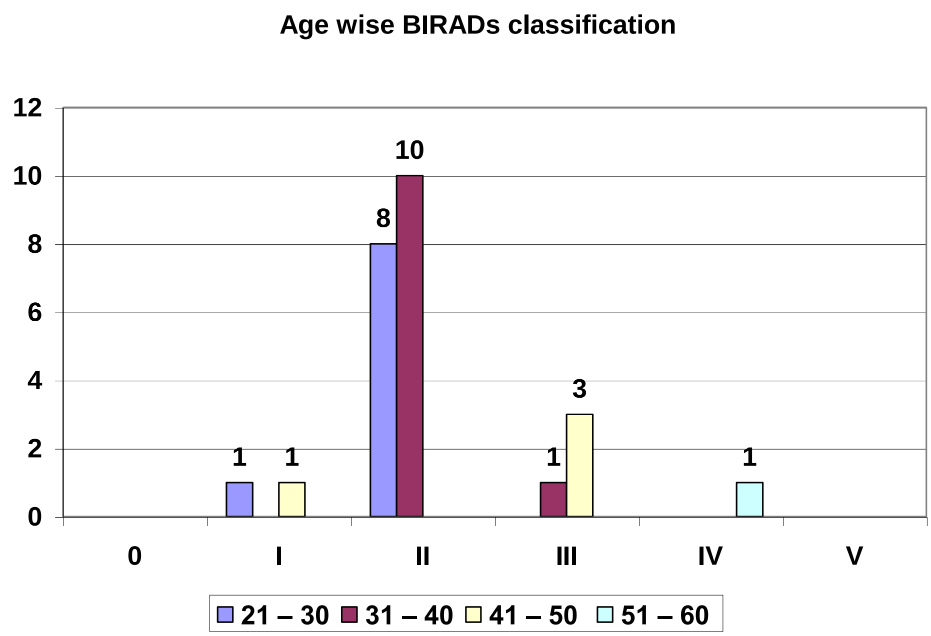
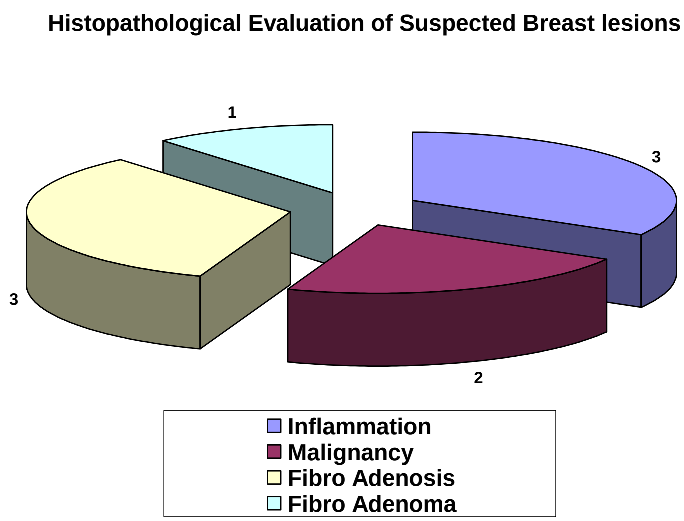


Table – 5
Histopathological Evaluation of Suspected Breast lesions.

	No.of cases	Percentage
Inflammation	3	33.33
Malignancy	2	22.22
Fibro Adenosis	3	33.33
Fibro Adenoma	1	11.11

A total number of 9 patients underwent biopsy preoperative or excisional. Out of which one had tuberculosis of breast and 2 had inflammatory mastitis.

In the malignant category, one had medullary carcinoma and other had malignant cysto sarcoma phylloids. Three had fibro adenosis and one had fibro adenoma.


Histopathological Evaluation of Suspected Breast lesions
1
3
3
2
Inflammation
Malignancy
Fibro Adenosis
Fibro Adenoma

S.No.	Age in years	Imaging Diagnosis	BIRADS 0	BIRADS I	BIRADS II	BIRADS III	BIRADS IV	BIRADS V	HPD	Follow Up
1	25	Negative		+						
2	27	Negative		+						
3	31	Negative		+						
4	35	Negative		+						
5	31	Negative		+						
6	36	Negative		+						
7	35	Negative		+						
8	37	Negative		+						
9	31	Negative		+						
10	40	Negative		+						
11	33	Negative		+						
12	33	Negative		+						
13	40	Negative		+						
14	40	Negative		+						
15	45	Negative		+						
16	43	Negative		+						
17	44	Negative		+						
18	52	Negative		+						
19	54	Negative		+						
20	28	Negative		+						
21	39	Negative		+						
22	27	Negative		+						
23	29	Negative		+						
24	40	Negative		+						
25	29	Negative		+						
26	30	Fibro Adenosis				+			FibroAdenosis	Benign
27	28	Rt Inflammatory Mammary Abscess			+				T.B. Abscess	Benign
28	30	Fibro cystic disease Rt			+					Benign
29	29	Fibro cystic disease Rt			+				Fibro adenosis	Benign
30	25	Fibro Adenosis			+				Fibro adenosis	Benign
31	33	Inflammatory node Lt			+				Inflammatory node	Benign
32	27	Fibro cystic disease Rt			+					Benign

33	39	Mass Lt				+			Malignancy	Malignant
34	32	Fibro Adenoma both breast			+				F.A. Both	Benign
35	37	Bilateral small fibro adenoma			+					Benign
36	38	Abscess RUOQ			+				Chronic granulomatous mastitis	Benign
37	45	Abscess healed		+						Benign
38	42	Fibro cystic disease Rt				+				Benign
39	41	Left mass + Axillary node				+				Benign
40	29	Sebaceous cyst Lt		+						Benign
41	43	Small multiple fibro adenoma				+				Benign
42	27	Bilateral mastitis			+					Benign
43	51	Rt mass & axillary lymphnode					+		Malignancy	Malignant
44	37	Ductal Mass			+				Inflammation	Benign
45	33	Fibro adenoma Rt			+					Benign
46	34	Fibro cystic disease Rt			+					Benign
47	33	Fibro adenoma Rt			+					Benign
48	29	Fibro cystic disease Rt			+					Benign
49	37	Fibro cystic disease Rt			+					Benign
50	36	Fibro cystic disease Rt			+					Benign

DISCUSSION

PERFORMANCE PARAMETERS

The combined use of X ray mammography and high resolution Ultrasonography and the use of BIRADS categorization in our study performed very well in terms of diagnostic efficacy.

For example, William E. Barlow et al, reported sensitivity of 85.8%, and specificity of 87.7%, in their study on the performance of diagnostic mammography for women with signs or symptoms of breast cancer.

New Hampshire Mammography Network study was a large community based mammographic service ; ours done in a hospital set up, with a very smaller number of women had obvious reasons to fare better.

The better performance of our study compared to the above mentioned two studies may also be due to the fact that we used high resolution US and X ray mammography in combination, while the other studies involved X ray mammography alone. In all the patients above 35 years, both modalities were employed before giving out the final assessment in terms of BIRADS. For women of < 35 years we relied mainly on the High Resolution US. Still, for all the patients with suspicious clinical or US findings, we completed the work up with diagnostic mammography.

It will be useful to recall from literature the study of Thomas M. Kolb, MD, et al. They analyzed 27,825 patient evaluations to compare the performance of Screening Mammography, physical examination, and breast US and to evaluate the factors that influenced the same. Their conclusion was that addition of screening US significantly increases detection of small cancers and depicts significantly more cancers and at smaller size and lower stage than does Physical Examination, which detects independently extremely few cancers.

AGE DISTRIBUTION

The mean age of the women in our was 33.8 and 35.4 years. Women in the 31-40 yrs age constitute the single largest group. This can be explained by heightened awareness and hence anxiety about breast cancer in women of this age group. Also subtle symptoms and signs in these women are viewed with suspicion by the clinicians, hence increased referrals for imaging work up. This trend is also seen in many of the studies we referred to, including the New Hampshire Mammography Network study.

BIRADS ASSESSMENT

A total number of 19 women were assigned BIRADS II category (benign), 2 in BIRADS I, 2 in BIRADS III, and 2 in BIRADS IV category. Higher number of women with benign diagnoses rather than normal or negative work up is in deference with other community based studies.

The accuracy of BIRADS assessment increased with increasing age of the patients studied.

William E. Barlow et al also observed, in their analysis of diagnostic mammograms that both sensitivity and specificity of screening mammography increased with age and decreased with increasing breast density. In an another study Thomas M. Kolb, MD et al analyzed 27,825 Patient evaluations and concluded that mammographic sensitivity for breast cancer declined significantly with increasing breast density and was independently higher in older women with dense breasts.

MISSING CANCERS :

Women who had negative results in the initial work up, later may turn out with suspicious features during their follow up studies. Hence we should advise regular check up at frequent intervals and biopsy of the palpable mass.

One case aged 28 years presented with breast lump and mild tenderness. Mass was nonspecific with diffuse increase in density. Ultrasonogram revealed mixed echogenic loculated collections.

Puneet et al reported 4.5% of Breast TB in their series of breast lumps. Compared to this our number is very low (< 1%). One possible reason for this is that our study population contained women with better socio economic status and had to involve more number of women from low socio economic status also.

A 39 year old lady presented with mass in her left breast. Another 51 year old lady with mass with right axillary node. On mammography the mass was lobulated with some part o the margin irregular suggesting local breast invasion.

On histological examination it was proved to be medullary carcinoma. As per literature, medullary carcinoma constitutes 5 to 7 percent of all invasive breast carcinomas. In initial stage, the carcinoma may be mistaken for fibro adenoma.

CONCLUSION

X ray Mammography and high resolution ultrasonography used in combination perform well in the evaluation of breast conditions.

BIRADS categorization is the optimal method for expressing the final assessment of the imaging work up and its widespread use should be encouraged.

One woman was detected to have Tuberculosis of the breast. Given the prevalence of tuberculosis in our country, we could have found more cases ie. involving more number of women from the low socio-economic strata.

Sonography is very useful in evaluating palpable lumps when there is dense tissue in the area of the palpable lump on mammography. By aggressively scanning these areas, sonography detects malignant nodules that are missed by mammography. If lesions do not contain calcifications and surrounding tissue observes them, they can be missed on mammography. Palpable abnormalities span a spectrum from vague thickenings to rock hard immovable lumps. Sonography can prevent biopsy by showing normal or definitively benign findings. Several studies have now shown an extremely high negative predictive value for the combination of negative mammography and normal benign U S findings.

Mammogram is an effective, non invasive means of examining the breast, commonly searching for breast cancer. Cancer is not preventable but early detection leads to a much higher chance of recovery and lowers the mortality from this disease.

PROFORMA

Name :	Age:	Sex:
Occupation:	Sl.No.:	IP/OP No.:
Address:	Ph.No:	Date:
Ref Dr.	Ph.No.:	

Past History:

H/O previous Mammography or other imaging, biopsy, surgery, any relevant treatment history, marital status, obstetric history.

Clinical diagnosis:

Other diagnostic test: chest X-ray, Lab if any.

Imaging evaluation:

1. Mammography findings:
2. Ultrasonography findings:
3. BIRADS category and Recommendations:

Follow up:

HPE report:

ABBREVIATIONS

US	-	Ultra Sonography
XRM	-	X-Ray Mammography
USM	-	Ultrasound Mammography
HPE	-	Histopathological Examination
MLO	-	Medio -Lateral Oblique
DCIS	-	Ductal Carcinoma In Situ
CC	-	Cranio-Caudal

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