Sudan University of Science and Technology

College of Graduate Studies

Characterization of Female Breast lumps by Using Ultrasonography in United Arab Emirates

توصيف كتل الثدي في إناث الامارات العربية المتحدة بإستخدام جهاز الموجات فوق الصوتية

A Thesis Submitted, as a partial fulfillment of aware of Master Degree in Diagnostic Medical Ultrasound Imaging Technology

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M arch 2015

صدق الله العظيم

) سورة العلق الآيات من 1- 5)

DEDICATION

I dedicate this thesis to my family who support me to finish this effort

- **To my mother she is blessing me by her continuous prayers.**
- **To my sisters for nursing me with affections and love and their dedicated partnership for success in my life.**
- **To my friends, teachers and collogues.**

AKNOLEDGMENT

First, I thank God who has blessed and guided me to accomplish this thesis.

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Abbreviations

TPUS	Meanig
BI-RADS	columnar alteration with prominent special snouts and secretions
MRIUSE	Magnetic Resonaznce imaging
USG	Ultra sonogram
CAT	Computerized axial tomography (scan)
CT	Chemotherapy
NSR	Non Significant result
IBC	Inflammatory Brest cancer
6- MP	6-Mercaptopurine (anti cancer drug)
6-TG	6-Thioguanine (zanti cancer drug)
AA	Anaplastic Anaemiaz
ABC	Advanced Breast Cancer
ABMT	Autologous bone marrow transplant
ADR	Adverse Drug Reaction
AE	Adverse event
AFP	Alphafetoprotein - eg. expressed by germ cell tumours and other cancers
AIDS	Acquired immune deficiency syndrome
ALAT	Alanine aminotransferase / alinine transaminase
ALCL	Anaplastic Large-cell Lymphoma

ALL	Acute lymphoblastic leukaemia
ALT	Alanine Aminotransferase
AMKL	acute megakaryocytic leukemia
AML	Acute Myeloid leukaemia
ANC	Absolute neutrophil count
ANED	Alive no evidence of disease
ANLL	Acute non-lymphatic leukaemia
ARMS	Alveolar rhabdomyosarcoma
ASR	Age Standardised Rate (Incidence)
AUC	Area under the curve
B-ALL	cell Acute Lymphoblastic Leukaemia
BAER	Brainstem Auditory Evoked Response
BCC	Basal Cell Carcinoma
BM	Bone Marrow
BM	Blood Monitoring (eg for glucose)
BMJ	British Medical Journal
BMR	Basal Metabolic Rate
BMT	Bone Marrow Transplant
BNF	British National Formulary
BP	Blood pressure
BRM	Biological Response Modifier
BSA	Body Surface Area
BSE	Breast Self Examination

ABSTRACT

This study was aim to identify sonographic criteria for benignancy and malignant masses. Several studies have described the sonographic characteristics commonly seen in benign lesions of the breast but this study try to answers three main questions, which were

- Does ultrasound distinguish cysts from solid masses?
-Does ultrasound distinguish benign and malignant solid breast masses?
-Does ultrasound allow detecting early breast cancer?

The material of this study by using a scientific questionnaire and device which been used in this research carried out by an ultrasound machine (GE healthcare Volsoun E6) with linear transducer with highly frequency of (7.5-13 MHz) Doppler color and power Doppler. The sample of this study which consisted of 64 female U.A.E patients over the age of 20 to 70 years which consisted of female evaluated clinical breast symptoms such as palpable masses, focal pain and suspicious nipple discharge As well as those female patients findings abnormal mammogram examination and refer to ultrasound . The duration of the study was from December 2014 to June 2015 in Khalifa – A- Healthcare Center.

Main Results:

Of the 64 patients, 64 breast masses were detected and confirmed by biopsy .thirty seven (59%) masses were found to be malignant. Most of breast cancer masses located in the upper outer of the left breast. And 27 (41%) masses were benign according to biopsy result most of benign masses were fiboradenoma. Mammography had 60 % sensitivity and ultrasound 87% in detecting early breast malignancy. The study showed that the age between .31-50 years is more affective age with masses

Conclusion:

This work was facilitated by evolving technical improvements in U/S equipment that provided better resolution and images. They demonstrated that U/S may be used to accurately classify some solid lesions as benign allowing follow-up with imaging than biopsy.

ملخص البحث

الهدف تحديد معايير الموجات فوق الصوتية للأورام الخبيثة والحميدة. وقد وصفت العديد من الدراسات خصائص الموجات فوق الصوتية كما هو شائع في الاورام الحميدة في الثدي : ولكن هذا السلوك في محاولة للإجابة علي ثلاثة أسئلة رئيسية هي
هل تستطيع الموجات فوق الصوتية تمييز الخراجات ؟ -
هل بامكان الموجات فوق الصوتية تمييز اورام الثدي الصلبة الحميدة والخبيثة ؟-
هل الموجات فوق الصوتية تسمح الكشف عن سرطان الثدي في وقت مبكر؟-

وقد تنفيذ هذه الدراسة باستخدام الاستبيان العلمي و الجهاز الذي تم استخدامه في هذا البحث من قبل جهاز (GE healthcare) مع ترددات عالية من (7.5 إلى 13 ميجاهيرتز الموجات فوق الصوتية (Volsoun E6
واستخدام لون دوبلر.وكانت عينة هذه الدراسة تكونت من 64 مريضة من الامارات العربية المتحدة التي كانت تتراوح الأعمار فوق 20 إلى 70سنة والتي تتألف من الإناث التي قيمت بأعراض الثدي السريرية مثل كتلة واضحة ، ألم موضعي أو تشويه وتغيير في شكل الحلمة كما الحال للإناث التي قامت بعمل فحص الماموجرم وكانت النتيجة غير طبيعية حولت إلى الموجات الفوق الصوتية . وكانت مدة الدراسة من ديسمبر 2014 إلي يونيو 2015 في مركز خليفة ألف للرعاية الصحية.

: أهم النتائج

من 64 مريضة تم تحديد وتأكيد الكتل في الثدي بالخزعة . حيث تم العثور منها على 37 حالة (59%) كانت أورام خبيثة والتي كانت معظمها في الجزء العلوي الخارجي في الثدي الأيسر . ووجدت 27 حالة (41%) أورام حميدية . ووفقاً لنتيجة الخزعة وجد أن معظم الاورام الحميدة كانت من نوع الألياف الحميدة. كما ظهرت حساسية التصوير الشعاعي للثدي (الماموغرام) 60% و 87% للموجات فوق الصوتية في الكشف المبكر للكتل الصغيرة بالثدي كما أظهرت الدراسة أن الفئة العمرية مابين 31 إلى 50 هم أكثر عرضة لوجود الكتل في الثدي.

: الاستنتاج

أظهر هذا العمل المتطور التحسينات التقنية للمعدات حيث تمكن جهاز الموجات فوق الصوتية بتقديم أفضل الصورة بتقنية عالية وواضحة .
كما يمكن لجهاز الموجات فوق الصوتية أن يستخدم في التصنيف بدقة بعض الأورام الصلبة الحميدة ومتابعتها بدلاً من استخدام الخزعة .

Chapter one

Introduction

1.1 Introduction

Breast cancer is a malignant tumor that starts in the cells of the breast. A malignant tumor is a group of cancer cells that can grow into (invade) surrounding tissues or spread (metastasize) to distant areas of the body. The disease occurs almost entirely in women, but men can get it, too. it is one of the most common causes of cancer deaths today, coming fifth after lung, stomach, and liver and colon cancers. It is the most common cause of cancer death in women.Ultrasound characteristics typical of malignant breast masses. *(August 31, 2015 By Steven Halls)*

The most typical sonographic presentation of a malignant breast mass would probably be an irregular, heterogeneous, hypoechoic mass, with speculations and angular margins *(GanesanS., KarthickG.,JoshiM.,Br J Radiol. 2006;79:843–849)*.

Breast ultrasound can image several different types of breast conditions, including both benign (non-cancerous) and malignant (cancerous) lesions. Ultrasound is frequently used to evaluate breast abnormalities that are found with screening mammography or diagnostic mammography or during a physician performed clinical breast exam. Ultrasound allows significant freedom in obtaining images of the breast from almost any orientation. This provides sample images of a variety of breast conditions that can be imaged with ultrasound. For general information on breast ultrasound.

1.2 Problem of the study

A lump in the breast is a cause of great concern. High frequency, high-resolution USG helps in its evaluation. This is exemplified in women with dense breast tissue where USG is useful in detecting small breast cancers that are not seen on mammography. Several studies in the past have addressed the

issue of differentiating benign from malignant lesions in the breast. The American College of Radiology has also brought out a BIRADS-US classification system for categorizing focal breast lesions. (W Bruening, SUhl, J Fontanarosa, J Reston 2012).

1.3 Research questions

Does ultrasound distinguish cysts from solid masses?

Does ultrasound distinguish benign and malignant solid breast masses?

Does ultrasound allow detecting early breast cancer?

1.4 Objective

The general objective of this study is to identify sonographic criteria for benignancy and malignant masses.

1.4.1 Specific objective:

- To distinguish cysts from solid masses.
- To compare the masses seen on ultrasound if (malignant or benign) by the result of biopsy
- To evaluate clinical breast symptoms such as palpable masses, focal pain and suspicious nipple discharge

1.4.2 Overview of study

Chapter One:

Deal with introduction

Chapter two:

Include Literature review

Chapter Three:

Deal with material and Methods

Chapter Four:

Include result presentation

Chapter Five:

Deal with discussion, conclusion and recommendation

Chapter two

2. Theoretical background

2.1 Anatomy

Women and men both have breasts, but women have more breast tissue than men. Each breast lies over a muscle of the chest called the pectoral muscle. The female breast covers a large area. It extends from just below the collarbone (clavicle), to the armpit (axilla) and across to the breastbone (sternum).

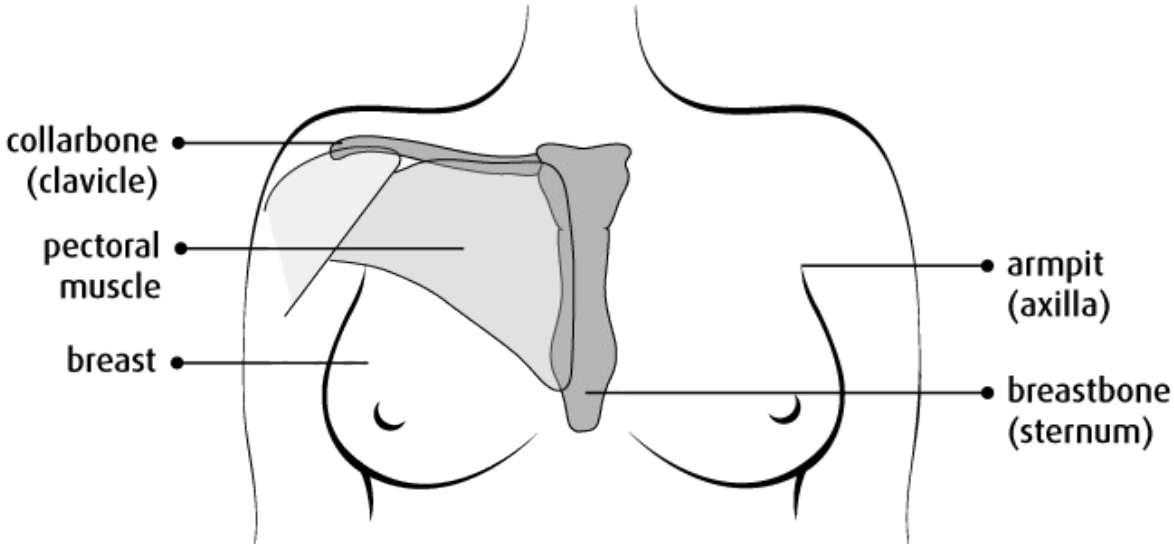

Figure (2.1) the Breast and Surrounding Structure

2.1.1 Structure

The breast is a mass of glandular, fatty and connective tissue. The breast is made up of:

- lobules – glands that produce milk
- ducts – tubes that carry milk from the lobules to the nipple
- fatty and connective tissue – surrounds and protects the ducts and lobules and gives shape to the breast
- areola – the pink or brown, circular area around the nipple that contains

small sweat glands, which release (secrete) moisture as a lubricant during breast-feeding

- nipple – the area at the centre of the areola where the milk comes out

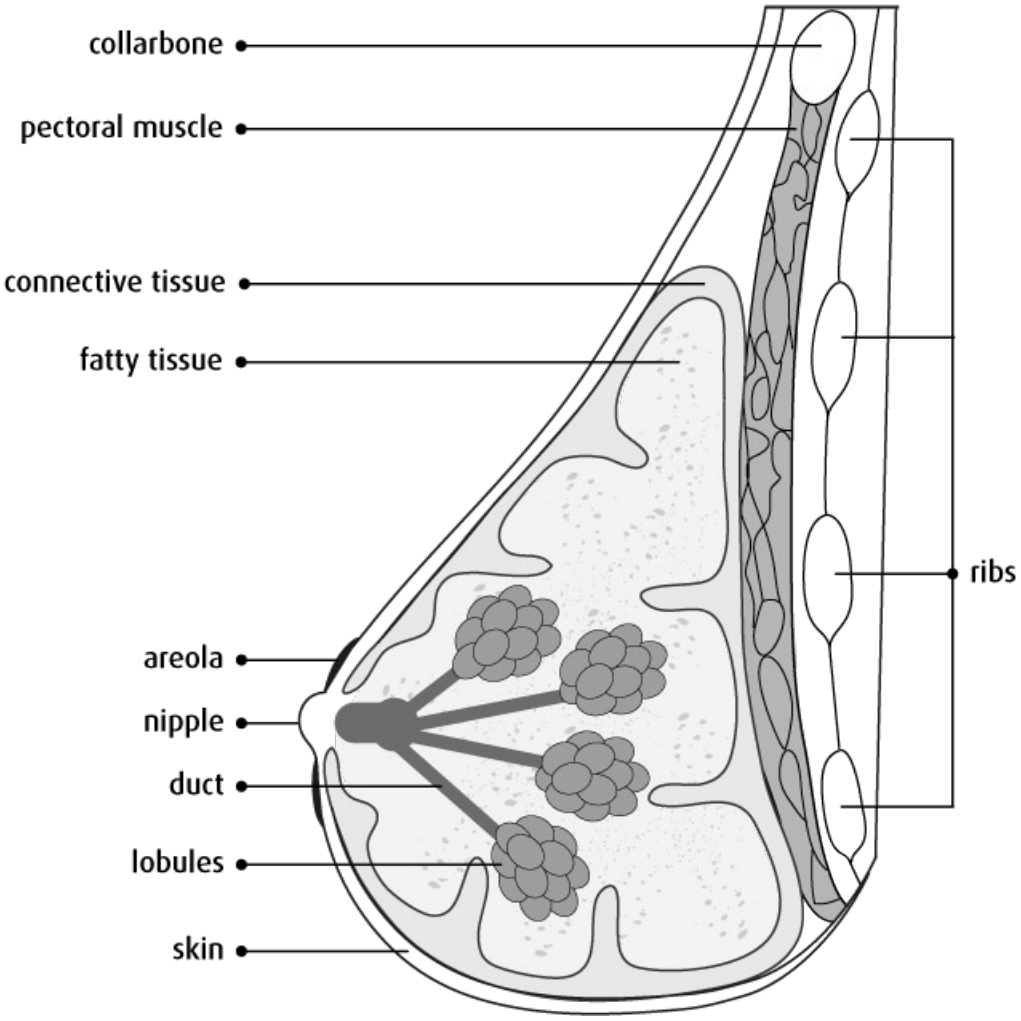

Figure (2.2) the Breast

Ligaments support the breast. They run from the skin through the breast and attach to muscles on the chest. There are several major nerves in the breast area, including nerves in the chest and arm. There are also sensory nerves in the skin of the chest and axilla (Marieb, 1989).

2.1.2 The lymphatic system of the breast

The breast has many blood vessels and lymph vessels. Lymph vessels are thin tubes similar to blood vessels. They collect and move lymph fluid away from the breast into small bean-shaped masses of lymphatic tissue, called lymph nodes, in the area around the breast. The lymph vessels and lymph nodes are part of the lymphatic system, which helps fight infections.

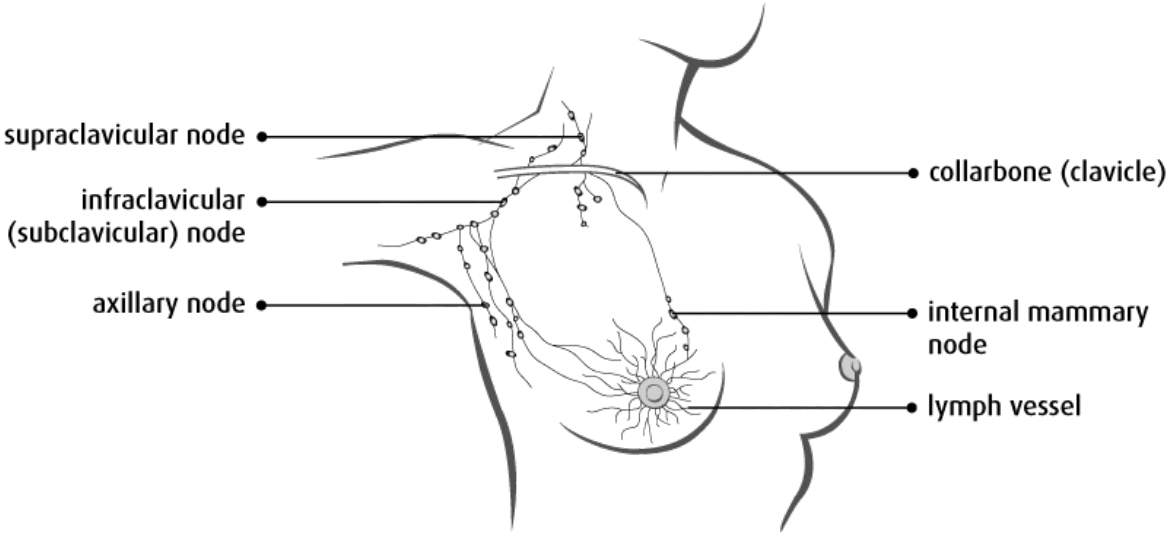

Figure (2.3) Breast Lymph Nodes

The breast lymph nodes include:

- supraclavicular nodes – above the collarbone
- infraclavicular (or subclavicular) nodes – below the collarbone
- axillary nodes – in the armpit (axilla)
- internal mammary nodes – inside the chest around the breastbone (sternum)

Axillary lymph nodes

There are about 30–50 lymph nodes in the axilla. The number varies from woman to woman.

The axillary lymph nodes are divided into 3 levels according to how close they are to the pectoral muscle on the chest:

- level I (low axilla) – located in the lower or bottom part of the armpit, along the outside border of the pectoral muscle
- level II (mid axilla) – located in the middle part of the armpit, beneath

the pectoral muscle

- level III (high axilla) – located below and near the centre of the collarbone, above the breast area and along the inside border of the pectoral muscle

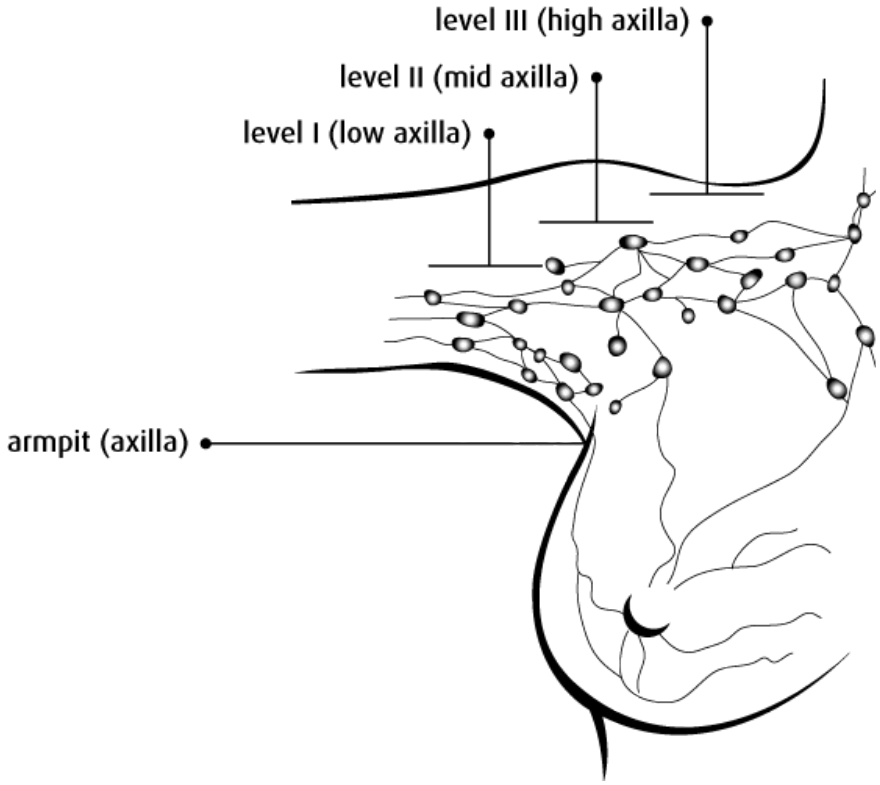

Figure (2.4) Axillary Lymph Nodes

When breast cancer spreads, it usually goes to level I lymph nodes first, to level II next and then to level III.

2.2 Physiology

2.2.1 Breast development

Breast tissue changes at different times during a woman's life. It changes during puberty, during the menstrual cycle, during pregnancy and after menopause.

Female breasts do not begin growing until puberty (around 10–12 years of age). At this time, the breasts respond to hormonal changes (mostly increased estrogen and progesterone) in the body and begin to develop. During puberty, the breast ducts and milk glands grow. The breast skin stretches as the breasts

grow, creating a rounded appearance. Young women tend to have denser breasts (more glandular tissue) than older women.

In older women, much of the glandular and ductal tissue is replaced with fatty tissue and breasts become less dense. Ligaments also lose their elasticity when women age, causing the breasts to sag.

The size and shape of women's breasts vary considerably. Some women have a large amount of breast tissue and have larger breasts. Others have a smaller amount of tissue with little breast fat. A woman's breasts are rarely the same size. Often one breast is slightly larger or smaller, higher or lower or shaped differently than the other (Marugg, 1997).

2.2.2 Hormones and the breast

Estrogen is the main female hormone. It influences female sexual characteristics, such as breast development, and it is necessary for reproduction. Most of the estrogen in a woman's body is made by the ovaries, though a small amount is made by the adrenal glands.

Progesterone is the other female sex hormone made in the ovaries. Its role is to prepare the uterus (womb) for pregnancy and the breasts for producing milk for breast-feeding (lactation).

The breast tissues are exposed to monthly cycles of estrogen and progesterone throughout a woman's childbearing years.

- In the first part of the menstrual cycle, estrogen stimulates the growth of the milk ducts.
- Progesterone takes over in the second part of a woman's menstrual cycle, stimulating the lobules.

After menopause, the monthly cycle of estrogen and progesterone end. However, the adrenal glands continue to produce estrogen so that a woman keeps her sexual characteristics (Mayers, 2001).

2.2.3 Function

The breast's main function is to produce, store and release milk to feed a baby. Milk is produced in lobules throughout the breast when they are stimulated by hormones in a woman's body after giving birth. The ducts carry the milk to the nipple. Milk passes from the nipple to the baby during breast-feeding (Puglisi, 2005).

2.3. Pathology

When your breast was biopsied, the samples are taken were studied under the microscope by a specialized doctor with many years of training called a pathologist. The pathologist sends your doctor a report that gives a diagnosis for each sample taken. Information in this report will be use to help manage your care. The questions and answers that follow are meant to help you understand medical language you might find in the pathology report from a biopsy, such as a needle biopsy or an excision biopsy (www.imaginis.com)

2.3.1 Benign Breast Conditions

Benign changes can include adenosis, sclerosing adenosis, apocrine metaplasia, cysts, columnar cell change, columnar cell hyperplasia, collagenous spherulosis, duct ectasia, columnar cell change with prominent apical snouts and secretions (CAPSS), papillomatosis, or fibrocystic changes.

2.3.2 Atypical Hyperplasia

Hyperplasia is a term used when there is an abnormal pattern of growth of cells within the ducts and/or lobules of the breast that is not cancerous. Some growths look more abnormal, and may be called atypical hyperplasia.

2.3.3 Ductal Carcinoma In Situ

This term is used for the earliest stage of breast cancer, when it is confined to the layer of cells where it began.

2.3.4 Lobular Carcinoma In Situ

Lobular carcinoma in situ (LCIS) is a type of in situ carcinoma of the breast, but it is not considered a pre-cancer (Birdwell, 2003).

2.3.5 Breast Cancer

Carcinoma is a term used to describe a cancer that begins in the lining layer (epithelial cells) of organs like the breast. Nearly all breast cancers are carcinomas. Most are the type of carcinoma that starts in glandular tissue called adenocarcinoma.

2.3.6 Breast Cancer Symptoms

According to(The American Cancer Society)lists the following symptoms associated with breast cancer:

- Presence of a lump or thickening in the breast;
- Swelling, dimpling, redness, or soreness of skin;
- Change in shape or appearance of the nipple; and
- Nipple discharge.

A physician should be consulte if they persist. It is important to note, however, that these symptoms may be cause by factors unrelated to cancer. Most breast cancers are detected on mammograms before any symptoms therefore; regular screening is of the utmost importance.

A painless lump in the breast, changes in the breast size and shape, swelling in the armpit, Nipple changes or discharge. Breast pain can also be a symptom of cancer, but this is not common. There are often no symptoms of the breast cancer, but sometimes women may discover a breast problem on their own, Signs and symptoms to be aware of may include (Nowak, 2004).

2.4 Risk factors for breast cancer

Every woman wants to know what she can do to lower her risk of breast cancer. Some of the factors associated with breast cancer -- being a woman, your age, and your genetics, for example -- can't be changed. Other factors -- being overweight, lack of exercise, smoking cigarettes, and eating unhealthy food - can be changed by making choices. By choosing the healthiest lifestyle options possible, you can empower yourself and make sure your breast cancer risk is as low as possible (Singletary SE, 2003).

2.4.1 Breast Ultrasound:

Ultrasound is an essential breast imaging tool. Initially, the role of breast ultrasound was solely to distinguish cysts from solid masses. However, with major advances in ultrasound technology during the past 20 years, ultrasound can also now distinguish benign and malignant solid breast masses.

Ultrasound is now used to evaluate masses seen on mammography and magnetic resonance imaging (MRI) and may also be used to evaluate clinical breast symptoms such as palpable masses, focal pain and suspicious nipple discharge. Moreover, ultrasound is the imaging modality of choice for image guided breast biopsies. Knowledge of the specific benign and malignant ultrasound characteristics of breast masses is imperative for accurate diagnosis and optimal patient management.

The reason why any lesion is visible on mammography or US is the relative difference in the density and acoustic impedance of the lesion, respectively, as compared to the surrounding breast tissue.

This is exemplified in women with dense breast tissue, where US is useful in detecting small breast cancers that are not detected on mammography (Appleton DC, Hackney L, Narayanan S. 2014).

2.4.2 Normal breast parenchymal patterns

In the young non-lactating breast, the parenchyma is primarily composed of fibroglandular tissue, with little or no subcutaneous fat. With increasing age and parity, more and more fat gets deposited in both the subcutaneous and retromammary layers (*Br J Radiol*. 2003).

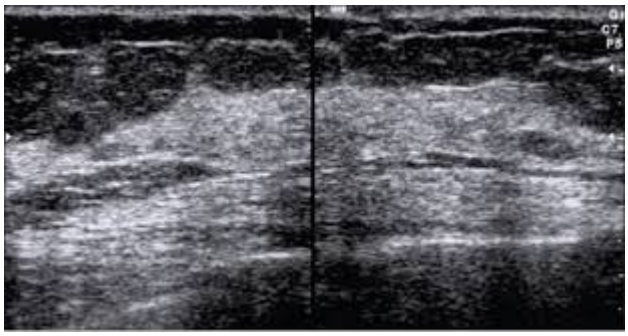

Figure (2.5) Normal breast. Mid transverse scan of a normal breast. The fibroglandular parenchyma is echogenic (arrowheads) and is surrounded by hypoechoic fat

Mammographic features are associated with breast cancer risk, but estimates of the strength of the association vary markedly between studies, and it is uncertain whether the association is modified by other risk factors; according to study conducted from w Fajardo LL, Hillman BJ, Frey C. Correlation between breast parenchymal patterns and mammographers' certainty of diagnosis. Normal breast parenchymal patterns.

2.5 Abnormal appearances

2.5.1 Breast cysts

Breast cysts are the commonest cause of breast lumps in women between 35 and 50 years of age. A cyst occurs when fluid accumulates due to obstruction of the extra lobular terminal ducts, either due to fibrosis or because of intraductal epithelial proliferation. A cyst is seen on USG as a well-defined, round or oval, anechoic structure with a thin wall. They may be solitary or multiple.

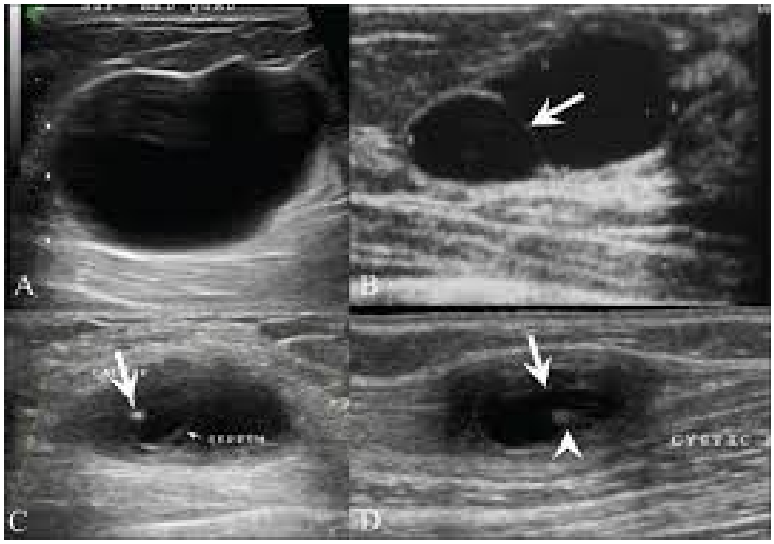

Figure (2.6) (A–D) Breast cysts usually reveal thin walls and through transmission (A). An inflamed cyst (B) reveals A thick edematous wall (arrow) with internal layering of thick/thin fluid (arrowhead). A galactocele (C) reveals diffuse low-level echoes in the cyst. Chronic.

Complex cyst*:* When internal echoes or debris are seen, the cyst is called a complex cyst. These internal echoes may be caused by floating cholesterol crystals, pus, blood or milk of calcium crystals (Berg, 2001).

2.5.2 Chronic abscess of the breast

Patients may present with fever, pain, tenderness to touch and increased white cell count. Abscesses are most commonly located in the central or subareolar area. An abscess may show an ill-defined or a well-defined outline. It may be anechoic or may reveal low-level internal echoes and posterior enhancement.

2.6 Fibrocystic breast condition

This condition is referred to by many different names: fibrocystic disease, fibrocystic change, cystic disease, chronic cystic mastitis or mammary dysphasia. The USG appearance of the breast in this condition is extremely variable since it depends on the stage and extent of morphological changes. In the early stages, the USG appearance may be normal, even though lumps may be palpable on clinical examination. There may be focal areas of thickening

of the parenchyma, with or without patchy increase in echogenicity. Discrete single cysts or clusters of small cysts may be seen in some Focal fibrocystic changes may appear as solid masses or thin-walled cysts. About half of these solid masses are usually classified as indeterminate and will eventually require a biopsy.

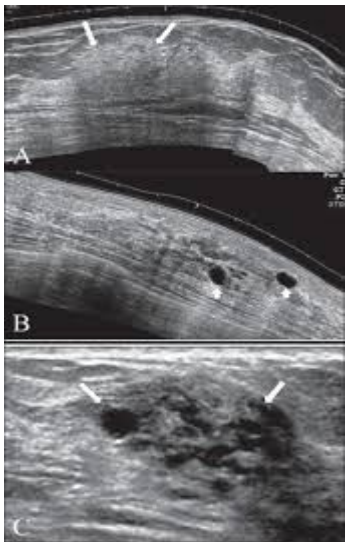

Figure (2.7) (A-C) Fibrocystic breast condition. Fibrocystic change. Extended view images (A, B) show a focal area of thickening of the breast parenchyma (A) with patchy increase in echogenicity (arrows) and scattered, discrete, thin-walled cysts (arrowheads in B). The lump may shows…

2.6.1 Duct ectasia

This lesion has a variable appearance. Typically, duct ectasia may appear as a single tubular structure filled with fluid or sometimes may show multiple such structures as well. Old cellular debris may appear as echogenic content. If the debris fills the lumen, it can be sometimes mistaken for a solid mass, unless the tubular shape is picked up

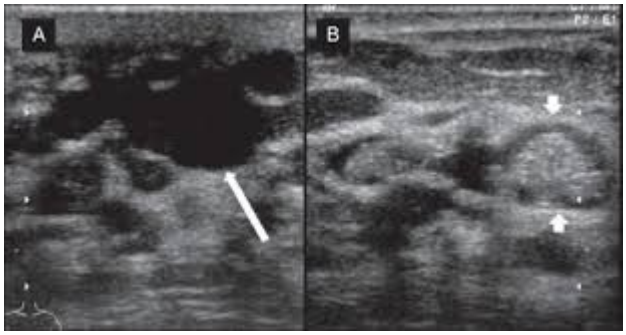

Figure (2.8) (A, B) Duct ectasia Chronic duct ectasia. Longitudinal image (A) shows a dilated duct containing inspissated debris (arrow) is seen. In crosssection (B), the intraductal debris may appear as a focal lesion (arrowheads)

2.6.2 Fibroadenoma

Fibroadenoma is an estrogen-induced tumor that forms in adolescence. It is the third most common breast lesion after fibrocystic disease and carcinoma. It usually presents as a firm, smooth, oval-shaped, freely movable mass. It is rarely tender or painful. The size is usually under 5 cm, though larger fibroadenomas are known. Fibroadenomas are multiple in 10–20% and bilateral in 4% of cases. Calcifications may occur. On USG, it appears as a well-defined lesion. A capsule can usually be identified. The echotexture is usually homogenous and hypoechoic as compared to the breast parenchyma, and there may be low-level internal echoes. Typically, the transverse diameter is greater than the anteroposterior diameter. In a small number of patients, the mass may appear complex, hyperechoic or isoechoic. A similar USG appearance may be seen with medullary, mucinous or papillary carcinoma.

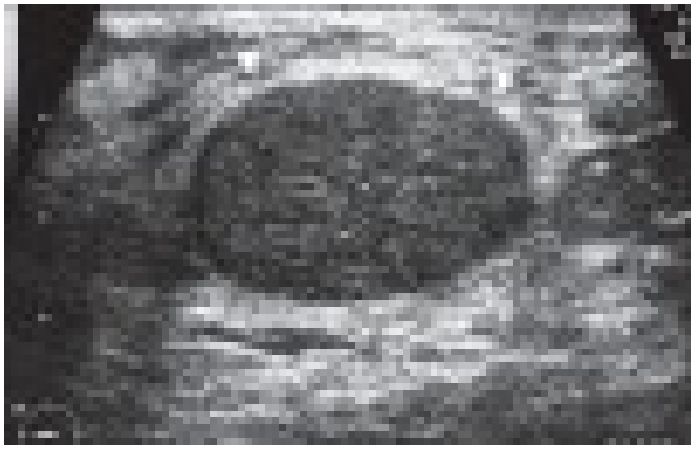

Figure (2.9) Fibroadenoma. Transvere image reveals a typical larger transverse than anteroposterior diameter, homogenous echotexture, and a thin capsule (arrowheads)

2.6.3 Cystosarcoma phyllodes

This is a large lesion that presents in older women. Some authors consider it to be a giant fibroadenoma. The mass may involve the whole of the breast. It usually reveals well-defined margins and an inhomogeneous echostructure, sometimes with variable cystic areas. The incidence of malignant change is low.

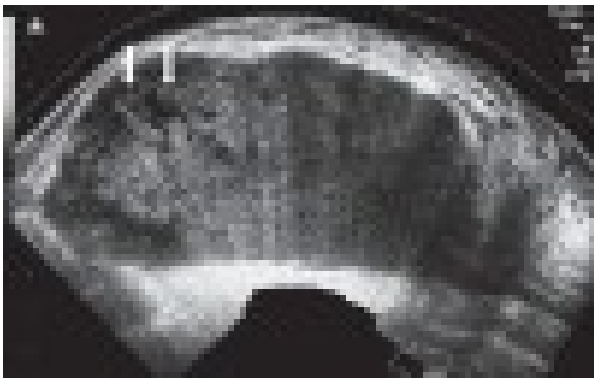

Figure (2.10) Cystosarcoma phyllodes. Transverse scan reveals a large well-defined mass. There is inhomogeneous echotexture, with small areas of cystic degeneration (arrows)

2.6.4 Lipoma

Lipoma is a slow-growing, well-defined tumor. It may be a chance finding or the patient may present with complaints of increase in the size of the involved

breast, though no discretely palpable mass can be made out. The tumor is soft and can be deformed by compression with the transducer. A thin capsule can usually be identified and the tumor often reveals an echogenic structure, with a stippled or lamellar appearance.

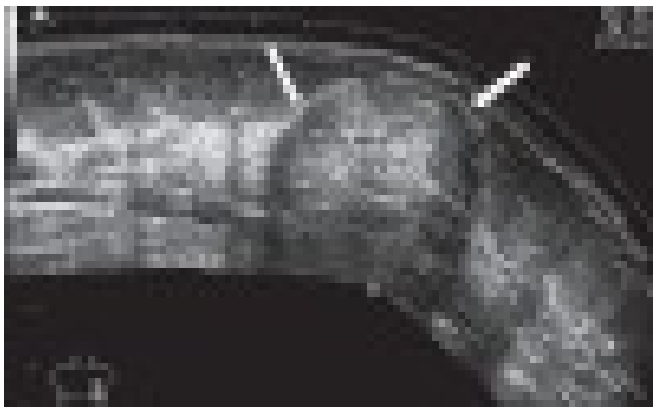

Figure (2.11) Lipoma. Sagittal extended view reveals a subtle echogenic mass with a reticular pattern and a well-defined, thin capsule (arrows)

Breast ultrasound: criteria for benign lesions

Several studies have described the sonographic characteristics commonly seen in benign lesions of the breast:

1. Smooth and well circumscribed
2. Hyperechoic, isoechoic or mildly hypoechoic
3. Thin echogenic capsule
4. Ellipsoid shape, with the maximum diameter being in the transverse plane
5. Three or fewer gentle lobulations
6. Absence of any malignant findings

2.7 Breast cysts

Breast cysts are the commonest cause of breast lumps in women between 35 and 50 years of ageA cyst occurs when fluid accumulates due to obstruction of the extralobular terminal ducts, either due to fibrosis or because of intraductal epithelial proliferation. A cyst is seen on USG as a well-defined,

round or oval, anechoic structure with a thin wall, they may be solitary or multiple Characteristics of malignant lesions. Malignant lesions are commonly hypoechoic lesions with ill-defined borders. Typically, a malignant lesion presents as a hypoechoic nodular lesion, which is ‘taller than broader’ and has speculated margins, posterior acoustic shadowing and microcalcifications. Three-dimensional scanners with the capability of reproducing high-resolution images in the coronal plane provide additional important information. The spiky extensions along the tissue. It was initially believed that color Doppler scanning would add to the specificity of US examination, but this has not proven to be very efficacious; however, in certain situations it does help resolve the issue, particularly when there is significant vascularity present within highly cellular types of malignancies Benign and malignant characteristics of breast lesions at ultrasound according to astudy conducted fromDr Henry Knipe and Dr Frank Gaillard et al.

2.7.1 Criteria for benign lesions

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2.8 Previous study

2.8.1 Differentiation masses in the breast using ultrasound

According to a study carried *by British Journal of Cancer* (2012) .Mmammographic screening are routinely investigated using ultrasound and often ultrasound guided core biopsy (Liston and Wilson, 2010; Willett

et al, 2010). Despite the accuracy of greyscale ultrasound in differentiating benign from malignant solid breast masses, such masses usually undergo either image guided core biopsy or short-term follow-up (Stavros *et al*, 1995).

Static ultrasound elastography, which has been available for many years, provides a colour map of tissue elasticity superimposed on the real-time greyscale ultrasound image. Invasive breast cancers are stiff compared with normal and benign tissues (Fleury *et al*, 2009) and often show areas of stiffness which are larger than the greyscale abnormality (Itoh *et al*, 2006; Schaefer *et al*, 2011). To overcome the lack of quantitative data generated by static elastography, scoring systems comparing the size and distribution of areas of elasticity within the greyscale ultrasound abnormality have been developed (Itoh *et al*, 2006; Fleury *et al*, 2009). Static elastography has been shown to have similar diagnostic performance to conventional greyscale ultrasound imaging but poor interobserver variability has prevented its widespread use (Regner *et al*, 2006; Burnside *et al*, 2007).

Shear wave elastography allows acquisition of objective measurements of lesion stiffness in kilopascals, unlike static elastography which does not give quantitative results (Athanasiou *et al*, 2010). Shear wave elastography has been shown to yield accurate information with regard to benign/malignant differentiation of solid breast masses in two previous small studies (Athanasiou *et al*, 2010; Evans *et al*, 2010). The small amount of data available suggests good shear wave reproducibility with an intraclass correlation coefficient of 0.80. This contrasts with the poor reproduciblity seen with static elastography (Regner *et al*, 2006; Burnside *et al*, 2007; Evans *et al*, 2010).

There has been only two large published study assessing the diagnostic

performance of shear wave elastography combined with greyscale ultrasound to differentiate between benign and malignant solid breast masses (Chang *et al*, 2011; Berg *et al*, 2012), and no previous studies have assessed the reproducibility of shear wave elastography when four images rather than two are analysed. The BE1 study addressed the reproducibility of the interpretation of shear wave images but not the reproducibility of shear wave images of the same lesion taken by different operators (Cosgrove *et al*, 2011). Most shear wave studies have used the mean stiffness findings most useful, however, the BE1 study found the maximum stiffness value most helpful in distinguishing benign from malignant breast masses.

The aim of the study was to assess the performance of shear wave elastography combined with BI-RADS classification of greyscale images for benign/malignant differentiation in a large group of patients.

Sonographic features of the most common benign breast lesions

The classification of benign breast lesions on the basis of histological origin

Cysts are cause by over-distension of the terminal duct lobular units (TDLU) due to progressive filling with liquid, fibrosclerosis of the loose connective intralobular tissue and coalescence of single dilated ductules in a polylobated mass up to a single tensive cyst.

Cysts can be divided into three groups: simple, complicated and complex cysts. Simple cysts present five basic characteristics: a well-circumscribed appearance, anechoic contents, a thin echogenic external capsule, enhanced through-transmission and subtle acoustic shadows at the edges . Cysts with these features are very common in women of 30–50 years of age, and unless they are symptomatic they do not require evacuation or monitoring. If the mass is mammographically visible or palpable, it is important to make sure that this finding corresponds to the cyst and that there are no adjacent, more important, solid lesions.

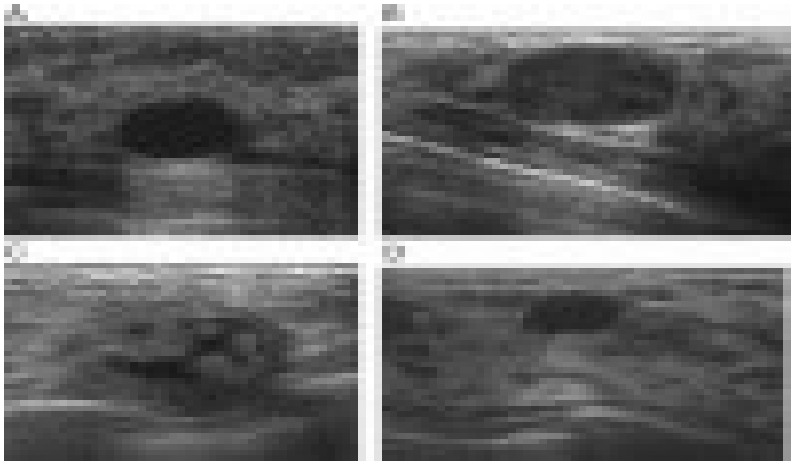

Figure (2.12) Simple cyst (A): US shows a mass which appears well-circumscribed, with anechoic contents, thin echogenic exterior capsule, enhanced through-transmission, subtle acoustic shadowing at the edges. Complicated cyst (B): US shows that the content is not purely.

There may be possible echoes within the cyst due to technical artifacts or improper adjustment of the gain or due to excessive probe compression, which can generally be eliminated in harmonic imaging. There are also complicated cysts (so called because the content is not purely anechoic), which show diffused echoes of low amplitude, mainly due to the presence of amorphous material with cellular debris, blood cells and macrophages with foamy cytoplasm or liquid–liquid levels (e.g. galactocele). They should be evacuated if they are symptomatic or if there are diagnostic doubts.

High-grade invasive ductal carcinomas and medullary carcinomas, as well as extra mammary metastatic lesions can show a marked hypoechoic image and have a rounded shape with enhanced through-transmission, thereby simulating a complicated cyst. However, a careful analysis of the shape and contour of the lesion as well as Doppler evaluation will raise diagnostic suspicion.

Complex cysts, which are generally less worrisome when located in the breast than those arising in other organs, may indicate the presence of malignancy or infection.

Morphological features which are suspicious for malignancy are thick isoechoic intracystic septations, mural nodules, fibrovascular stalk in the solid components and a microcystic appearance or microlobulated contour. In 85%–90% of cases the lesion is a benign intracystic papilloma, and in the remaining 10%–15% of cases it is a papillary lesion with atypia or intracystic papillary carcinoma.

Definitive diagnosis requires histological analysis after core biopsy or preferably using vacuum-assisted device, leaving a marker to identify the sampling location. Morphological features indicating inflammation or infection are: relatively uniform isoechoic circumferential cyst wall thickening, hyperemia of the cyst wall and presence of blood in the cyst sediment with the image showing fluid-debris level. If these three features coexist and the patient is symptomatic, the sediment is likely to be purulent. In this case the patient should undergo needle aspiration with subsequent bacterial culture and antibiogram.

Abscesses may originate from infection of the subareolar ducts and/or preexisting galactocele (puerperal mastitis), or from ruptured ectatic ducts or cysts with initial chemical inflammation and subsequent bacterial superinfection. US features are similar and distinction is based on whether or not the patient is breastfeeding.

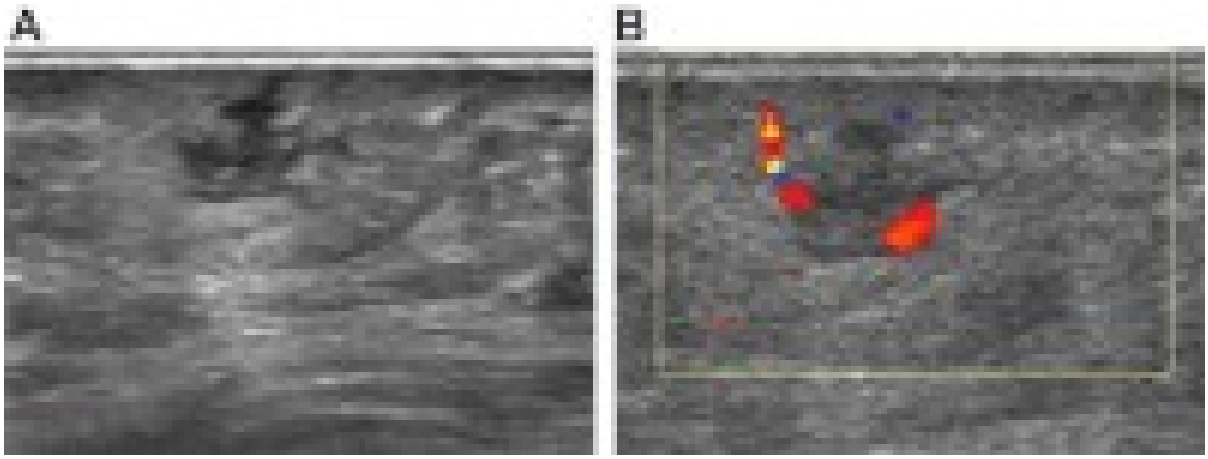

Figure **(2.13) Abscess: US shows a hypo-anechoic mass with irregular margins (A) and peripheral hypervascularity (B).**

Puerperal mastitis has an acute onset and although it is of lobar or sublobar origin, the classic inflammatory signs may involve the whole organ. Penetration of germs - more commonly Staphylococcus – occurs through a crack or fissure in the area of the nipple and it finds an excellent culture medium in the milk contained in the subareolar ducts or galactocele. If mastitis is not treated properly, an abscess will develop with necrotic tissue and denatured milk floating within the pus contained in the abscess cavity. When originating from a preexisting galactocele, the abscess may develop earlier and tend to be more demarcated with a roughly oval or multilobulated shape. When the subareolar ducts are involved, the abscess is often multiloculated due to the confluence of several small abscesses (Gordon PB, Goldenberg SL, 1995).

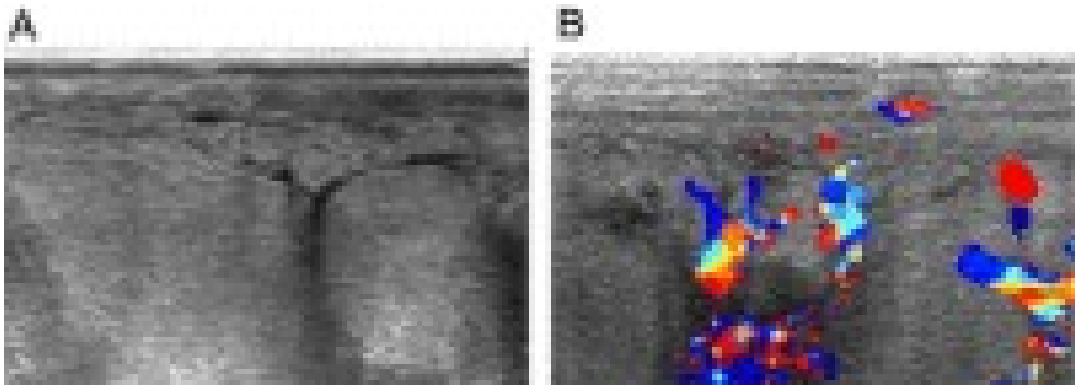

Figure (2.14) Mastitis: US shows subcutaneous and parenchymal edemaassociated with small fluid collections (A) and diffuse hypervascularity (B).

When the original event is a focal chemical mastitis caused by rupture of ducts or cysts and consequent release of lipid-rich secretions, it is an inflammatory condition involving the large ducts, known as ductal ectasia, which affects perimenopausal women. This often causes multilobar bilateral

involvement with episodes of focal periductal mastitis and abscesses which are typically located around the areola. Bacterial infection is a result of aspiration attempts or communication with ducts which are already colonized by germs or hematogenous seeding.

US image of these abscesses is elongated and follows the axis of the duct of origin, with markedly thickened walls, early involvement of the nipple and marked inflammation of the surrounding tissues.

Nonpuerperal abscesses tend to recur easily and become chronic with cutaneous fistula formation which can be difficult to eradicate. A marked fibrotic reaction causes permanent retraction of the nipple. In this case neoplastic disorder should be included in a differential diagnosis.

However, several other benign breast conditions may during their evolution go through phases mimicking complex cysts, such as galactocele, seroma, hematoma, liponecrosis and hemangioma. A painless lump developing during or a few weeks after ended breastfeeding is generally thought to be a galactocele. US monitoring may show spontaneous resolution, or a targeted aspiration may be carried out in cases of diagnostic doubt.

A galactocele is a cystic dilatation of the terminal ducts and ductules containing milk, so the appearance of a galactocele may vary during the monitoring. At first it appears as a anechoic cyst with possible septation, as the milk is fresh with homogeneously emulsified fat globules in a liquid component. Later the content becomes moderately echogenic, when the fat tends to form increasingly large and less emulsified globules, which are distributed unevenly or are suspended above the liquid component, sometimes forming the classic fat-fluid level which is also mammographically visible in the mediolateral view. When the milk is curdled, the galactocele may mimic a solid nodule; however, it is easily compressed, there is no vascular signal at color Doppler, and the contents may move according to the pressure. A chronic galactocele, whose liquid component has been completely

reabsorbed, may appear as a simple or complex lipid cyst.

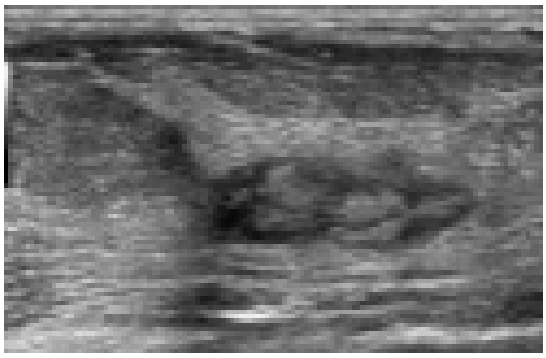

Figure (2.15) Galactocele in the intermediate stage: US shows moderately echogenic contents with fat tending to form voluminous unemulsified globules, which are distributed heterogeneously in the liquid component.

Seromas are collections of serous fluid arising unpredictably after interventional procedures, and they commonly occur after surgical resection or breast augmentation. After breast resection they occur at the level of the wound proportionally to the extension of the operation. After breast augmentation they tend to occur between the prosthetic shell and the fibrous capsule, more or less completely surrounding the prosthesis. Axillary seromas occurring due to lymph node dissection are actually lymphoceles. In both cases hemorrhagic extravasation may occur with consequent hematoma, particularly if the patient is receiving anticoagulant treatment.

These collections may be round or oval shaped if they are distended, whereas they may look angular and flat if the surgical cavity is slightly anfractuous. Seromas may initially be anechoic or markedly hypoechoic, but diffuse low-level echoes or thin fibrin septations subsequently appear within them. The presence of blood which tends to clot leads to sediment, pseudonodule, wall thickening and coarse septa formation showing no vascularity at power Doppler and a hypoechoic heterogeneous pattern at US becomes hyperechoic after coagulation. Hematoma may resolve spontaneously or become chronic with varying aspects mimicking also a solid mass, and it may develop

liponecrosis with possible wall calcification. In blunt trauma cases there may not be a real pseudocystic hematoma, but an edema in the adipose tissue may be observed in the presence of superficial skin bruising.

Liponecrosis is a nonsuppurative inflammatory process resulting from saponification of the adipose tissue after biopsy and/or surgical resection with seroma or hematoma formation and possibly exacerbated by subsequent radiotherapy. Extravasation of blood causes edema and stromal thickening with ischemia and necrosis due to increased local pressure and consequent adipocyte rupture. Accumulation of macrophages and plurinucleate giant cells containing necrotic lipid vacuoles results in an “oil cyst”, mammographically visible as a “soap bubble” image. If the initial US image shows a pseudonodular hyperechoic edematous area, fat liquefaction gives raise to a complex cyst. It is sometimes multilocular and has the appearance already described for seroma and hematoma (presence of echogenic bands and mural pseudonodules, often mobile when the patient changes position, yielding no vascular signals at color-power Doppler). During healing, cyst wall fibrosis develops, and parietal calcification occurs showing an egg-shell shape. Fibrous tissue may replace the fat content inside the cavity, and if the extent of necrosis and inflammation is important, the final stage may show an area of well-circumscribed hyperechoic fibrosis of irregular shape and angular edges, sometimes with acoustic absorption and shrinking or deformation of the surrounding tissues. In this case scirrhous carcinoma should be included in a differential diagnosis.

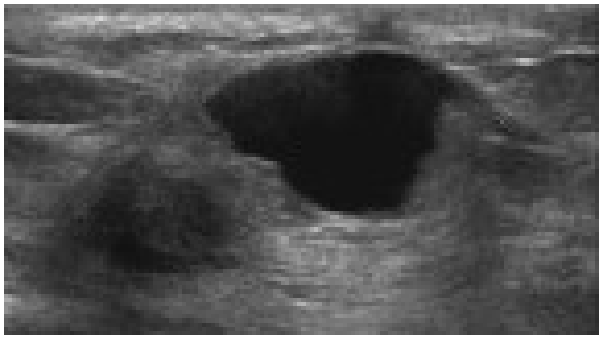

Figure (2.16) Liponecrosis: US shows a nodule mimicking a complex cyst. This benign vascular tumor is often clinically invisible

, although it is situated subcutaneously and can measure more than 1 cm in diameter. It is an oval or polylobed pseudonodular mass, and US appearance depends on the caliber of the blood vessels. Capillary hemangiomas are largely homogeneously hyperechoic and cavernous hemangiomas present a mixed echotexture. Both have a soft texture and can easily be compressed by probe pressure. In case of thrombosis, hypoechoic areas can be observed, often with phlebolithic calcifications, which are granular or amorphous.
Fibroadenomas are benign solid tumors developing from a terminal duct lobular unit due to uncoordinated proliferation of the epithelial and stromal component (presumably due to estrogen stimulation) which involves part of the surrounding tissues. These tissues are partially compressed by the expansive growth, thereby creating a sort of a pseudocapsule.
Fibroadenomas have an internal structure composed of stromal and epithelial elements. The stromal element may undergo a myxoid degeneration, such as sclerosis, hyalinization and calcification, whereas the epithelial element may present all possible proliferative and non-proliferative aspects of the breast parenchyma, such as apocrine metaplasia, ductal hyperplasia, sclerosing and florid adenosis. Fibroadenomas characterized by apocrine metaplasia, ductal hyperplasia, sclerosing adenosis or cysts are defined as “complex”.
Fibroadenomas have two peaks of incidence: in the third and in the fifth decade of life, but they may also occur after menopause as a result of hormone replacement therapy. They can grow rapidly but usually up to max. 2–3 cm. Giant and juvenile fibroadenomas are exceptions which may reach 6–10 cm. They have a highly cellular stroma and should be distinguished from benign phyllodes tumor. They can be multiple and bilateral in approximately 20%–25% of patients. During pregnancy and breastfeeding these lesions may become more irregular due to episodes of infarctions and

therefore more difficult to distinguish from carcinomas. However, carcinoma rarely develops within a fibroadenoma; this occurs in 1 out of 1000 cases with an increased risk related to “complex” fibroadenomas, and in that case they are mainly in situ while infiltrating carcinomas occur more rarely. At US examination, classic fibroadenomas, which are mobile and smooth, present the following characteristics: elliptical or slightly lobulated shape, horizontal orientation (transverse diameter greater than the anterior-posterior diameter), isoechoic or mildly hypoechoic echotexture, well-defined curvilinear margin with a complete thin, echogenic capsule, unaltered US beam transmission beyond the lesion and subtle acoustic shadows on both sides of the nodule.

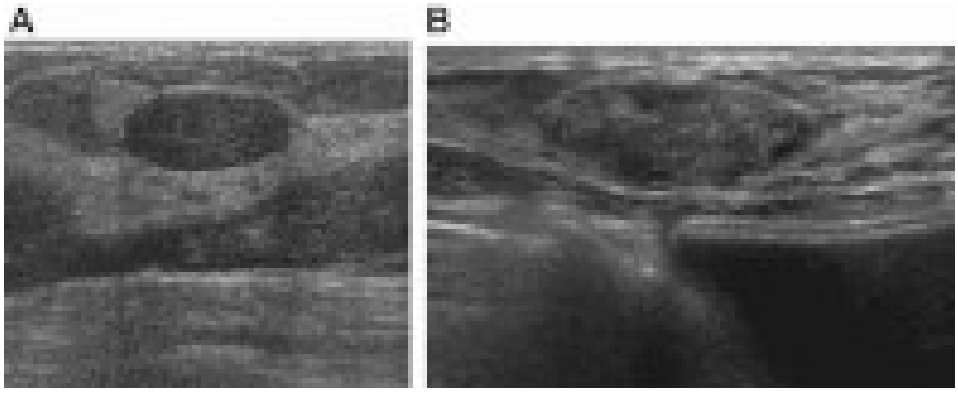

Figure (2.17)

Fibroadenoma (A): US shows an elliptic mass with horizontal orientation, slightly isoechoic echotexture, sharp rounded margins with a complete thin echogenic capsule, unaltered US beam transmission beyond the lesion, subtle edge shadowing on both sides …

If the nodule presents a microlobulated appearance, it differs from a classic or presumed fibroadenoma (BI-RADS 2 or 3) and becomes suspicious for malignancy (BI-RADS 4a), and needle biopsy with micro-histological analysis is therefore required. Complex” fibroadenomas also require histological analysis due to the presence of microcalcifications (associated with ductal hyperplasia), or heterogeneous echotexture due to the presence of microcysts (apocrine metaplasia) or small hyperechoic areas (sclerosing

adenosis).

Fibroadenoma variants with evident epithelial hyperplasia and a very little stromal component include tubular adenomas and lactating adenomas. The latter occurs particularly during breastfeeding and in the third trimester of pregnancy; it is sometimes quite big, elastic in consistency and therefore compressible almost like a lipoma. These lesions are scattered in the parenchyma, which presents widespread changes due to lactation; only rarely an evident pseudocapsule is seen, the shape is oval and generally microlobulated due to the presence of multiple microlobules or microcysts which contain milk. The echotexture is slightly hypoechoic, often mixed, but sometimes also hyperechoic, when the lipid component is not sufficiently emulsified in the liquid. Lactating adenomas present an elevated vascularization at color/power Doppler.

The term “phyllodes tumor” was introduced by Lemonaco in 1960. This lesion has so far been called by 62 different names, thereby indicating the difficulty encountered by the pathologists in characterizing the lesion since it was described by Muller for the first time in 1838 as a “cystosarcoma”. Later, Lee and Pack described the first case of malignant phyllodes tumor in 1931, and in 1946 Foote and Stewart concluded that malignant transformation arose from the stromal elements and not from the epithelial cells. In 1951, Treves and Sunderland divided phyllodes tumors into three subclasses: benign, borderline and malignant (classification still being used) based on the number of mitosis, the type of cellularity and nuclear atypia.

Phyllodes tumors account for 2%–3% of all fibroepithelial lesions and have a peak incidence in the perimenopausal age and another peak before the age of 20. Histologically there is a marked intraductal growth of intralobular stroma with leaflike projections (the term “phyllodes” originates from the Greek word “phyllos” = leaf) that are pathognomonic of this lesion. Among these hyperplastic stromal cells, distorted slitlike pseudocystic spaces are visible.

Phyllodes tumors are very similar to intracanalicular fibroadenomas, and histological underestimation is possible when a limited amount of sampling material is available (e.g. cytological sampling but also core biopsy). In these cases, diagnosis is assumed when the nodules are larger than 3 cm in diameter or fast-growing (benign lesions have an estimated doubling time of about 4 months, malignant lesions a little over one month). Phyllodes tumors presumably arise ex-novo and have an expansive growth that leads to the formation of a pseudocapsule consisting of compressed adjacent parenchyma. This aspect may also be present in the malignant variant, which more frequently presents infiltrating margins. It is therefore difficult to distinguish them taking into account that the histological features may vary from area to area within the mass. In the past, phyllodes tumors could exceed 10 cm in diameter, but nowadays diagnosis is made much earlier. Malignant transformation may lead to hematogenous distant metastases, such as sarcomas, without involving regional lymph nodes.
Excision must necessarily be large to prevent local recurrence.
Mammography shows a circumscribed mass of high density with lobulated margins, rarely with a few coarse calcifications. At US, a phyllodes tumor appears as a mildly hypoechoic mass, often pseudocapsulated, without posterior acoustic shadowing. Inside the mass, pseudocystic spaces are sometimes so compressed that they look like characteristic hyperechoic striations. Cystic spaces tend to be thinner and more horizontally oriented compared to the oval or round ones found in complex fibroadenomas. In the malignant variants, these pseudocystic spaces are coarser, and the echotexture may be rather heterogeneous due to areas of colliquative necrosis and reparative fibrosis (Liberman L, Bonaccio E, Hamele-Bena D. 1996).

Figure (2.18) Phyllodes tumor. US shows moderately hypoechoic nodules with pseudocapsule, unaltered US beam transmission beyond the lesion; characteristic hyperechoic striations within the lesion, expression of pseudocystic spaces.

Focal fibrosis corresponds to a focal area of homogeneous fibrous tissue with no glandular structures, and the US image therefore shows an intensely and homogeneously hyperechoic mass, well-circumscribed but not encapsulated, which is drop-shaped or spindle-shaped with a horizontal axis.

Diabetic mastopathy, which typically occurs about 20 years after diagnosis of type I diabetes, is a result of an altered collagen metabolism and it is a hard, palpable, painless nodule. Mammographic image is non-specific, but US appearance is very suspicious, similar to spiculated malignant lesions (a taller than wide hypoechoic mass with irregular margins and acoustic absorbtion). Like lobular carcinoma, diabetic mastopathy can be multifocal, multicentric and bilateral. Color Doppler US and particularly MRI may show a lack of vascularity and enhancement, but the US appearance still requires biopsy.

Pseudoangiomatous stromal hyperplasia (PASH), which is probably caused by excessive progestinic stimulation, is frequently a microscopic incidental

finding or it may be a real mass. Histological analysis shows dense breast stromal tissue containing a complex pattern of linear spaces caused by the separation of collagen fibrils, which resemble vascular spaces (hence the name “pseudoangiomatous”) and they may suggest a low grade malignant angiosarcoma (distinction is achieved by immunohistochemical markers for vascular tumors).

At US a number of PASH nodules are similar to complex fibroadenomas with heterogeneous echotexture and sometimes a few microcysts, or similar to phyllodes tumors, so they can be classified as BI-RADS 3, but in most cases the masses have irregular or microlobulated margins and they require biopsy.

Granular cell tumors (mioblastomas) are stromal tumors probably originating from Schwann cells, as they yield a positive reaction to S-100 protein. They may arise anywhere in the body, particularly in the tongue, but also in the breast, predominantly in the upper internal quadrant, i.e. the area which is innervated by the supraclavicular nerve. US image shows a hypoechoic or slightly hyperechoic nodule depending on whether the scan is parallel or perpendicular to the interior fibrils (anisotropy). The mass has an oval shape and a horizontal axis but seemingly the margins are infiltrative also at histological examination, often resulting in overlying skin dimpling, and biopsy is therefore always indicated.

Breast hamartomas are roughly oval masses with a thin pseudocapsule. They can be of varying size and contain variable amounts of fat, glandular tissue and fibrous connective tissue, all of normal histology. US image is usually heterogeneous with a variable mixture of isoechoic elements (fat and glandular tissue) and hyperechoic elements (fibrous connective tissue); it sometimes shows a target or multilayered appearance which is pathognomonic like the mammographic features. Consistency and compressibility depend on the fat component, which is extremely variable. Diagnosis may be difficult when the masses are small with a low component

of fat and an incomplete pseudocapsule. Hamartomas are most common in women over 40 years of age, and they are generally asymptomatic. They are not at risk of malignancy, so in cases of classic hamartomas further investigation or a specific follow-up is not required.

Figure (2.19) Hamartoma: US shows heterogeneous appearance of the lesion with a mixture of isoechoic (adipose tissue and glandular lobules) and hyperechoic (fibrous tissue) elements.

Papillomas are intraductal epithelial proliferations of papillary appearance; they have a fibrovascular stalk and are therefore well vascularized and highly cellular, being extremely soft and fragile. A distinction is usually made between papillomas which arise as single lesions in the large retro-periareolar ducts, most frequently in the perimenopausal period, and papillomas which arise in the peripheral ducts, most frequently seen in younger patients and most often as multiple lesions. The latter are associated with various proliferative aspects of the surrounding terminal ductal-lobular units, also with atypical characteristics; they are therefore considered at high risk of malignant transformation. Papillomas occurring in the large ducts may vary in size from a few millimeters up to extending over a variable length of the duct lumen involving the ramifications. They tend to release secretion resulting in the expansion of the duct itself and frequent spontaneous secretion from the nipple. The secretion is most commonly serous but due to partial infarction and necrosis of the papilloma, secretion may contain blood. As a result of

hypersecretion and expansive growth of the mass, duct obstruction may also occur resulting in cystic dilatation of the excretory duct and intracystic papilloma. Given the variable appearance and extent of intraductal papillomas, US diagnosis requires the presence of circumscribed ectasia of a milk duct whose lumen contains echoic material. In the early stages it may look like an isoechoic or slightly hypoechoic nodule with a microlobulated or lobulated surface and Color Doppler examination will show a marked vascular signal at the fibrovascular stalk. Later there will be signs linked to the expansion of the papilloma along the duct with involvement of the ramifications, and subsequently transformation to intracystic papilloma. Intraductal papilloma should be studied with scans performed along radial and antiradial planes and with alternated compression and decompression of the duct using the US probe to differentiate it from any mobile intraductal echoes associated with thickened secretions due to ductal ectasia. Color/power Doppler is essential to detect the absence of intraluminal vascular signals typical of all stages of ductal ectasia, which involves multiple milk ducts bilaterally, symmetrically or asymmetrically. Probe compression during Doppler examination should always be mild. The extension of the papilloma should be studied carefully at US examination using maneuvers aimed at following the course of the ducts, which are often tortuous, and at minimizing the possible interference of the nipple on the visibility of the most central portions of the ducts. Sometimes the papilloma may be masked by dense secretions or blood clots, which may be mobile and more compressible than the papilloma. Papilloma may therefore be assumed if there is still a residual circumscribed dilatation of the duct under compression. When papilloma becomes intracystic, the extension should be carefully investigated toward the proximal duct, where the mass arises. The lack of ductal extension suggests a cyst containing papillary apocrine metaplasia.

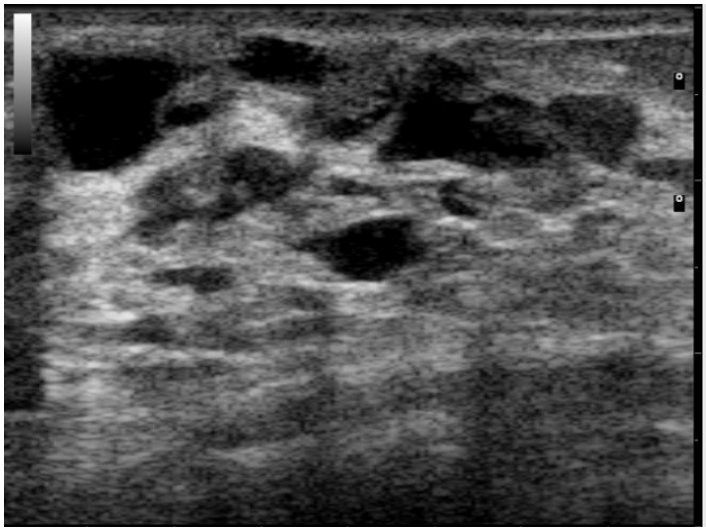

Figure (2.20) Intraductal papilloma: US shows a well-circumscribed subareolar duct ectasia with an isoechoic nodule with microlobulated surface in the lumen.

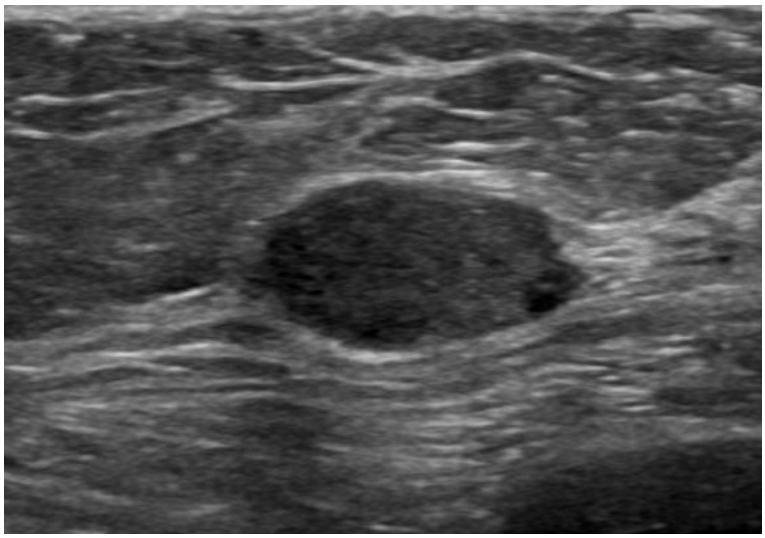

Figure (2.21) Intracystic papilloma: US shows a cyst with a prominent mass inside. In the presence of significant discharge from the nipple,

The finding of an intraductal vegetating mass will in most cases suggest a papilloma, whereas malignant forms are found in only 10% of cases. Like galactography, also US cannot clearly differentiate between papilloma, ductal carcinoma in situ (DCIS) and papillary carcinoma (usually intracystic), although the latter is more likely to occur with a palpable or mammographically visible mass, rather than with nipple discharge. Papillomas of peripheral ducts very rarely give rise to duct ectasia and nipple

discharge. They may be invisible at US, otherwise they should be included in the differential diagnosis between other benign and malignant solid nodules. US is often preferred to galactography in the study of nipple discharge, as it may provide a diagnosis of papilloma and localize the lesion with a view to surgical biopsy. US is also used as a guide for needle biopsy with vacuum-assisted devices, which is preferred to core biopsies because a greater amount of tissue is obtained (sometimes the entire lesion) with the possibility to make a more accurate histological diagnosis and often definitively stop the secretion. Inflammatory, infectious and reactive diseases rarely affect the breast, and these lesions generally occur as secondary locations in patients with known systemic or target-organ specific diseases.

The radiological and clinical features of breast lesions caused by immunologic, reactive, and infectious diseases (sarcoidosis, tuberculosis, Wegener's granulomatosis) often mimic those of malignancy, and they therefore frequently require biopsy considering the possible coexistence of both diseases. Some infectious diseases (echinococcosis, actinomycosis, blastomycosis) may result in localized lesions with US appearance of complex cysts. However, foreign body granulomatous lesions are more frequent, sometimes containing cholesterol crystals, and siliconomas are quite characteristic. Silicone gel leaking from a broken breast implant capsule or due to continuous transcapsular leakage gives rise to pericapsular granulomatous lesions, which often present the typical "snow-storm" US pattern. However, initially US image may be similar to that of a complex cyst; in the intermediate stage a granulomatous lesion may mimic an isoechoic nodule, and later, an ill-defined hypoechoic pseudonodular image may develop due to foreign body reaction and fibrosis with sound absorption, similar to carcinoma.

These lesions most frequently occur in the upper outer peripheral quadrant toward the axillary tail, but they can occur everywhere, even in the inner

marginal edge. The classic appearance of an oval or lobulated, isoechoic or hypoechoic nodule with well-circumscribed margins and a hyperechoic central fatty hilum provides the diagnosis without the need for further investigation.

Chapter Three

Material and Method

This research will be carried out by an ultrasound machine with linear transducer with highly frequency of (7.5-13 MHz) and color Doppler.

3.1 Designs of the study

This an analytical, case controlled study, which consisted of female clinical breast symptoms and abnormal mammogram cases

3.2 Population of the study

Adult Female patient evaluate clinical breast symptoms such as palpable masses, focal pain and suspicious nipple discharge As well as those female patients findings abnormal mammogram examination and refer to ultrasound to distinguish cyst or fibroadenoma… etc.

3.3 Sample and type of the study

The sample of this study consisted of 64 with female patient.

3.4 Duration and place of the study

The study will be conducted on the period from December 2014 to June 2015 in UAE in Khalifa A Center.

3.5 Technique of data collection

This research will be implemented by an ultrasound machine with high frequency line transducer (7.5—13 MHz)

Patient position: patient medial lesion

Patient is supine

Ipsilateral arm is placed over the patient’s head.

Lateral lesion

Patient is opposite.

Superior lesion

Patient is sitting

Apply gentle uniform pressure with ultrasound transducer.

Increase transducer pressure for

Greater penetration

Scanning the sub areolar region.

Scanning is done in three directions:

1. Radial
2. Transverse
3. Longitudinal

Localization is by the clock face.

3.6 Study variables

The variable of the study will be consisted of age, gender, weight, height, BMI, patient family history and sonographic features for benign and malignant solid masses.

3.7 Method of data analysis

- The data will be analyzed using Excel and SPSS high-frequency technology, particularly with 7.5–13 MHz probes, has brought out a totally new facet in US breast imaging. For example: High-density probes provide better lateral resolution
- Harmonic imaging leads to improved resolution and reduced reverberation and near-field artifacts
- Real-time compound scanning results in increased tissue contrast resolution
- Extended or panoramic views provide a better perspective of the lesion in relation to the rest of the breast

Harmonic imaging and real-time compounding has been shown to improve image resolution and lesion characterization. More recently, US elastography seems to be quite promising. Initial results indicate that it can improve the specificity and positive predictive value of US in the characterization of breast masses.

Chapter four – Results

Table (4.1): show the age range and the frequency with the percentage.

age	Frequency	Percent
18 - 30	2	3.1
31-50	43	67.2
51 - 70	17	26.6
71 and above	2	3.1

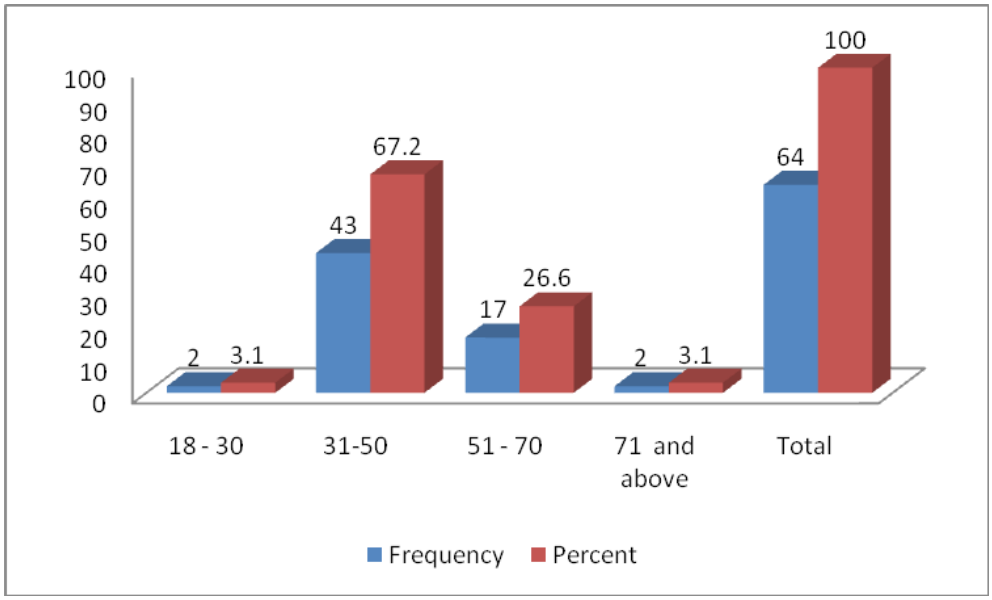

Figure (4.1): illustrate the block diagram of frequency values with percent.

Table (4.2) the margin

Margin	Frequency	Percent
Around	3	4.7
ill defined	1	1.6

Margin	Frequency	Percent
Irregular	2	3.1
irregular with speculated & angulations	2	3.1
irregular, microlobulated&angulation	1	1.6
not well circumscribed	3	4.7
Lobulated	6	9.4
lobulated &angulation	2	3.1
Loculated	1	1.6
Macrolobulated	3	4.7
microlobulated &angulation	1	1.6
Multiloculated	1	1.6
obscured margin	1	1.6
Oval	1	1.6
Retoareolar dilated ducts , no intraductal solid component ,	1	1.6
Speculated	5	7.8
speculated & angulation … tall more than width	1	1.6
speculated & angulation	13	20.3
well defined	16	25.0
Total	64	100.0

Table (4.3) Shape

Shape	Frequency	Percent
Around	4	6.2
around and oval	2	3.1
ill defined	24	37.5
Macrolobulated	2	3.1
Oval	17	26.6
Speculated	2	3.1
Tubal	2	3.1
well defined	11	17.2

Shape	Frequency	Percent
Total	64	100.0

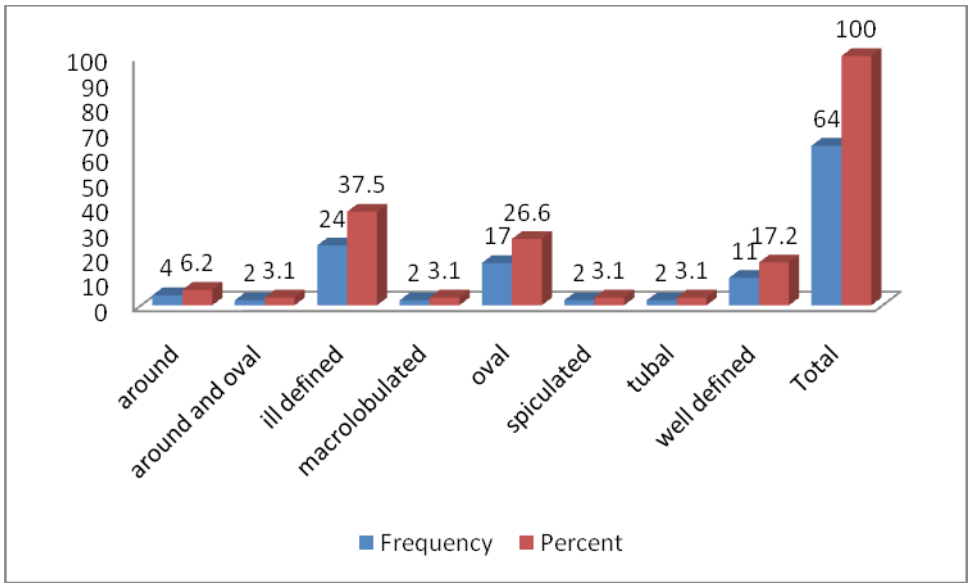

Figure (4.3): illustrate the relation with frequency and the percent (around, around and oval ,ill defined, oval, speculated,tubal,well defined, total).

3. ECHOGENICITY

Table (4.4): show the echogenicity and the frequency related with percent.

Echogenicity	Frequency	Percent
an echoic	2	3.1
Hetergenous	4	6.2
Hypeochoic	52	81.2
hypoechoic & isoechoic	2	3.1
Isoechoeic	4	6.2

Echogenicity	Frequency	Percent
Total	64	100.0

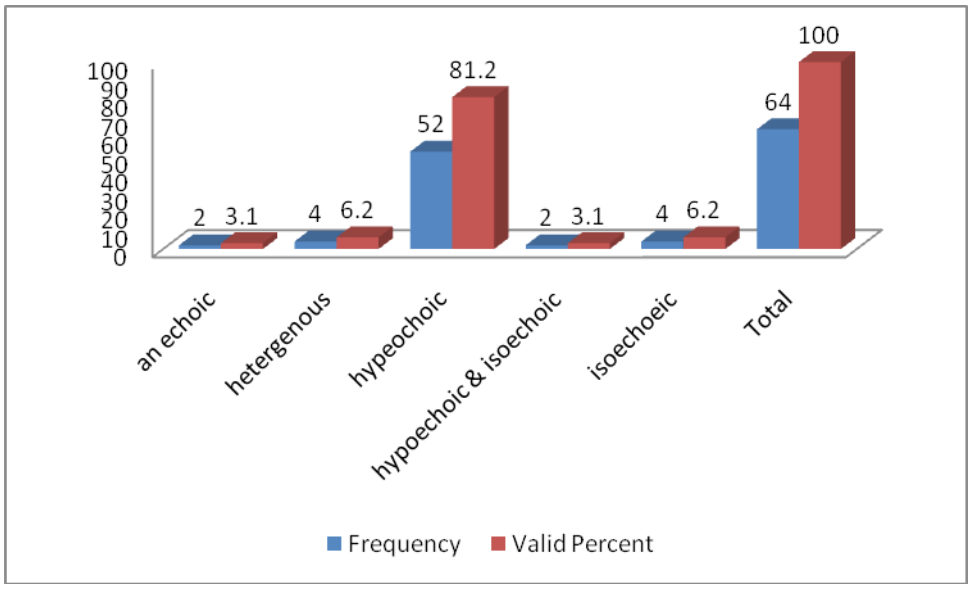

Figure (4.4): which illustrate the frequency and valid result which is taken in to the values.

Table (4.5): show posterior with the frequency and percent

Posterior	Frequency	Percent
Yes	11	17.2
No	53	82.8
Total	64	100.0

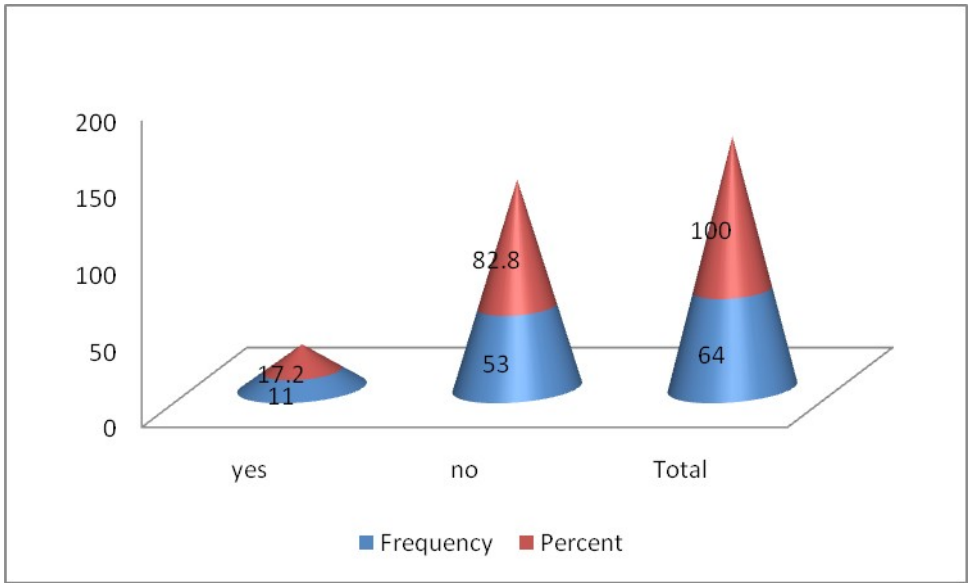

Figure (4.5): which illustrate the data with cone shape between the frequency and the percentage.

Table (4.6): Show the acoustic relation with frequency and percent.

acoustic	Frequency	Percent
No	18	28.1
Yes	46	71.9
Total	64	100.0

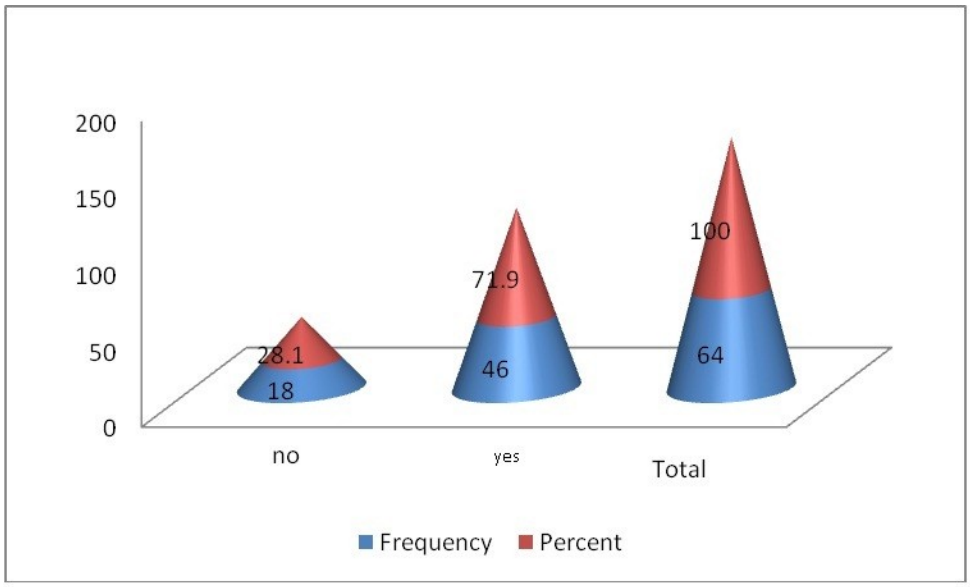

Figure (4.6): illustrate the results of the table above the x-axis show the

frequency and the y-axis percent.

Table (4.7): Show the result vascular with frequency and percentage.

Vascular	Frequency	Percent
Central	2	3.1
Internal	9	14.1
No	41	64.1
Peripheral	6	9.4
peripheral & internal	6	9.4
Total	64	100.0

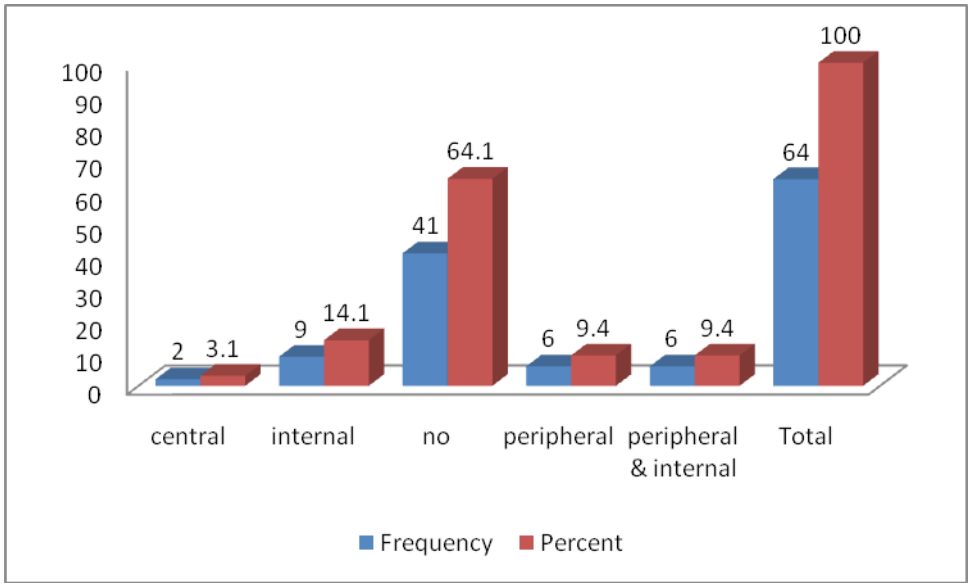

Figure (4.7): illustrate the relation between frequency data and percentage

Table (4.8): show the lymph and the frequency with the valid percentage and the total of both frequencies and the valid percent.

lymph	Frequency	Valid Percent
No	20	31.2
Yes	44	64.1

lymph	Frequency	Valid Percent
Solarity	20	3.1
Multiple	24	1.6
Total	64	100.0

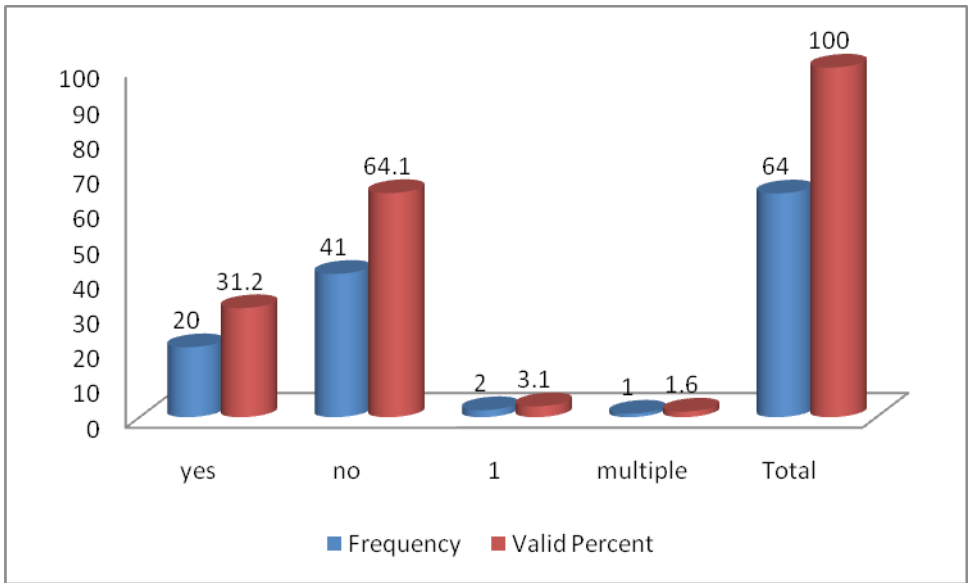

Figure (4.8): Chart illustrate the relation according to the frequency and valid percent.

Table (4.9): show calcification of frequency percentage

calcification	Frequency	Percent
No	23	35.9
Yes	41	64.1
Total	64	100.0

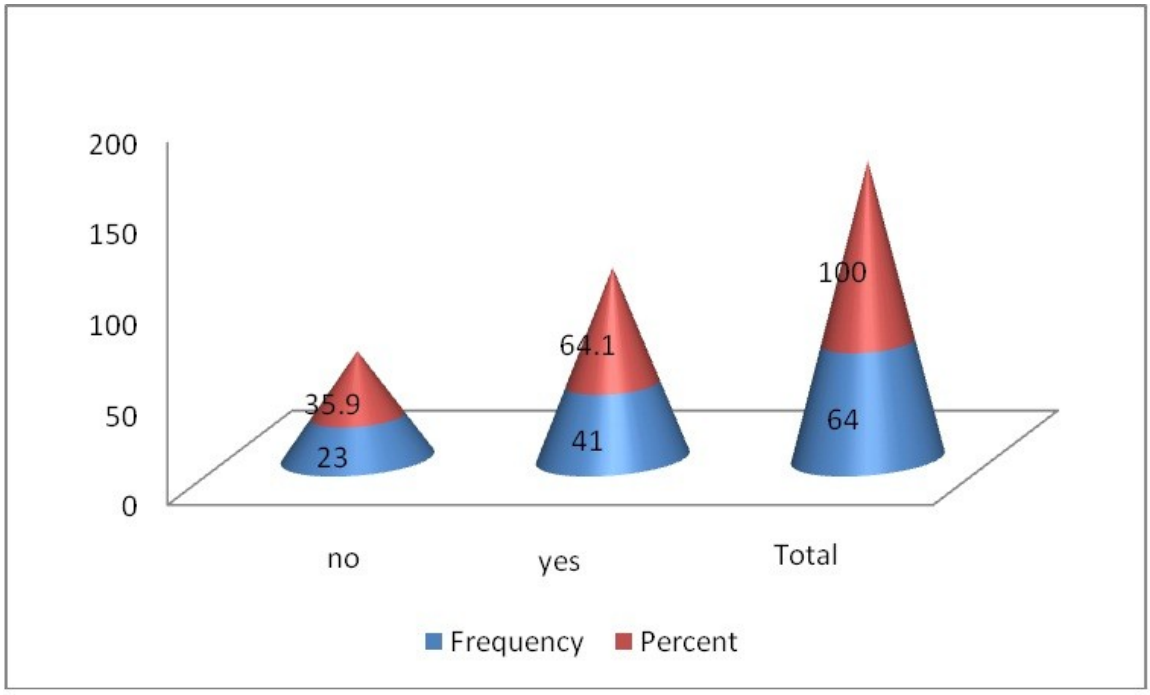

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Figure (4.9): Cone chart with frequency and percentage data

Table (4.10): show the correlation which is significant at 0.01 level (2-tailed) between the vascular and calcification.

Correlations			
		vascular	Calcification
Vascular	Pearson Correlation	1	.565**
	Sig. (2-tailed)		.000
	N	64	64
Calcification	Pearson Correlation	.565**	1
	Sig. (2-tailed)	.000	
	N	64	64
**. Correlation is significant at the 0.01 level (2-tailed).			

Table (4.11): show the predicators. (Constant), age

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.068[a]	.005	-.011-	2.08959
a. Predictors: (Constant), age				

Table (4.12): show the predicators.(dependent) ,age

ANOVA[b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.267	1	1.267	.290	.592[a]
	Residual	270.717	62	4.366		
	Total	271.984	63			
a. Predictors: (Constant), age						
b. Dependent Variable: shape						

Chapter five

Discussion, conclusion and recommendation

5.1 Discussions

The appearance of specific types of breast mammography carcinoma have been studied. Although appearances vary greatly, some patterns are typical. Mucin-containing carcinomas are often circumscribed but may have irregular

margins. These lesions may be either hypoechoic or isoechoic relative to subcutaneous fat. , mammography showed hypoechoic, solid masses in all of their cases.

The lesions demonstrated acoustic shadowing or increased acoustic enhancement. Some lesions had circumscribed margins, and some were not circumscribed.

Tubular carcinoma is usually hypoechoic but is without circumscribed margins and acoustic posterior shadowing. Invasive ductal carcinoma typically appears as an irregularly shaped mass with spiculated margins with shadowing and architectural distortion of adjacent breast tissue. This lesion may contain malignant microcalcifications.

Invasive lobular carcinoma often does not cause a desmoplastic reaction. This type is frequently missed on mammography and may be difficult to see on sonograms. Butler et al reported that these lesions were ultrasonographically occult in 12% of their cases. In approximately 60% of cases, it appeared as a heterogeneous, hypoechoic mass with angular or ill-defined margins and posterior acoustic shadowing. In 15% of cases, US demonstrated focal shadowing without a discrete mass; in 12% of cases, US showed a lobulated, circumscribed mass.

Medullary carcinoma often appears as a hypoechoic mass with acoustic enhancement (increased through transmission). It may be mistaken for a cyst on US.

So at al studied papillary carcinoma of the breast; they found that the cystic in situ form may appear as either a solid mass or a complex cystic mass with an internal solid component. In both types, acoustic enhancement tends to be increased. Doppler study may demonstrate intratumoral blood flow. Invasive papillary carcinoma usually appears as a solid mass, although it may also appear as a complex cystic and solid mass.

Ductal carcinoma in situ of the breast often appears as suggestive micro

calcifications on mammography. However, it may occasionally appear as a solid mass on ultrasound.

After more covering study within 64 patients, is to identify sonographic criteria for benignancy and malignant masses. It's would probably be an irregular, heterogeneous, hypoechoic mass, with speculations and angular margins.

The table (4.4) shows the illustrated the relation with frequency and the percent to high light the effective it's, in different sample shown.

The echogenicity is greater in hypoechoic and is less than in the anechoic, hypoechoic and isoechoic. Even in, table (4.5) posterior is more negativity than positivity, acoustic Table (4.9) and classification cross tabulation table (4.10), is shown the more positivity and less negativity. What given in lymph is different because there is multiple which less than both negative is and positive, what has been delivered with age is shown that the age between 31-50 years is more affective age with masses.

According to vascular in the table (4.7) shown more exception than refuse.

5.2 Conclusion

This work was facilitated by evolving technical improvements in US equipment that provided better resolution and images. They demonstrated that US maybe used to accurately classify some solid lesions as benign, allowing follow-up with imaging rather than biopsy.

5.3 Recommendation

For the diagnosis of any breast lump it cannot be relied a single imaging modality as none of the currently available test is sufficiently sensitive and specific to make a definite diagnosis. Hence it's important to have a multidisciplinary (triple) assessment, based on clinical, imaging and histological examination.

Whereas additional information may be gained from the presence of color in breast masses on Power Doppler flow mapping, we must rely primarily on clinical, mammographic and the combined sonographic characteristics of masses to provide the most comprehensive and beneficial individualized patient care. After mammography and physical examination, ultrasound is clearly the most available non-invasive tool we have evaluation of breast masses. We suggest that mammographers should utilize this versatile modality, both to guide biopsy and reduce the numbers of biopsies and concomitantly, patient and physician anxiety.

Guidelines for optimal use of Elastography and Doppler ultrasound have been proposed. It's also recommended that more recent ultrasound developments be tested in a quest to improve the sensitivity of this imaging modality as a predictor of malignancy.

Discrepancies between B-mode and strain images may be promising tools for distinguishing benign from malignant lesion.

We also recommended all of female patients less than 40years old to do ultrasound scan as screening to predict early breast cancer.

The most profound limitation of the study was the small sample size. So we recommended that multicenter study with larger sample be considered.

References

Appleton DC, Hackney L, Narayanan S. 2014 Apr.Ultrasonography alone for diagnosis of breast cancer in women under 40. *Ann R Coll Surg Engl*. 96(3):202-6.

Baker JA, Kornguth PJ, Soo MS, et al. 1999 Jun. Sonography of solid breast lesions: observer variability of lesion description and assessment. *AJR Am J Roentgenol*. 172(6):1621-5.

Bassett LW, Ysrael M, Gold RH, Ysrael C1991 Sep. Usefulness of mammography and sonography in women less than 35 years of age. *Radiology*.. 180(3):831-5.

Berg WA, Zhang Z, Lehrer D, Jong RA, Pisano ED, Barr RG, et al. Detection of breast cancer with addition of annual screening ultrasound or a single screening MRI to mammography in women with elevated breast cancer risk. *JAMA*. 2012 Apr 4. 307(13):1394-404.

Berg WA. Rationale for a trial of screening breast ultrasound: American College of Radiology Imaging Network (ACRIN) 6666. *AJR Am J Roentgenol*. 2003 May. 180(5):1225-8.

Beyer T, Moonka R. Normal mammography and ultrasonography in the setting of palpable breast cancer. *Am J Surg*. 2003 May. 185(5):416-9.

Bosch AM, Kessels AG, Beets GL, et al. Interexamination variation of whole breast ultrasound. *Br J Radiol*. 2003 May. 76(905):328-31.

Butler RS, Venta LA, Wiley EL, et al. 1999 Feb. Sonographic evaluation of infiltrating lobular carcinoma. *AJR Am J Roentgenol*. 172(2):325-30.

Conant EF, Dillon RL, Palazzo J, et al. 1994 Oct. Imaging findings in mucin-containing carcinomas of the breast: correlation with pathologic features. *AJR Am J Roentgenol*. 163(4):821-4.

Crystal P, Strano SD, Shcharynski S, Koretz MJ2003 Jul. Using sonography to screen women with mammographically dense breasts. *AJR Am J Roentgenol*. 181(1):177-82.

CT MR. 2000 Aug. 21(4):325-36.

Evans WP. Breast masses. Appropriate evaluation. *Radiol Clin North Am*. 1995 Nov. 33(6):1085-108.

Georgian-Smith D, Taylor KJ, Madjar H, et al 2000 Jun. Sonography of palpable breast cancer. *J Clin Ultrasound*.. 28(5):211-6.

Gordon PB, Goldenberg SL. Malignant breast masses detected only by ultrasound. A retrospective review. *Cancer*. 1995 Aug 15. 76(4):626-30.

Hall FM. Screening breast US. *Radiology*. 2002 Sep. 224(3):930-1; author reply 931-2.

Hall FM. Screening breasts US. *Radiology*. 2003 May. 227(2):607-8; author reply 608-9.

Houssami N, Irwig L, Simpson JM, et al. Sydney Breast Imaging Accuracy Study: Comparative sensitivity and specificity of mammography and sonography in young women with symptoms. *AJR Am J Roentgenol*. 2003 Apr. 180(4):935-40.

Huber S, Wagner M, Medl M, Czembirek H. 2003 Mar.. Benign breast lesions: minimally invasive vacuum-assisted biopsy with 11-gauge needles patient acceptance and effect on follow-up imaging findings. *Radiology*. 226(3):783-90.

Jackson VP, Reynolds HE, Hawes DR. 1996 Oct .Sonography of the breast. *Semin Ultrasound CT MR*.. 17(5):460-75.

Jackson VP. Management of solid breast nodules: what is the role of sonography?. *Radiology*. 1995 Jul. 196(1):14-5.

Joseph E, Clark R, Berman C, et al. Screening Childhood Cancer Survivors for Breast Cancer. *Oncologist*. 1997. 2(4):228-234.

Kerlikowske K, Smith-Bindman R, Ljung BM, Grady D. Evaluation of abnormal mammography results and palpable breast abnormalities. *Ann Intern Med*. 2003 Aug 19. 139(4):274-84.
Kim AH, Kim MJ, Kim EK, Park BW, Moon HJ. 2014 Jul. Positive predictive value of additional synchronous breast lesions in whole-breast ultrasonography at the diagnosis of breast cancer: clinical and imaging factors. *Ultrasonography*. 33(3):170-7.

Kolb TM, Lichy J, Newhouse JH. Comparison of the performance of screening mammography, physical examination, and breast US and evaluation of factors that influence them: an analysis of 27,825 patient evaluations. *Radiology*. 2002 Oct. 225(1):165-75.
zLeung JW, Sickles EA. 2000 Jul. Multiple bilateral masses detected on screening mammography: assessment of need for recall imaging. *AJR Am J Roentgenol*.. 175(1):23-9.

Liberman L, Bonaccio E, Hamele-Bena D. 1996. Benign and malignant phyllodes tumors: mammographic and sonographic findings. *Radiology*. 198:121-124.

Liberman L, Menell JH. 2002 May. Breast imaging reporting and data system (BI-RADS). *Radiol Clin North Am*. 40(3):409-30, v.

Mehta TS. 2003 Jul. Current uses of ultrasound in the evaluation of the breast. *Radiol Clin North Am*. 41(4):841-56.

Mendelson EB, Baum JK, Berg WA, et al. 2003. ACR Breast imaging and reporting data system ultrasound. *ACR Breast Imaging Atlas*.

Mendelson EB, Berg WA, Merritt CR. 2001 Jul. Toward a standardized breast ultrasound lexicon, BI-RADS: ultrasound. *Semin Roentgenol*. 36(3):217-25.

Moy L, Slanetz PJ, Moore R, et al.2002 Oct.. Specificity of mammography and US in the evaluation of a palpable abnormality: retrospective review. *Radiology*. 225(1):176-81.

Rahbar G, Sie AC, Hansen GC, et al. 1999 Dec. Benign versus malignant solid breast masses: US differentiation. *Radiology*. 213(3):889-94.

Sheppard DG, Whitman GJ, Huynh PT, et al. 2000 Jan. Tubular carcinoma of the breast: mammographic and sonographic features. *AJR Am J Roentgenol*.. 174(1):253-7.

Simpson WL Jr, Hermann G, Rausch DR, Sherman J, Feig SA, Bleiweiss IJ, et al. *J*. 2008. Ultrasound detection of nonpalpable mammographically occult malignancy. *Can Assoc Radiol* Apr. 59(2):70-6.

Skaane P. 1998 Jan., Engedal K. Analysis of sonographic features in the differentiation of fibroadenoma and invasive ductal carcinoma. *AJR Am J Roentgenol*. 170(1):109-14.

Smith RA, Saslow D, Sawyer KA, et al. 2003 May-Jun. American Cancer Society guidelines for breast cancer screening: update 2003. *CA Cancer J Clin*. 53(3):141-69.

Stavros AT, Thickman D, Rapp CL, et al. 1995 Jul. Solid breast nodules: use of sonography to distinguish between benign and malignant lesions. *Radiology*. 196(1):123-34.

U.S. Food and Drug Administration (FDA). FDA approves first breast ultrasound imaging system for dense breast tissue. Available at http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm319867.htm. Accessed: September 18, 2012.

Weinstein SP, Conant EF, Orel SG, et al. 2000 Nov-Dec , Spectrum of US findings in pediatric and adolescent patients with palpable breast masses. *Radiographics*.. 20(6):1613-21.

Zonderland HM, Coerkamp EG, Hermans J, et al. 1999 Nov. Diagnosis of breast cancer: contribution of US as an adjunct to mammography. *Radiology*. 213(2):413-22.