## Evaluation of the Relationship between Sonographic Features and Histological Findings in Female Breast Lesions at State House Clinic, Abuja

<table>
<thead>
<tr>
<th>Serial No.</th>
<th></th>
</tr>
</thead>
</table>
| Author 1  | NWACHUKWU IFEOMA CHISOM  
PG/M.Sc/03/37861 |
| Author 2  |  |
| Author 3  |  |
| Title     | Evaluation of the Relationship between Sonographic Features and Histological Findings in Female Breast Lesions at State House Clinic, Abuja |
| Keyword   |  |
| Description | DEPARTMENT OF MEDICAL RADIOGRAPHY AND RADIOLOGICAL SCIENCES |
| Category  | FACULTY OF HEALTH SCIENCES AND TECHNOLOGY |
| Publisher |  |
| Publication Date |  |
| Signature | Digitally Signed by: Content manager’s Name  
DN : CN = Weabmaster’s name  
O= University of Nigeria, Nsukka  
OU = Innovation Centre |

**NWACHUKWU IFEOMA CHISOM**

**PG/M.Sc/03/37861**
EVALUATION OF THE RELATIONSHIP BETWEEN SONOGRAPHIC FEATURES AND HISTOLOGICAL FINDINGS IN FEMALE BREAST LESIONS AT STATE HOUSE CLINIC, ABUJA

By

NWACHUKWU IFEOMA CHISOM
PG/M.Sc/03/37861

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF MEDICAL RADIOGRAPHY AND RADIOLOGICAL SCIENCES
FACULTY OF HEALTH SCIENCES AND TECHNOLOGY
UNIVERSITY OF NIGERIA
ENUGU CAMPUS

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M. Sc.) DEGREE IN MEDICAL IMAGING

SUPERVISOR: DR. M. C. OKEJI

JUNE, 2014.
APPROVAL PAGE

NAME: Nwachukwu, IfeomaChisom
REG NO: PG/M.Sc./03/37861
DEGREE: M.Sc.

TITTLE OF DISSERTATION: Evaluation of the relationship between sonographic features and histological findings in female breast lesion at State House Clinic, Abuja.

EXAMINATION COMMITTEE

Prof. K. K. Agwu  
Head of Department

Dr. Mark Okeji  
Supervisor

External Examiner

Date of Approval………………………………………………...
DEDICATION

To my lovely husband, Ifeanyi
To my precious children; Tukwasi, Ebube and Chimazuru.
To my lovely mother, Constance Ifeoma Nwachukwu.
ACKNOWLEDGEMENT

My profound gratitude goes to my supervisor, Dr. M.C. Okeji, who by his cordial and amiable disposition ensured the completion of this work. My gratitude also goes to the Head of Department, Prof. K.K Agwu, who encouraged me immensely with his fatherly disposition. I also thank Dr. C.U. Eze, Idigo, F.U (Mrs), Dr. A.O. Okaro, Dr. S. O. I Ogbu, Dr. Angel-Mary Anakwue, Dr. KaluOchie and a host of other academic and non-academic staff of the Department of Radiography and Radiological Science, University of Nigeria, Enugu campus.

I acknowledge the assistance rendered by Dr. Emeka Onyia, Prof. IfeomaOkoye, Dr. Olatunji and Dr. Shamaki.

Special thanks to the following colleagues Miss. AyiolaOlurin, Mrs. ObyOjiego, Nancy Obunuwa, SuleDanjuma, ChimaEzeoke and Kamal Lamido.

Special thanks to my mother who has been a great source of encouragement throughout the programme. To my immediate family members: Ifeanyichukwu (lovely) Tukwasichukwuobi, Ebube and Chimazurufor bearing with me in the course of the programme.
ABSTRACT
This study aimed to correlate the ultrasonographic features with histological findings in breast lesions seen at State House Clinic, Abuja, to determine the sensitivity, specificity and accuracy of ultrasound in the diagnosis of breast lesions using histology as gold standard. Ethical approval was obtained from the Ethical Committee of the State House Clinic, Abuja. Sonography was conducted on 150 patients aged 15 to 69 years (mean age 40 years) who presented with breast lesions at State House Clinic, using Philip HD 4 machine equipped with 7.5 MHz probe. Pathology reports of the patients were reviewed and correlated with the ultrasonography findings. The American College of Radiology’s Breast imaging Reporting and Data System (BI-RADS) descriptors was used to categorize the sonographic features into different BI-RADS assessment category. The BI-RADS in this study accurately predicted 94 benign breast lesions and 56 malignant lesions while histology identified 96 breast lesion and 54 malignant lesions. This gave a sensitivity of 74.04%, specificity of 83.33%, positive predictive value (PPV) of 71.42%, negative predictive value (NPV) of 85.10% and accuracy of 0.85. The difference may be attributed to the limitation of relying purely on morphological appearances. Correlation of the histology results with that of BI-RADS prediction in this study, showed no statistically significant difference (p = 0.056 > 0.05)
TABLE OF CONTENTS

Title Page - - - - - - - - - - - - - - i
Approval Page - - - - - - - - - - - - - ii
Dedication - - - - - - - - - - - - - iii
Acknowledgements -- - - - - - - - - - - - iv
Table of Contents- - - - - - - - - - - - - v

CHAPTER ONE: INTRODUCTION - - - - - - - - - 1
1.0  Background of study - - - - - - - - - 1
1.1  Statement of Problem - - - - - - - - - 5
1.2  Objective of Study - - - - - - - - - 5
1.3  Significance of Study - - - - - - - - - 6
1.4  Scope of Study - - - - - - - - - 7
1.5  Limitations of study- - - - - - - - - 7
1.6  Definition of Terms - - - - - - - - - 7

CHAPTER TWO: LITERATURE REVIEW - - - - - - 10
2.1  The Breast: Anatomy, Histology and Pathology - - - - 10
    2.1.1 Anatomy - - - - - - - - 10
    2.1.2 Histology - - - - - - - - 13
    2.1.3 Pathology - - - - - - - - 15
    2.1.4 Histology of breast cancer- - - - - - - 17
    2.1.5 The implication and importance of breast lesions - - 19
2.2  Public health importance of breast lesions and the peculiarity of breast cancer in Nigeria - - - - - - - 21
    2.2.1 Evaluation of the breast - - - - - - - - 22
2.3  Different ultrasound features - - - - - - - - 28
2.4 Efficacy and reliability of different ultrasound features used in evaluating breast lesions - - - - - - - - 35
2.5 Efforts to establish sonomammography as a single screening modality in resource limited environments - - - - - - - - 44

CHAPTER THREE: RESEARCH METHODOLOGY - - 47
3.1 Research design - - - - - - - - 47
3.2 Duration - - - - - - - - 47
3.3 Target population - - - - - - - - 47
3.4 Sample size - - - - - - - - 47
3.5 Sampling technique - - - - - - - - 48
3.6 Patient inclusion criteria - - - - - - - - 48
3.7 Ethical clearance - - - - - - - - 49
3.8 Equipment - - - - - - - - 49
3.9 Scanning technique - - - - - - - - 49
3.10 Ultrasound features describing breast lesions- - - - 51
3.11 Statistical methods for data analysis - - - - - - 58

CHAPTER FOUR: DATA PRESENTATION - - - - 61
4.1 Tables- - - - - - - - 61

CHAPTER FIVE: DISCUSSION AND CONCLUSION - - 69
5.1 Demographic data - - - - - - - - 69
5.2 Evaluation of common ultrasonographic features of breast lesions 70
5.3 Test of proficiency and ability of sonomammography to discriminate benign and malignant lesions - - - - - - -- - 72
5.4 Conclusion - - - - - - - - 75
5.6 Areas of further research -  -  -  -  -  -  -  75
References -  -  -  -  -  -  -  -  76
Appendix -  -  -  -  -  -  -  -  84
EVALUATION OF THE RELATIONSHIP BETWEEN SONOGRAPHIC FEATURES AND HISTOLOGICAL FINDINGS IN FEMALE BREAST LESIONS AT STATE HOUSE CLINIC, ABUJA

By

NWACHUKWU IFEOMA CHISOM
PG/M.Sc/03/37861

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF MEDICAL RADIOGRAPHY AND RADIOLOGICAL SCIENCES
FACULTY OF HEALTH SCIENCES AND TECHNOLOGY
UNIVERSITY OF NIGERIA
ENUGU CAMPUS

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M. Sc.) DEGREE IN MEDICAL IMAGING

JUNE, 2014
CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND OF STUDY

Breast cancer is one of the commonest malignant tumors in the world and is one of the leading causes of death due to cancer in women (Pisani et al., 1999). Recent global cancer statistics indicates rising global incidence of breast cancer which is occurring at a faster rate in populations of the developing countries that previously enjoyed low incidence of the disease (Okobia et al., 2006).

Nigeria is among the countries that are recording increase in the incidence of breast diseases including cancer (Abudu et al., 2007). At the Cancer registry Ibadan, Nigeria, it was observed that between 2005 and 2008 the number of female patients who presented with breast cancer ranged from 2,456 to 3,821 patients. These figures according to Abudu et al (2007) represented only patients that came for radiotherapy. This implies that the overall figure would definitely be more than the figures presented.
The prevalence of breast cancer among other female cancers varied, depending on the location according to records from cancer registries in Nigeria. The percentages include 35.3% in Ibadan, 28.2% in Ife-Ijesha, 44.5% in Enugu, 17% in Eruwa, 35.7% in Lagos, 20.5% in Zaria and 29.8% in Calabar (Banjo, 2004). In all the centers, except Calabar and Eruwa, breast cancer was rated first among other cancers.

Another important feature of the studies was that 83 – 87% of breast cancer cases in Nigeria present at late stage. According to Okobia et al., (2006) at the advanced stage, there was hardly any benefit to be derived from any therapy. This late presentation was responsible for the high mortality and morbidity associated with breast cancers in Nigeria (Adesunkammi, 2006). The decline in mortality rate from breast cancer observed in developed countries was largely due to early detection and treatment (Oluwatosin and Oladepo, 2006, Okobia et al., 2006). At present, most of breast imaging is directed at early detection in order to intervene timely and reduce high mortality (Rahbaret al., 1999, Dennis et. al., 2001).

The most definitive laboratory confirmation of breast disease is by histology. This involves an invasive technique of biopsy for both benign and malignant cases. It is therefore, pertinent to evaluate any imaging modality that can increase the level of probability that a breast lump is either benign or malignant in order to reduce the number of unnecessary biopsies. Many imaging options are available for the breast
but the right choice is however, dependent on important factors namely: nature of the lesion, age of the patient, finance, availability and accessibility.

Mammography remains a sensitive method for detecting pre-clinical breast carcinoma though its limited specificity results in unnecessary biopsy of lesions to determine whether they are benign or malignant. Mammography screening cannot be used effectively in resource-limited country like Nigeria because of its cost (Shyyan et al., 2006). In developed countries, imaging the breast with MRI and digital mammography is a common practice but not the case in Nigeria.

In majority of the sub-Saharan countries, the absence of state-of-the art imaging modalities makes breast ultrasound (BUS) an attractive diagnostic tool especially now that future role for sonography in breast imaging was suggested (ACR, 2000). Ultrasonography does not utilize ionizing radiation, it is affordable, readily available, repeatable, sensitive and a pre-interventional tool, (Obajimi2005, Shyyan et al., 2006). Ultrasound plays a vital role in differentiating cystic from solid breast masses.

Result of a previous research showed that ultrasonography can lower the number of equivocal mammographic findings, either by downgrading them to benign findings or upgrading them to suspect malignant findings, thus increasing the sensitivity and specificity of mammography and clinical examination (Anderson 2003). Okoye (2008) observed increased prevalence of breast cancer in younger age group of 20 to 35 years with glandular breast tissues. Sonomammography would have
been the imaging modality of choice for the above mentioned group but it is yet to be approved as a screening tool.

The characterization of mammographic lesions into categories was developed by the American college of Radiology (ACR) for reporting and data analysis within the United States of America (Meritt, 2000). It is referred to as Breast Imaging Reporting and Data System (BI-RADS) categories. This lexicon though not perfect has been successfully used in mammography. BI-RADS category assigns scores indicating the level of probability of a lesion being benign or malignant. These categories were developed for mammography rather than sonography to help standardize and improve the quality of mammographic reporting and data analysis within the United States.

The growing use of ultrasonography around the world created the need for a standardized method for lesion characterization, description and reporting (Obajimi, 2005). Since ultrasonography is cheap and readily available there is therefore need for its accuracy in evaluating breast masses to be documented since many clinicians are requesting it as the first option in assessing breast masses.

Presently, to the best of the researcher’s knowledge, there is absence of a study on the accuracy of ultrasound in the diagnosis of female breast lesions in our locality. The purpose of this study therefore was to determine the accuracy of ultrasound in diagnosing female breast lesions as well as relate ultrasound findings to findings
from histopathology at State House Clinic, Abuja. This will help ascertain if ultrasound can be used as a stand-alone imaging modality.

1.1 STATEMENT OF PROBLEM

i. It has been observed that mammography and other sophisticated screening tools for breast diseases are not readily and widely available in our locality due to cost (Adesunkammi et al, 2006). There is therefore the need for a cheaper and reliable alternative.

ii. Ultrasonography is relatively cheap and a more available modality but its diagnostic yield in breast cancer screening has not been determined in our locality.

iii. Comparison of ultrasound predicted lesions with histology has not been conducted in our locality.

1.2 OBJECTIVE OF THE STUDY

The general objective was to determine the accuracy of sonography in the diagnosis of breast lesions (stand-alone modality) where it is the only imaging modality available. The specific objectives were;
1. To evaluate common ultrasonographic features of breast lesions seen at State House clinic, Abuja.

2. To correlate the ultrasonographic features with histological findings on same patient.

3. To determine the sensitivity, specificity and accuracy of ultrasound in the diagnosis of breast lesions using histology as gold standard.

4. To re-evaluate the accuracy of BI-RADS score based on ultrasound in predicting the malignancy or otherwise of breast lesions.

1.3 SIGNIFICANCE OF THE STUDY

1. This study will make recommendations on the use of Sonomammography, a relatively cheaper, more available tool for serial imaging of patients at risk of breast cancers. It can reduce the number of questionable biopsies without sacrificing diagnostic information.

2. The result of this study will underscore the need for sonomammography in places where there are no mammography screening program.

3. It will provide comparative assessment of Sonographic features and detailed histological description of mammary tissues that are related to tumor growth for staging breast cancer.
4. The result of this study will helps in avoiding delays in management, especially in cases where clinical diagnosis is equivocal.

5. It will help provide documentation of sonomammographic features and a guide to the acceptance of its outcome to the practitioners.

1.4 SCOPE OF THE STUDY

The study involved female patients from 15 years and above who consented to be enlisted into the study. Fifteen years was chosen as the lower age limit because it is the upper limit of the mean age for the onset of puberty in females (Moore and Dalley, 1999). The study focused on patients referred to the State House Clinic, Abuja during the period of the study.

1.5 LIMITATIONS OF STUDY

1. Absence of cancer registry in Abuja, Nigeria made data collection on cancer patients difficult.

2. The use of secondary data by the researcher may have introduced some bias but not sufficient to invalidate the results.

3. The number of willing participants affected the sample size.

1.6 DEFINITION OF OPERATIONAL TERMS.
1. **TUMOUR**: a mass of abnormal tissue that arises without obvious cause from preexisting body cells, has no purposeful function, and is characterized by a tendency to independent and unrestrained growth.

2. **LESION**: a zone of tissue with impaired function as a result of damage by disease or wound. Secondary lesions (such as crusts and scars) are derived from primary ones.

3. **BENIGN**: describes a tumour that does not invade and destroy the tissue in which it originates or spread to distant sites in the body i.e. a tumour that is not cancerous.

4. **MALIGNANCY**: describes a tumour that invades and destroys the tissue in which it originates and can spread to other sites in the body directly or via the bloodstream or lymphatic system.

5. **BREAST BIOPSY**: is the removal of cells or tissue from a suspicious mass in the breast. The tissue or cells are then examined under a microscope to check for cancer cells. It may be performed when an abnormal breast change is found during mammogram, ultrasound or physical examination. A biopsy is the only way to determine if a potential trouble spot is cancerous or benign.

6. **MASS**: describes as a lump or aggregation of coherent material.

7. **ECHOGENICITY OF NORMAL BREAST TISSUE**: is the standard against which all other normal anatomic tissues and pathological lesions should be
compared. Terms such as hypoechoic, hyperechoic and anechoic, refer to the paucity, abundance and absence of echoes on the image respectively.

8. COUPLING AGENT: A liquid or gel used to fill the gap between the skin and the transducers, so that there is no intervening air to interfere with ultrasound transmission.

9. REAL–TIME: In general parlance, this is a term used to describe a process or system in which there is negligible time delay between the input of data and the output of processed data. The term is more usually reserved for B-Mode system in which the scanning is performed rapidly by electronic or electromechanical means such as use of multiple transducer arrays. This enables a dynamic process to be recorded or imaged.

10. ULTRASOUND: This is a mechanical, longitudinal wave (sound wave) with high frequency of over 20 kHz. These waves, are inaudible to humans but can be transmitted in beams and used to image tissues of the body.

11. TRANSDUCER: This is the part of the ultrasound unit that comes in contact with the patient. It converts electrical energy into ultrasound waves, which pass through the patient’s tissues. It also receives the reflected waves and changes them again into electric energy. A transducer is often called a probe and is connected to ultrasound scanner by a flexible cable.
2.1 ANATOMY

The breast is composed of fat, fibrous and glandular tissues depending greatly on the hormonal status of the woman. There can be considerable variation in the image of the breast depending upon the ratio of the parenchyma to stroma elements in the area of the breast that is to be imaged. The parenchyma includes the lactiferous ducts and alveoli of the breast as well as the interlobular connective tissue. The stroma or supporting tissues can be divided into fat and dense connective tissue. In the young non–lactating breast, the parenchyma is primarily composed of fibroglandular tissue with little or no subcutaneous fat. As age and parity progresses, more fat get deposited in both the subcutaneous and mammary layer (Howlett et al., 2003).
The following areas can be sonographically demonstrated in normal breast (Stavros et al., 1995):

**Skin:** Usually 1 to 3mm thick, is imaged as two hyperechoic lines with a very thin hypoechoic zone between them. These lines correspond to the interface between the transducer and the skin and between the skin and subcutaneous tissue.

**Subcutaneous Fat:** This lies between the tissue and appears hypoechoic. The echogenic strands of Cooper’s ligaments are sometimes seen traversing the fat.

Fig 1: Breast anatomy that can be visualized on ultrasound (courtesy of DurreSabih)
Fibroglandular Layer: It is separated from subcutaneous layer above, by highly echogenic superficial fascia. In young women with glandular breast, the parenchyma is of high homogeneous echoes. The lactiferous ducts may be seen as small tubular anechoic structures radiating from the nipple.

Retromammary Layer: It is hypoechoic, and lies in between the deep fascial plane (same echoes as the superficial fascia) of the breast and the underlying pectoralis muscle, defining the posterior border of the glandular tissue.

Pectoralis Muscle Layer: The pectoralis muscles can be clearly imaged sonographically in the direction of their fibers and they appear as low level echogenic structures running deep in the breast above the ribs and parallel to the skin.

Dilatation of the lobules could be seen in the breast tissue, and appear as tubular anechoic structures with echogenic walls.

Cystic breast changes may occur with each menstrual cycle and could be seen in ultrasound as mild duct dilatation during the period between ovulation and menstruation. The post-menopausal breast demonstrates varying amounts of tissue interspersed among predominantly fatty tissue with subsequent replacement by fat (Stavros et al., 2004).

Ribs: This forms the ventral aspect of the thoracic cage over which the breasts lie. They are composed of bone laterally and cartilage medially. The ribs appear as short linear highly echogenic structures laterally with posterior acoustic shadowing and are
interposed by intercostals muscles. Medially they are oval shaped hypoechoic structures containing low level internal echoes.

Nipple and Areola: They show attenuating shadowing (posterior acoustic shadowing) of the ultrasound beam.

The tail of Spence is that portion of the breast that extends to the axillary region and appears as hypoechoic.

The breast parenchyma pattern depends greatly on age, parity, pregnancy and lactation and hormonal status of the patient. The young non-lactating and nulliparous breast is primarily composed of fibroglandular tissue with little or no subcutaneous fat. With increasing age and parity, fat is deposited in both the subcutaneous and retromammary layers.

During pregnancy, there is a substantial increase in glandular tissue in the breast. Here the ultrasound demonstrates a finely granular echo pattern with little subcutaneous fat. The subcutaneous and retromammary fat layers are compressed by glandular tissue and are decreased in size. Late in pregnancy, and during lactation, the lactiferous ducts increase in size and number with resultant duct.

**BLOOD SUPPLY AND DRAINAGE OF THE BREAST**

The arterial supply to the breast is carried by the perforating branches of the internal mammary arteries that lie along the medial aspect of the breast, intercostal
perforators, and by lateral thoracic and thoraco-abdominal branches of the axillary artery. The venous drainage is by the superficial breast veins.

2.1.2 HISTOLOGY OF BREAST TISSUE

Breast tissue can be classified histologically as either stromal or epithelial-myoepithelial. Stromal elements include fat and fibrous tissues (including cooper's ligaments). There are two types of stroma fibrous tissue: dense interlobular stroma fibrous tissue and loose stroma fibrous tissue that surrounds ducts (periductal) and lies within lobules (intralobular). A large portion of stroma fibrous tissue is composed of extra cellular matrix, which in turn is composed of variable of fibroblast, collagen and hyaluronic acid. Dense interlobular stroma fibrous tissue is high in collagen and low in hyaluronic acid, whereas loose interlobular and periductal stoma tissue is high in hyaluronic acid and contain less collagen. Hyaluronic acid is a huge hydrophilic molecule that facilitates passive diffusion into and out of epithelial cells and is soft and pliable, allowing for easy expansion and contraction of ducts and lobules under hormonal influences.

Loose stroma fibrous tissues are also more vascular and contain inflammatory cells than those dense interlobular fibrous tissues. The differences between the loose and dense stroma fibrous tissue are very important for the sonographers because the loose and dense stroma fibrous elements have markedly different echo features.
The epithelial and myoepithelial elements of the breast excluding the skin, line the ducts of all sizes and the ductules (acini) within the terminal ductal lobular unit (TDLU) as well as the terminal duct. Each TDLU contains variable numbers of ductules (usually 30 to 50) and loose intralobularstroma fibrous tissue. Epithelial cells line each ductile and are surrounded by more widely spaced myoepithelial cells that likely contract during breast feeding, expressing milk from the lobules into the ductal system.

Most breast pathology arises within the TDLU. Most ductal carcinoma are thought to arise within the terminal duct near it’s junction with the lobule, and then spreading intraductally through the extra lobular terminal ducts to large duct and retrogradely into intralobularductules. Large central duct generally give rise to intraductalpapillomas and the duct ectasia-periductal mastitis complex.

2.1.3 BREAST PATHOLOGY

In benign proliferative hyperplastic breast condition according to Stravos et al (2004), there is more glandular and fibrotic tissue than expected for the patient’s age and parity. The tissue is also morphologically abnormal. There are five main types: adenosis (epithelia hyperplasia of the lobules), papillomatosis (epithelial hyperplasia of the ducts), fibroadenoma, papilloma and fibrocystic condition. These five types usually do not occur as pure forms. Although one may predominate, they frequently coexist.
Adenosis: Histologically, adenosis represents an increase in the number of lobules and number of acini within each lobule. These acini show epithelial proliferation and dilatation. The microcalcification represents calcified debris within the lumina in these acini. Adenosis tends to regress with age, especially after menopause.

On mammography, adenosis may be seen as patchy or homogenous areas of increased density. The breasts appear denser than expected for the patient’s age and parity. Scerosing adenosis is a specific type of adenosis, where connective tissue proliferation is predominant and thought to represent a late stage where the epithelial elements have regressed and are replaced by fibrosis.

Fibroadenoma: The lesion represents the most common benign tumour of the breast. It is thought to arise from adenosis. On physical examination, they are firm but relatively movable as they do not induce proliferation of fibroblasts in surrounding breast tissue. It may be seen on mammography as well circumscribed masses. They are frequently multiple and bilateral and rarely exceed 30mm in diameter. They generally arise in younger women and rarely developed or grow after menopause.

On ultrasound, fibroadenoma have smooth, well defined margins and are round, oval, or nodular. There are internal echoes whose homogenous attenuation results in intermediate strength echoes behind the mass. The sonographic appearance cannot be distinguished reliably from that of a circumscribed carcinoma. Coarse calcifications within a fibroadenoma may be brightly reflective on ultrasound.
On histology section, they contain both fibrotic and glandular tissue in varying proportions. Considering their glandular composition, it is not surprising that fibroadenomas regress with age.

**Papillomatosis:** It is microscopic papillary proliferation in the large and small lactification ducts. It is often associated histologically with benign adenosis and may have similar mammographic characteristics, i.e. micro calcifications and patchy areas of increased density.

**Papilloma:** When the intraductal proliferation reaches macroscopic size, the condition is termed intraductal papilloma. This region usually occurred in the retroareolar region and may cause a serous sanguineous nipple discharge.

Cysts arise from adenosis when the lumina of the ducts and acini become dilated and lined by atrophic epithelium. They also appear on mammography as round or oval well circumscribed masses. The margins of cysts may be completely or partially defined or completely obscured by adjacent fibroglandular tissue. Neither cysts nor fibroadenomas grow after the menopause, so that any increase in the size of a mass during that period should be suspect for carcinoma. Cysts just like fibroadenomas are often multiple or bilateral. Calcification is infrequent, but may be seen as thin peripheral eggshell, different from the coarse peripheral calcification of fibroadenomas. Fibrocystic breasts often contain increased fibrotic tissue so that
fibrocystic condition may be subclassified as predominately cystic, fibrotic or indeterminate.

Although a fibrocystic condition often produces no symptoms, a cyst may be severely painful and tender. These symptoms may be continuous or may appear only in the premenstrual phase of menstrual cycle, and are related to fluid pressure within the cyst. Aspiration may be therapeutic as well as diagnostic. Another feature that helps to differentiate cysts from carcinoma is that cyst may develop quickly, often before menses, and diminish in size just as rapidly. The consistency of cysts depends on their fluid pressure. When the pressure is low, they are soft, but when it is high, they are firm. The strict ultrasound criteria for a simple cyst include well circumscribed margins, a bright posterior wall, round or oval contours, absence of internal echoes and through transmission. If all these criteria are met the accuracy of diagnosis of a simple cyst is 100%.

2.1.4 HISTOLOGY OF BREAST CANCER

Invasive ductal carcinoma, which arises from the epithelium of the breast ducts, accounts for nearly 94% of invasive breast cancers. Invasive lobular carcinoma arises from the acini of the breast lobules and account for 5.5% of cases. Less than 1% of invasive breast cancers are of sarcomatous or other mesenchymal origin. Ductal carcinoma-in-situ (DCIS) and lobular carcinoma-in-situ (LCIS) are confined to the
ducts and acini, respectively. There are four subtypes of DCIS: comedocarcinoma, micropapillary carcinoma, cribriform carcinoma and solid carcinoma. Among these subtypes, comedocarcinoma is the most aggressive.

2.1.5 THE IMPLICATION AND IMPORTANCE OF BREAST LESIONS.

Some common breast benign lesions are mainly developmental abnormalities, inflammatory lesion, fibrocystic changes, stromal lesions and neoplasm. Benign lesions are far more frequent than malignant lesions (Caleff et al., 2004). With the use of mammography, sonomammography, MRI of the breast and the extensive use of needle biopsies, the diagnosis of a benign disease can be accomplished. It is important for radiologist, pathologist, oncologist and sonographers to recognize benign lesions distinguish them from in-situ and invasive breast cancer, so that the most appropriate treatment modality for each case can be established. The incidence of benign breast lesions begin to rise during the second decade of life and peaks in the fourth and fifth decades, as opposed to malignant diseases, for which the incidence continue to increase after menopause, although at a less rapid pace. Shaaban et al., (2002) and Hartmann et al., (2005) in their separate studies established that in the above mentioned lesions, the subsequent risk for breast cancer is associated with the histological appearance of the lesion, age, biopsy and the degree of family history of breast cancer. According to researchers, the risk of breast cancer
in young women is a diagnosis of atypical epithelial proliferation and is twice the risk observed among women over 55 years with a diagnosis of atypical epithelial proliferation. Bazzochiet al., (2001) defined juvenile papillomatosis of the breast as severe ductal papillomatosis occurring in young women less than thirty years old. This disease is associated with a heightened risk for breast cancer. Therefore all benign papillary lesions of the breast should be surgically excised since a considerable number of atypical lesion and malignant lesions could be missed.

Simple fibroadenomas are not associated with any increased risk for subsequent cancer. However, women with complex fibroadenomas may have a slightly higher risk for subsequent cancer (Carter, 2001).

Also fibroadenoma in older women or women with a family history of breast cancer has a higher incidence of associated carcinoma (Shabtai, 2001 and EL-wakeel, 2003). Cystosarcomaphyllodes may arise from a pre-existing fibroadenoma, and although usually benign, it may show evidence of malignancy in 5% of cases (Page and Willia, 1991). It probably develops from breast tissue and is characterized by exuberant stromal cellularity. Although rare in adolescent, it’s the most common malignant breast lesion in this group.
EMPIRICAL REVIEW

2.2 PUBLIC HEALTH IMPORTANCE OF BREAST LESION AND PECULIARITY OF BREAST CANCER IN NIGERIA

Breast carcinoma is the commonest female malignancy worldwide with the benign breast disease presenting four times as often as carcinoma of the breast in Nigerian women (Adebamowo et al., 2000). The incidence of breast cancer according to Adesunkammi et al., (2006) is lower in blacks than Caucasians population. Recent studies from many centers in Nigeria indicate that breast carcinoma is rapidly increasing (Abudu et al., 2007). According to Abudu et al., (2007) the true prevalence was under reported, as most of the studies were retrospective and hospital based. Okobia et al., (2006) reported that majority of Nigerian breast cancer patients presented with advanced diseases which had dismal prognosis. The late presentation impacted significantly on the quality of life of the affected women and their families. A study by Okoye (2010) attributed the reason for late presentation to include, lack of awareness, ignorance of the disease, procrastination, belief that it cannot be treated by conservative medicine, fear of mastectomy, patronage of
traditionalist and spiritual healers, delay in referrals from peripheral hospitals and failure of general practitioners to subject excised breast lumps for histological diagnosis. Also other contributory factors were poverty, poor education and social status.

Adeyemoye et al., (2006) in their work suggested introduction of imaging modalities that are easily available and accessible which will ensure early detection, treatment and subsequent improvement in the prognosis.

2.2.1 EVALUATION OF THE BREAST

There are a lot of imaging modalities available for evaluation of the breast. They are Mammography, Ultrasound, MRI, Digital Mammography, Computerized Tomography, color Doppler, Sonoelastography (Obajimi, 2005). All these imaging modalities except ultrasound, cannot be used effectively in resource-limited countries like Nigeria because, of their unavailability and cost (Shyyanet, al., 2006).

**Mammography** : This is examination of the breast using lower energy X-ray. It can be used either for screening or diagnostic purposes. A screening mammography is an x-ray examination of the breast in a woman who has no symptoms of breast disease. The goal of screening mammogram is to discover breast lesions at its pre-cancerous stage. Finding small breast cancers early with a screening mammogram greatly improves a woman’s chance of successful treatment. A diagnostic mammography is an x-ray examination of the breast which either had a problem or had a change shown
on screening mammography. Ibitoye et al (2003) and Adeyemoye et al, (2006) documented that while mammography has an advantage over ultrasound in detecting breast diseases, It cannot be used in patient with dense breast.

Several Nigerian authors, Okoye (2009), Ibitoye et al.,(2006) and Adebamowo (2007) had reported that breast cancer could occur at an age between 25-45 years, even when the breast is dense. They therefore recommended sonomammography as an alternative for screening purposes. Also, Shyyan (2006) in his study asserted that mammography may not be used efficiently used in resource-limited country such as Nigeria (Shyyan 2006).

**Ultrasound:** Sonomammography involves the use of high frequency ultrasound transducers for breast imaging. The procedure is painless and has emerged as the single most helpful adjunct to mammography in evaluation of the clinically or mammographically abnormal breast (Skanne, 1999). Sonomammography has been recommended as the first imaging modality in the evaluation of a palpable mass, in a pregnant or lactating woman and for women less than 30 years of age (Jackson, 1995, Berg, 2003). Also, it may be used as an adjunct to mammography for evaluation of women over 30 years (Skanne, 1999). Ultrasound has a greater ability than mammography to characterize complex cysts (fluid collection) and solid nodules (Stravos, 2004). The superiority of ultrasound over mammography in the diagnosis of cystic lesion could lead to a significant reduction in the needle aspirations and
biopsies. It is the most often used for imaging guide in percutaneous procedures, preoperative needle or wire localization Berg, (2003).

Ultrasound is the only modality that can be used in conditions such as inflammatory process e.g. mastitis with marked pain and precludes the application of compression as required for mammography. Furthermore, the method of image acquisition differs between mammography and ultrasound. The mammographic image is a two-dimensional summation of anatomy and pathology resulting in superimposition of tissues which tends to obscure anatomy and pathology. The ultrasound image on the other hand is essentially a tomographic slice through the breast. Ultrasound can identify different echogenicities of various normal tissues and suffers less from superimposition of densities as in mammography. Ultrasound is capable of showing the breast ductal-lobular anatomy and pathology (Stravos, 2004). Many factors may limit the quality of sonomammography which includes the equipment, the operator and the lesion itself, (Adeyemoye, 2006). One of the main limitations of sonomammography is its inability to demonstrate micro-calcification. The other limitation is in the evaluation of the area deep to the nipple. This area is commonly lost in intense shadowing and imaging is compromised.

**Magnetic Resonance Imaging (MRI):** Magnetic resonance imaging of the breast is a non-invasive imaging technique of mapping the internal structure of the breast. MRI can be useful in pre-surgical evaluation in patient with known breast cancer to detect
any additional lesion that might change the surgical approach. It completely avoids the use of ionizing radiation and appears to be without hazards. It employs radio frequency radiation in the presence of carefully controlled magnetic fields in order to produce high quality cross-sectional images. It portrays the distribution of hydrogen nuclei and parameters relating to their motion in water and lipids. It is a very expensive modality and generally unavailable in resource-limited countries (Shyyan, 2006).

In two separate studies Warner et al., (2004), and Kriege et al., (2004), reported that MRI screening finds more cancer than mammography in women who are genetically predisposed to breast cancer. However, it was known if the difference is great enough to save additional lives. Also, in the circumstances of a negative mammogram and negative physical examination, the probability of a breast cancer being diagnosed by MRI is extremely low.

**Other breast imaging modalities:**

a. Digital mammography, an image of the breast is recorded electronically rather than on a film. The acquired digital image can be stored in computer memory and interpreted on a high-definition monitor.

b. Scintimammography (nuclear medicine test), used to detect cancer cells in patients with abnormal mammograms. It is discouraged as a first line test and uses a small amount of radioactive substance (technetium 9), injected into the patient vein, which
is then taken up by cancer cells. This improves evaluation of dense breast and lesions difficult to identify with mammography. Radiation exposure associated with Scintimammography is a great disadvantage.

c. Automated Breast Volume Scanner (ABVS): This is an innovation in Breast Ultrasound Imaging-Ultrasound system acquires full volume images of the breast. It offers a more comprehensive representation of the global anatomy of the breasts. It is ideal for dense breast tissues, thereby increasing diagnostic confidence. It allows acquisition of coronal view images (views from nipple line to the breast wall). There’s improved comfort and reduction in examination time.

d. Harmonic imaging is a procedure in which the ultrasound machine scans images at the frequency it is transmitted. This technique potentially can suppress reverberation and other near field noise but it may limit depth of penetration and result in loss of resolution, unless the newer broadband harmonic imaging techniques are used. Harmonic imaging has been shown to reduce the number of false positive complex cysts or solid masses seen at breast sonography and improves the examiners confidence that the lesion is in fact truly cystic and benign. The procedure also shows potential to better define the boundaries of lesions- an important feature in distinguishing benign from malignant lesions.

e. Vibrational doppler imaging or sonoelastography: In the early 1990s, a technique
called elastography was described by Ophir et al., (1991). With this technique, the tissue is compressed, and the tissue strain resulting from this compression is imaged. Since its invention, this concept has been proposed for elasticity imaging of a wide range of different applications, including breast (Ito et al., 2006). Sonoelastography or vibrational doppler imaging is similar, but an external transducer separate from the ultrasound transducer applies the vibration.

In Vibrational doppler imaging approach, the external transducer is vibrated at various frequencies and the amount of tissue vibration at each frequency is quantified, using a quantitative power Doppler algorithm built into the scanner. Vibrational doppler imaging looks at the visco-elastic properties of tissue.

**Elastography:** This is an image formation process that looks at the elastic properties of tissues by applying a slight compression to the tissue and comparing an imaging obtained before and after compression. The data collected before and after compression are compared, using a cross correlation technique to determine the amount of displacement each small tissue underwent in response to the compression applied by the ultrasound transducers. The compression is very small, usually only 0.2 to 0.6 mm. The rate of displacement of the breast tissue as a function of distance from the transducer causing the compression is called a strain image and constitutes the elastogram. It shows promise for diagnosing cancerous breast lesion in a non-invasive manner.
2.3 DIFFERENT ULTRASONIC FEATURES

Mammography services are expensive and not easily accessible for many women especially in developing countries (Kiguli-malwadde et al., 2010). Additionally, the cost of biopsies is also high and a large number of biopsies have adverse effects on women who undergo them (Howard 1987). Therefore, the evaluation of breast masses without resorting to formal biopsies is highly desirable. Sonomammography is non-invasive, cheap and widely available. It is necessary that the distinctive ultrasound features of these breast masses are documented since many clinicians use it as the first option in assessing breast masses. Bari,(2004), Malik et al; (2006) and Mubuuke 2010 agreed that some ultrasonographic appearances can be useful in distinguishing benign and malignant lesions. The ultrasound feature descriptors used to predict disease outcome are as follows; Shape: round/oval or irregular, Margins: well circumscribed or non-circumscribed, Length/height ratio: wider than taller or taller than wider, Echogenicity: hyperechoic, isoechoic or hypoechoic, Distortion of tissue planes: is there distortion of tissue planes or not.

Rahbar.et. al., (1999) in a blinded study used ultrasound to differentiate benign and malignant solid breast masses in a Caucasian population. Their studies enumerated
some features that characterized both benign and malignant masses. Ultrasound features that most reliably characterize masses as benign were a round or oval shape, circumscribed margins and a width to anterior-posterior dimension ratio greater than 1.4 cm (wider than tall). They also observed that when ultrasound was used in conjunction with mammography, the biopsy yield by ultrasound was not statistically significant (p<0.02). Furthermore, there were variations in ultrasound reports given by the different reviewing interpreters. It could therefore be deduced that certain ultrasound features could help differentiate benign from malignant masses.

Steven et al.,(2010) and Chiasawas et al.,(2011) in separate studies analyzed some benign or malignant sonographic characteristics of solid breast nodules. The most common features on a breast are the clarity and contour of the mass margins, the orientation and shape of the mass, the echo texture and echogenicity, and the effects on distal echoes. Other aspects of the mass such as compressibility and vascularity were also noted. The study went further to define some of the terms suggestive of malignancy and benignity. Suggestive of malignancy are spiculations, angular margins, hypoechoic and taller than wider. Spiculation consists of straight lines that radiate in a perpendicular fashion from the surface of the breast mass. An angular margin is observed as an angular configuration at the junction between relatively hypoechoic or isoechoic central portion of a solid mass and surrounding tissue. Angular margin are quiet distinct from lobulation which tend to be smooth and
rounded. The term tall-than-wide is described when normal tissues planes on the breast have a horizontal orientation; hypoechoic looks intensely black compared to the surrounding isoechoic fat. The researcher also noted that malignancy can also be isoechoic and hyperechoic on breast ultrasound so it is not a hard and fast finding by any means. It was observed that microlobulations, duct extensions, and posterior acoustic shadowing are also suspicious for breast cancer. Microlobulation observed on breast ultrasound indicate the presence of lots of very small (1mm to 2mm) lobulations on the surface of a solid breast nodule, and will be quite similar to mammogram findings. As these microbulations increase, the probability that the breast mass is malignant also increases.

A duct extension on breast ultrasound shows as a radially oriented projection that seems to arise from the lesions, and axis oriented towards the nipple.

If a breast lesion shows posterior acoustic shadowing on ultrasound this means that there is something about the mass or around the mass which attenuates the sonic beam strength when compared to normal adjacent tissues. Posterior acoustic shadowing is suspicious for malignancy, tends to be associated with low to intermediate grade breast tumors. Calcifications on breast ultrasound are also suspicious for malignancy. Calcifications on a solid mass which appear punctate are highly suspicious of malignancy, and will usually appear on ultrasound as bright, punctate foci. Spiculations and irregular borders have the highest positive predictive
value for breast cancer. In terms of the suggested BI-RADS descriptors for malignant nodules, spiculated margins have a positive predictive value for malignant breast cancer in about the 85% range.

Benign Ultrasound indicators include hyperechogenicity, thin well defined border. On ultrasound a benign breast mass will typically be well defined and with smooth margins. Benign breast lesions tend to be ovoid or round in shape, and are often wider-than-tall (which indicates a parallel orientation to the chest wall). According to American College of Radiology, ACR (2003), the ultrasound feature descriptors are defined as thus:

a) Shape:
Oval – a mass that is elliptical or egg shaped with 2 or 3 undulation (gently lobulated or macro lobulated).
Round – a mass that is spherical, ball-shaped, circular, or globular. A round mass has an anteroposterior diameter equal to its transverse diameter.
Irregular – a mass neither round nor oval in shape.

b) Orientation:
This feature of mass is unique to ultrasound imaging. Orientation defined with reference to the skin line. A parallel or “wider-than-tail” orientation is a property of some benign masses, notably fibroadenomas, however many carcinomas also have
this orientation. Shape and marginal characteristics should help dictate the level of suspicion of malignancy.

Parallel: The long axis of a lesion parallels the skin line (“wider-than-tall” or horizontal orientation).

Not Parallel: The anteroposterior or vertical dimension is greater than the transverse or horizontal dimension. These masses can also be obliquely orientated to the skin line (“taller-than-wide” or vertical orientation).

c) Margin: This is the edge or border of the lesion.

Circumscribed: Margin well defined or sharp, with an abrupt transition between the lesion and surrounding tissue.

Not Circumscribed: If the margin is not following features: indistinct, angular, microlobulated or speculated.

Indistinct: No clear demarcation between a mass and its surrounding tissue, boundary poorly defined.

Angular: Some or all of the margins have sharp corners, often forming acute angles.

Microlobulated: Short-cycle undulations impart a scalloped appearance to margin of mass.

Spiculated: the margin is formed or characterized by sharp lines projecting from the mass.
d) Lesion Boundary: It describes the transition zone between the mass and the surrounding tissue.

Abrupt Interface: the sharp demarcation between the lesion and surrounding tissue can be imperceptible or a distinct, well-defined echogenic rim of any thickness.

Echogenic Halo: there is no sharp demarcation between the mass and the surrounding tissue which is bridged by an echogenic transition zone.

e) Echo Pattern:

Anaechoic: Without internal echoes.

Hyperechoic: having increased echogenicity relative to fat or equal to fibroglandular tissue.

Complex: a complex mass contains both anaechoic (cystic) and echogenic (solid) components.

Hypoechoic: defined relative to fat: hypoechoic masses are characterized by low-level echoic throughout (for example, the appearances of fibroadenomas and complicated cysts.

Isoechoic: having the same echogenicity as fat, isoechoic masses may be relatively inconspicuous, particularly when they are situated within an area of fatlobules.

f) Posterior Acoustic Features: It represent the attenuation characteristic of a mass with respect to its acoustic transmission.
No Posterior Acoustic Feature: no shadowing or enhancement is present deep to the mass: the echogenicity of the area immediately behind the mass is not different from that of adjacent tissue at the same depth.

Enhancement: Sound transmission is unimpeded in its passage through the mass. Enhancement appears as a column that is more echogenic (whiter) deep to the mass.

Shadowing: Posterior attention of the acoustic transmission

Combined Pattern: Some lesions have more than one pattern of posterior attention.

g) Surrounding Tissue:

Edema: Increased echogenicity of surrounding tissue and reticulation (angular network of hypoechoic lines).

Architectural distortion: disruption of normal anatomic planes

Skin Thickening: focal or diffuse skin thickening.

h) Calcification: Calcification are poorly characterized with ultrasound but can be recognized as echogenic foci, particularly when in a mass.

Macrocalkification: are coarse calcifications that are 0.5mm or more in size. As in other parts of the body, macrocalcifications will attenuate the acoustic beam and cause acoustic shadowing.

Axillary lymphadenopathy: In whole breast ultrasound, the study should not be completed until a look is taken at the axilla. In sonomammography the normal node
measures about 1cm. It is also bean shaped with an echogenic hilum and a hypoechoic cortex giving the usual cortico-medullary differentiation.

2.4 EFFICACY/ RELIABILITY OF THE BREAST ULTRASOUND DESCRIPTOR
There are controversies regarding the utility of ultrasonography in the evaluation of solid breast masses for suspected malignancy. Stravoset. al., (1995) used ultrasound to distinguish between Benign and malignant lesions in 800 symptomatic patients. They used several sonographic criteria to classify benign and malignant lesions. They then compared thesonographic classifications with biopsy results. The sensitivity, specificity and negative and positive predictive values of the classifications were calculated. They found out that thenegative predictive value for a sonographicallybenign classification was 99.5% and that only 1.6% of malignant lesions was misclassified as benign. Their documented sensitivity for cancer was thus 98.4%.The study concluded that sonomammography can be used accurately to classify some solid lesions as benign, using imaging follow-up rather than biopsy. However, Jackson,(1995) in an editorial did not agree with Stravoset. al.,(1995) study protocol. He observed that the latter study protocol was developed before the American college of Radiology’s Breast imaging Reporting and Data System (BI-RADS) was widely publicized. He further observed that the categories used by
Stravoset. al. did not correspond to the final assessment categories of BI-RADS (“negative”, benign finding”, “probably benign finding”, suspicious abnormality”, highly suggestive malignancy). The report observed that correlation of sonography with mammographic findings is important because mammography remains the best breast imaging modality. He advised that whenever a new interpretation criteria is evaluated, it should be compared with the accepted imaging procedure (in this case, mammography) and that sequel to this both modalities must also be compared with the standard of reference, biopsy. It is only after all this is completed, that one would be able to access the efficacy of each technique. The report concluded that there is no doubt that ultrasound can enable detection and diagnosis of many benign and malignant lesions but that the crucial question is, “how does this information differ from or /and adds to the information obtained with mammography?” He opined that if the mammographic appearance is highly suspicious of malignancy, then biopsy should be performed promptly no matter what sonographic features were seen, also Dennis et al.,(2001) shares the same opinion. Jackson (1995) in another study retreated that the use of ultrasound for breast cancer screening may be harmful to women because some cancer will be missed undetected. According to him for sonomammography to compete with mammography as a successful screening modality, ultrasound must detect all cancers that are visible and invisible during mammography. The latter research discouraged the use of ultrasound
as a screening tool. Venta et al., (1994) and Hall (1997) observed that negative ultrasound result does not provide a reliable assurance that an actual mass does not exist.

Recently, more distinctive clarification has been made as to further classify cysts. These cysts that have thick walls, thick septations, or mural nodules were classified as complex, whereas those containing echogenic fluid or debris were classified as complicated cyst (Rumack et al., 2005). Venta et al., (1994) and Stevens, (2010) described cysts as having an anechoic interior, sharp margins with posterior acoustic enhancement. Benign solid lesions are usually hypoechoic but variable in ultrasound appearance, which can overlap with that of complicated cysts.

It is important to appreciate that there is an overlap in sonographic appearances of fibroadenoma and carcinoma, (Howlett et al., 2003).

Dennis et al., (2003) opined that no matter the descriptor, women who present with lump and a normal mammographic and ultrasound findings; biopsy is still recommended because of the known false–negative rate of mammography and the concern of missing a potentially curable cancer. Therefore, biopsy avoidance based on negative imaging results has not been widely accepted. In a study by Paulinelli et al., (2005) six features were listed in decreasing order of risk as suggestive of malignancy. They are absence of circumscribed margins, thickened cooper ligaments, a heterogenous echo texture, an antero posterior dimension larger than width,
presence of an anterior echogenic rim and posterior shadowing. They argued that problems still lies in the usage of these descriptors due to the importance each author ascribes to these features because they are far from being uniform. The term heterogeneous echo pattern does not exist in the BI-RADS lexicon, but in their experience and some other research, it was one of the most important features (Chen 2004).

Chen et al., (2004) analyzed sonographic features for the differentiation of benign and malignant breast tumors of different sizes to improve the diagnostic accuracy in small lesions. The sonographic features of 1203 histologically confirmed solid breast lesions were prospectively documented with respect to anterio–posterior (AP) diameter and width ratio, shape, margin, echogenicity, echo texture, posterior echo and bilateral refraction size. They found out that the accuracy of breast sonography in differentiating between benign and malignant tumors less or equal to 1cm, greater than or equal to 1.1 to 2cm and greater than or equal to 2cm in size was 75.6%, 86.4%, and 88.4% respectively. Univariate analysis demonstrated that all sonographic features were significant in tumors greater than or equal 1.1cm. Shape, margin, echogenicity and echo texture were the significant factors in those tumors less than or equal 1cm. Multiple logistic regression analysis demonstrated that margin, shape, posterior echo and echogenicity were the significant factors for differential diagnosis in tumors greater than 2cm. Echogenicity, margin, shape,
bilateral refraction sign and echo texture were the significant factors for tumors 1.1cm to 2.0cm. On multiple regression analysis, margin was the only significant factor for tumors less than or equal one. Tumor margin is the most reliable sonographic feature for evaluating breast lesions of any size group. With combination of significant factors and emphasis on specific features according to size of lesion, the diagnostic accuracy of ultrasound in the differential diagnosis of malignant and benign tumors may be improved.

Murad and Bari (2004) specifically mentioned that if these three most reliable criteria of shape, pattern of margin and width to AP ratio were strictly applied, the overall cancer biopsy yield would increase, and thus further confirming that certain sonographic features can help differentiate benign from malignant masses.

Lesnik and Haselbach, (1997) observed that although specific sonographic appearances of most common breast lesions described in literature appeared to have been developed over many years, there was yet no single parameter which allows differentiation of all lesions.

Berg et al., (2003) sought to understand the pathological basis of sonographic features of cystic lesions of the breast and to also ascertain appropriate assessment and management recommendations for these lesions based on sonographic appearance. The study concluded that symptomatic complicated cyst whose differential diagnosis ranged from abscess, hematoma, fat necrosis and galactocele should be managed on
clinical grounds and generally may warrant aspiration. In their series, they found that all clustered microcysts were benign, though further study is required and that complex cystic breast masses with thick wall and thick septations, intracystic masses, masses with mixed cystic and solid components, and solid masses with eccentric cystic foci would merit biopsy 18(23%) of 79 of such complex cystic lesions in their series proved to be malignant. Some may have irregular margins, further clouding the distinction of benign from malignant. Fine needle aspiration or core biopsy should be used to confirm the diagnosis of such fibroadenomas (Suttons, 2006). Although carcinoma can appear well circumscribed or have posterior acoustic shadowing in some cases, the classical ultrasound appearance of breast carcinoma is a hypoechoic mass with inhomogeneous internal echoes, irregular margins, and variable acoustic shadowing. Thus sonography is unable to reliably differentiate the histological subtypes of primary breast carcinoma, as there is considerable overlap in ultrasound appearances (Howlett et.al, 2003). Colour Doppler examination can be helpful in differentiating benign from malignant lesions with benign lesions generally appearing less vascular with low resistance flow. Studies have also shown that the specificity of sonomammography can be increased without compromising sensitivity, by the addition of sonographically guided cytology, after the normal breast sonography.
Various studies have shown the specific diagnosis of simple cyst by ultrasound to range between 94-98% using strict ultrasound criteria. Sonomammography according to Cosmacini et al., (2001) proved to be useful in patients with dense breast. About 82.1% of the patients with a histological diagnosis of benign status had a correct ultrasound diagnosis. The use of ultrasound to evaluate palpable masses is variable and some cyst may defy clinically guided aspiration either due to their mobility or surrounding fibrosis. Sonomammography and sonographically guided aspiration may be useful to avoid surgery. It can also provide additional piece of information that may tilt the balance towards earlier intervention in lesions that are marginally suspicious on physical examination. In addition, it can be used to triangulate the location of lesion and aid in preoperative positioning of surgical guide in some women in whom a biopsy of a non-palpable mammographically indeterminable lesion is to be performed. Studies carried out showed that in lesions classified as complex cysts, the malignancy rate was 0.3%. The malignancy rate is lower than that for lesions classified as probably benign using mammographic criteria (i.e. for lesions classified as category 3 lesions using B1-RADS). The accepted standard practice for management of probably benign lesions is follow-up studies. The low yield of malignancy suggests that complex cysts can be managed as well with follow-up imaging studies instead of intervention (Rumack et al., 2005)
Sonomammography is a very useful in accurately demonstrating the presence or absence of abscess collection in an acutely inflamed breast (Hanye et.al., 1991). This fact was supported by chui-me et.al., (2001) in a similar study conclude that ultrasound plays an important role in confirmation of clinical diagnosis breast abscess and aids significantly in the management of clinical diagnosis of breast abscess. The presence of hypoechoic rim surrounding a fluid space or central area of low-level echoes (i.e. grades 1 to 3 is indicative of a chronic abscess).

Also computers can be used to analyze Ultrasound images (Drukker et al., 2003). Several recent studies suggests that high resolution ultrasound can accurately differentiate benign from malignant solid lesions. Schnarkowski et al,(1996) did a study comparing current and high resolution ultrasound for diagnosis of breast lesions with the aim to assess the value of high resolution ultrasound in the diagnosis of breast lesions. They concluded that high–resolution ultrasound was more valuable in the differentiation and size determination of breast lesions than conventional ultrasound. This fact was confirmed by other authors (Skanne, 1999 and Giger et.al., 1999). The sensitivity, specificity and accuracy of ultrasound were further established by Philippe et.al.,(2003) when they recruited 22 women with mean age of 55years who have cases of breast carcinoma. The study compared the shape of the sonographic image of invasive breast cancer with that of the corresponding histopathology section stained for components of the extracellular matrix, hyaluronan
and collagen. They observed that the shape of the sonographic image of breast cancer was similar to the shape of its hyaluronan extracellular matrix. Hyaluronan accumulation in the stroma could explain the hyperechogenicity, because it was the predominant components within the tumour. The other main components (cells and collagen) have nearly the same acoustic impedance. Indeed the cartilaginous portion of the ribs, which is made of the same extracellular matrix, is almost hypoechoic. Their findings contributed in giving reasons for the sensitivity of breast sonography in the detection of invasive carcinoma and some invasive carcinomas which are not visible on mammography. Based on the above reasons, it could be generalized to other invasive breast cancer types such as lobular, tubular, mucinous and medullary. Consequently if no hypoechoic focal lesion can be detected on sonography, the likelihood of an invasive tumour is very low. This fact was confirmed by Buchbergeret.al., (2000) who showed that Sonography missed only 1 out of 95 invasive carcinomas. However in contrast to high performance of Sonography, x-ray mammography reported in the study, missed 35 invasive breast cancers .In a report by Kolb et.al.,(1998) 11 of 41 non palpable cancers were shown only on Sonography. Their findings can explain this, because, in dense breast, mammography is unable to distinguish the difference between the hydration of the dense surrounding tissue and the hydration of the hyaluronan rich tumour(Stravos 2004). In a study by Moon et al.,(2000), sonography demonstrated all the invasive tumours among 100
mammographically detected cluster micro calcification. They concluded that bilateral whole-breast ultrasound, when performed in patient with dense (BI-RADS Category 3 or 4 densities) breast tissue, is useful in detecting breast cancers not discovered with x-ray mammography or clinical breast examination. Crystal et. al.,(2003) used ultrasound to successfully screen women with mammographically dense breast. In patient with focal breast pain without any associated palpable mass, sonomammography may be useful for patients’ reassurances rather than cancer detection, Leung et al (2002). Also Revelon, (2002) correlated histopathologic types and imaging characteristics in focal fibrosis of the breast, they observed that histopathological type and specific imaging findings did not correlate statistically. The superiority of U/S to mammography in some clinical settings was highlighted by lister et. al., (1998), Strasseret. al., (1990) and De Gezeller et al., (1994). 111 palpable breast tumours were evaluated by De Gezeller H et. al.,(1994),they found out that the diagnostic accuracy for malignant breast tumors was 86.3% for u/s scan, 80.4% for mammography and 78.4 % for clinical evaluation.

2.5 ESTABLISHING SONOMAMMOGRAPHY AS A STAND ALONE MODALITY IN RESOURCE-LIMITED ENVIRONMENT
The highest incidence of breast lumps are relatively higher in women of reproductive ages Mubuuke (2010) and Okoye et al. 2009. Mubuuke(2010) study reported that ultrasound had a sensivity of 92.5% and specificity of 98.1% for 74 out of 80 breast
lump studied. Cystic masses had 100% diagnostic accuracy followed by fibroadenomas. Sensitivity of 100% and specificity of 100% was for differentiating purely cystic mass from solid masses. The sensitivity and specificity of ultrasound for detecting breast carcinoma was 57.1% and 62.8% respectively with a positive predictive value of 68.1%. He concluded that ultrasound should be used as first line of option in women under age 30 and as an adjunct to mammography for women older than 30. Stravos et al., (2004) reported 98.4% sensitivity of ultrasound in classifying breast masses as intermediate or malignant. Also Malik et al; (2006), observed that sensitivity of sonomammography was more for being 92% than malignant lesion 67% and its specialty was high for malignant lesions 92.4%. The study proved the efficacy of ultrasound as a method of choice to evaluate breast masses in young patient avoiding the need of biopsy. The study also reflects that benign diseases dominate the disease spectrum in young patient. Zonderland et. al., (1999), Skanne, (1999) proved in their studies that ultrasound has higher sensitivity of 91% and specificity of 97% when used in conjunction with mammography as compared to sensitivity of 83% and specificity of 97% achieved with mammography alone hence a complementary role for ultrasound. Mainiero et. al., (2005) in their study used sonography to categorize some breast masses in Caucasian population either as benign or malignant to avoid biopsy. All masses were categorized using ACR B–RADS before biopsy. Sonographic–pathological correlation was carried out
on 148 masses that met the sonographic criteria for probably benign masses. Only 1 out of the masses was malignant. The study had a negative predictive value of 99.3%. They concluded that a follow-up scan can be an acceptable alternative to biopsy for sonographically probable benign solid mass. Most benign and malignant lesions can accurately be categorized as a result of improvement in grey scale imaging and the development of sensitive colour duplex doppler in vascular mapping (Rumack et al., 2005).

Valaniset al., (1987), observed differences in histological type of breast lesions in both whites and blacks. Blacks have fewer well-differentiated tumours, the type associated with positive estrogen receptor and with better survival. Carmen et al., (2003) established that mammographic breast density is lower in African American women than in Caucasians and Latinas. This discrepancy may be an intrinsic racial difference due to undetermined causes, factors, such as growth rate of tumours and the incidence of calcifications. Further studies are required to confirm that the other forces do not have a negative impact on the efficacy of screening mammograms in African American women. The authors did not document any evidence any racial dependence of incidence of breast lesion.

It is therefore imperative to establish in our own environment whether sonography can be used as a standalone modality to evaluate breast lesion. This will help prevent patients from reaching the symptomatic stage when cure is impossible.
CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design: A prospective cross sectional survey design was adopted for this work. This was to ensure that all the patients who underwent sonography were also sent for histology for ease of data collection. A purpose approach was adopted.

3.2 Duration of Study: The study lasted for 24 months.

3.3 Target population: This comprised all patients referred for breast sonography and concurrent histology assessment within the period of the study in State House Clinic, Abuja who met the inclusion criteria.

3.4 Sample Size determination: A sample size of 150 was determined using Lwanga and Tyre (1986) equation for a finite population. For the purpose of this study, a pilot survey was conducted at State House Clinic and it was observed that 6% of female patients who presented for breast scan also were sent for histology assessment, hence 0.06 was used as the population proportion. The sample size, n, was then determined for the study as follows:
\[ n = \frac{Z P (1-P)}{d^2} \] For a finite population (Lwanga and tyre, 1986)

Where \( n \) = sample size

\( Z \) = \( Z \)-score corresponding to 5% level of significance with a critical value of 1.96.

\( P \) = population proportion.

\( d \) = sample error expected = 5% = 0.05

Then \[ n = (1.92)^2 \cdot 0.06 \cdot (1 - 0.06) = 86.6 = 87 \]

A sample size of 150 patients was chosen to improve confidence level and accommodate attrition.

3.5 **Sampling Procedure**:- All the patients who met the inclusion criteria and who were booked for sonography and histology examination within the study period were enlisted into the study until the sample size was met.

3.6 **Patient Inclusion and exclusion Criteria**:

   **Inclusion criteria:**
   
   a. There was history of breast disease.

   b. They were female patients of 15 years and above.

   **Exclusion Criteria:**
a. Female patients with breast implants.

b. Female patients with advanced breast cancer.

3.7 **Ethical Approval:** The Ethical Committee of the State House Clinic approved the research before the commencement of the study (see appendix 11). In addition, informed consent was obtained from all the patients prior to sonography. All other regulations regarding the use of humans for research were strictly adhered to.

3.8 **Equipment used:** A Philip’s HD4 ultrasound machine manufactured by Philips Medical systems, Phoenix, United States of America (2004). The equipment was calibrated to ensure accuracy of measurements. It is equipped with a 7.5MHZ curvilinear probe. The scanners have high resolution and electronic calipers with assumed speed of 1540m/s in soft tissue. This machine was used for sonomammography throughout the duration of the study.

Using the available freeze-frame capability, all the measurements were made on a frozen image using the on-screen electronic calipers.

3.9 **Scanning technique:** This was conducted by a radiologist with the assistance of the researcher. Prior to sonomammography, the breasts were examined physically to identify the position of the lesion and to obtain a clinical history. The clinical history included, time of onset, pregnancy status, presence or otherwise of nipple discharge and whether the lump was painful or otherwise. The technique adopted for the
sonographic scan was in accordance with Sanders *et al.* ed. (1998). All sonographic examinations were performed with the patient in a supine position for the medial parts of the breast and in a contra-lateral posterior oblique position with arm raised for the lateral parts of the breast. Mild compression was applied during scanning. The two breasts were scanned for each of the patient. The pectoralis muscle had to be seen on all scanned images to ensure that the whole breast was scanned. With smaller breasts, a stand-off pad was used in defining the near field anatomy. With large breast that tends to fall laterally, patient was put in an oblique position away from the side in question. Her knee raised and allowed to fall medially to help configure the rotation to the lower body. Ultrasound gel was applied on the breast and then scanned in both longitudinal and transverse planes. A clockwise approach was adopted, using the nipple as a reference point. The top right of the screen was labeled nipple and consistency was maintained with all the images as each hour of the clock. 12 o’clock is from the nipple towards the clavicle in the center of the breast, 6 o’clock is from the nipple down and so forth. After documenting these 12 views, a view was taken across the nipple or angled slightly to see if there was a lot of shadowing. Cautions were taken to keep the transducer perpendicular to the skin, so that any suspicious area can be reproduced. During the scan, if a mass was noted or palpated, further gentle compression with the transducer was applied to help clarify the area. The mass was fixed between the fingers and scanned thoroughly. A
modified format according to American College of Radiology (ACR) BI-RADS lexicon (2003) was used to document the sonographic features of the lesions.

3.10 Ultrasound features describing breast lesions

(ACR BI-RADS ultrasound classification format)

a. **Shape**
   - Oval
   - Round
   - Irregular

b. **Orientation**
   - Parallel
   - Not Parallel

c. **Margin**
   - Circumscribed
   - Not Circumscribed
     - Indistinct
     - Angular
     - Microlobulated
     - Spiculated

d. **Lesion boundary**
   - Abrupt Interface
   - Echogenic halo
e. **Echo pattern**
   - Anechoic
   - Hyperechoic
   - Complex
   - Hypoechoic

f. **Posterior acoustic features**
   - No Posterior features
   - Enhancement
   - Shadowing
   - Combined Pattern

g. **Surrounding tissue (identifiable effect)**
   - Duct changes
   - Cooper’s ligament changes
   - Edema
   - Architectural distortion
   - Skin thickening
   - Skin retraction/irregularity

h. **Calcifications**
   - Macroccalcification
   - Microcalcifications of out of mass
   - Microcalcification in mass
This format was used to record observation and collect data. They were used in a consistent manner.

BI-RADS ASSESSMENT SCORE: After the sonographic features listed above were evaluated, a BI-RAD category score was assigned to each lesion. This score represents the final assessment of the lesion. In like manner, when there were many different ultrasound findings of lesions in the same breast, the summary BI-RAD’S category for the entire breast will be the highest BI-RAD’S category in that breast. A final BI-RADS score was assigned to all the subjects. This study adopted the modified American College of Radiology Breast Imaging Reporting and Data System( BIRADS) Ultrasound Risk categories, represented below.

**TABLE 1: ACR BI-RAD ASSESSMENT CATEGORY**

<table>
<thead>
<tr>
<th>Assessment Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 0 – Incomplete</td>
<td>Additional imaging evaluation needed before final assessment.</td>
</tr>
<tr>
<td>Final Assessment</td>
<td></td>
</tr>
<tr>
<td>Category 1 - Negative</td>
<td>No lesion found (routine follow-up)</td>
</tr>
<tr>
<td>Category 2 - Benign finding</td>
<td>No malignant features e.g. cyst (routine follow-up for age, clinical management)</td>
</tr>
<tr>
<td>Category 3 - Probably benign finding</td>
<td>Malignancy is highly unlikely e.g. fibroadenoma (initial short interval follow-up).</td>
</tr>
<tr>
<td>Category 4 - Suspicious abnormality</td>
<td>Low to moderate probability of cancer, biopsy should be considered.</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Category 5 - Highly suggestive of Malignancy</td>
<td>Almost certainly cancer, appropriate action should be taken.</td>
</tr>
<tr>
<td>Category 6 - Known Cancer</td>
<td>Biopsy proven malignancy, prior to institution of therapy.</td>
</tr>
</tbody>
</table>

HISTOLOGY RESULT: The histology result of the 150 subjects scanned were collected from the histopathology department and matched against the ultrasound results.
Fig. 2: Micrograph of Fibroadenoma (from the histology)
Fig 3: Sonogram of fibroadenoma (from ultrasound)
Fig 4: Complex mass on ultrasound which turned out to be ductal carcinoma on histology.
Fig 5: Micrograph of ductal carcinoma(from histology)
3.11 STATISTICAL ANALYSIS

Both descriptive and inferential statistics were used in the analysis of the data

CLASSIFICATION OF EXAMINATION AS POSITIVE OR NEGATIVE

“Positive” ultrasound examination was taken to include all those who had BIRADS assessment category 4, BIRADS assessment category 5 and BIRADS assessment category 6.

“Negative” ultrasound examination includes those with BIRADS assessment category 1, 2, 3.

These recommendations were linked to the history. For this study, the ultrasound results from the left and the right breasts were combined and the more severe one (lesion) was used to categorize the patient.

By using the ultrasound outcome criteria described earlier and histological result, ultrasound assessment was linked with cancer outcome to identify true-positive, true-negative, false–positive and false–negative examinations.

Employing signal detection theory:

True –positive and False –Positive examination were defined as a positive ultrasound interpretation with (True –positive result) or without (False –positive result) a cancer diagnosis within one year.

False-positive was designated with respect to histology report.
A true-negative result was a negative ultrasound interpretation, including a probably benign assessment, with no report of cancer.

Similarly, a false-negative result was defined as a negative ultrasound interpretation, with positive histology. It is on the basis of this classification that:

**Sensitivity was calculated as**

\[
\text{Sensitivity} = \frac{\text{True positive}}{\text{True positive} + \text{false negative}} \times 100\%
\]

**Specificity**

\[
\text{Specificity} = \frac{\text{True positive}}{\text{True negative} + \text{false positive}} \times 100\%
\]

**Positive predictive value (PPV)**

\[
\text{PPV} = \frac{\text{True positive}}{\text{True positive} + \text{false positive}} \times 100\%
\]

**Negative predictive value (NPV)**

\[
\text{NPV} = \frac{\text{True negative}}{\text{True negative} + \text{False negative}} \times 100\%
\]

**Accuracy**

\[
\text{Accuracy} = \frac{\text{True Positive} + \text{True negative}}{\text{Total no of Subjects}} \times 100\%
\]
Analysis was done using Statistical Package for Social Science (SPSS version 16) statistical software. The significant and non significant sonographic features were obtained. Cross tabulation between ultrasound features and histological findings was established by Chi-Square test and level of significance determined at $p<0.05$. 
CHAPTER FOUR

PRESENTATION AND ANALYSIS OF RESULTS

A total of 150 patients whose age range from 15 to 69 years were enlisted into the study (table 2). The highest number of patients were within 30-39 years representing 28% (N=42).

Table 2: Age Distribution of patients presenting with Breast lesions

<table>
<thead>
<tr>
<th>S/N</th>
<th>Age Range (Years)</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>&lt;20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>20 – 29</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>3.</td>
<td>30 – 39</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>4.</td>
<td>40 – 49</td>
<td>29</td>
<td>19.33</td>
</tr>
<tr>
<td>5.</td>
<td>50 – 59</td>
<td>31</td>
<td>20.7</td>
</tr>
<tr>
<td>6.</td>
<td>60 – 69</td>
<td>18</td>
<td>12.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 3: Age distribution of BI-RADS prediction of breast Lesions based on ultrasound

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>No of Women with benign breast lesion</th>
<th>%</th>
<th>No. of women with malignant breast lesion</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>13</td>
<td>14</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>20 – 29</td>
<td>13</td>
<td>14</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>30 – 39</td>
<td>30</td>
<td>32</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>40 – 49</td>
<td>10</td>
<td>10</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>50 – 59</td>
<td>16</td>
<td>17.0</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>60 – 69</td>
<td>12</td>
<td>13</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>94</td>
<td>100</td>
<td>56</td>
<td>100</td>
</tr>
</tbody>
</table>

The highest number of patients with benign breast lesions according to BI-RADS assessment was within 30 – 39 years and constituted 30% of the patients while those with malignant lesions were within 40 – 49 years and constituted 19% of the patients studied.
**Table 4:** Age Distribution of histologically diagnosed Breast Lesions

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>No of Women with benign breast lesions</th>
<th>%</th>
<th>No. of women with malignant breast lesion</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;19</td>
<td>15</td>
<td>15.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20 – 29</td>
<td>14</td>
<td>14.6</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>30 – 39</td>
<td>31</td>
<td>32.3</td>
<td>11</td>
<td>20.3</td>
</tr>
<tr>
<td>40 – 49</td>
<td>15</td>
<td>15.6</td>
<td>14</td>
<td>25.9</td>
</tr>
<tr>
<td>50 – 59</td>
<td>16</td>
<td>16.7</td>
<td>15</td>
<td>27.8</td>
</tr>
<tr>
<td>60 – 69</td>
<td>5</td>
<td>5.2</td>
<td>13</td>
<td>24.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>96</td>
<td>100</td>
<td>54</td>
<td>100</td>
</tr>
</tbody>
</table>

The highest numbers of patients with benign breast lesions according to histology results were within 30 – 39 years and constituted 32.3% of the patients while those with malignant lesion were within 50 – 59 years and constituted 27.8 % of the patients.
Table 5: Physical assessment of the breast Vs BI-RADS Assessment.

<table>
<thead>
<tr>
<th>BI-RADS Assessment</th>
<th>Physical Assessment of the breast Vs BI-RADS Assessment</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign</td>
<td>Pain</td>
<td>7</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>Lump</td>
<td>30</td>
<td>31.9</td>
</tr>
<tr>
<td></td>
<td>Both Pain &amp; Lump</td>
<td>54</td>
<td>57.4</td>
</tr>
<tr>
<td></td>
<td>Breast discharge</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Lump &amp; breast discharge</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>94</td>
<td>100</td>
</tr>
<tr>
<td>Malign</td>
<td>Pain</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Lump</td>
<td>31</td>
<td>55.4</td>
</tr>
<tr>
<td></td>
<td>Both Pain &amp; Lump</td>
<td>8</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>Breast discharge</td>
<td>8</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>Lump &amp; breast discharge</td>
<td>8</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>56</td>
<td>100</td>
</tr>
</tbody>
</table>

For benign category, Pain and lump has the highest frequency (n=54, 57.4%) while for malignancy, presence of lump has the highest frequency (n=31, 55.4%).

Table 6 (appendix 1) shows the tabulation categorizing ultrasound features into benign and malignant lesions.
Table 7: Orientation of Lesion Vs BI-RADS Assessment

<table>
<thead>
<tr>
<th>BI-RADS ASSESSMENT</th>
<th>Benign</th>
<th>Malignant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1.5</td>
<td>8</td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>1.6 and above</td>
<td>86</td>
<td>10</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td><strong>94</strong></td>
<td><strong>56</strong></td>
<td><strong>150</strong></td>
</tr>
</tbody>
</table>

In table 6, the smaller the lesion (0 –1.5cm) the more likely it is to be malignant, while the bigger the size of lesion the more likely it is to be benign.
**Table 8:** Distribution of signal detection scores of sonographic features at varying age group, using histology as gold standard.

<table>
<thead>
<tr>
<th>Signal detection theory</th>
<th>&lt;19 yrs</th>
<th>20-29 yrs</th>
<th>30-39 yrs</th>
<th>40-49 yrs</th>
<th>50-59 yrs</th>
<th>60-69 yrs</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Negative 1. Negative</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>2. Benign</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>3. Probably Benign</td>
<td>3</td>
<td>1</td>
<td>17</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>13</strong></td>
<td><strong>12</strong></td>
<td><strong>28</strong></td>
<td><strong>10</strong></td>
<td><strong>13</strong></td>
<td><strong>4</strong></td>
<td><strong>80</strong></td>
</tr>
<tr>
<td>True Positive 4. Suspicious</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>12</td>
<td>10</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>5. Suggestive</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>9</strong></td>
<td><strong>14</strong></td>
<td><strong>12</strong></td>
<td><strong>5</strong></td>
<td><strong>40</strong></td>
</tr>
<tr>
<td>False Negative 1. Negative</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Benign</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3. Probably Benign</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>0</strong></td>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
<td><strong>0</strong></td>
<td><strong>3</strong></td>
<td><strong>8</strong></td>
<td><strong>14</strong></td>
</tr>
<tr>
<td>False Positive 4. Suspicious</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>5. Suggestive</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
<td><strong>5</strong></td>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

Distribution of the negative, true positive, false negative and false positive by age grouping according to BI-RADS assessment based on ultrasound. True negative has the highest frequency.
**Table 9**: Bi-RADs assessment and histology result cross tabulation

<table>
<thead>
<tr>
<th>HISTOLOGY RESULT</th>
<th>BI-RADS Assessment</th>
<th>Benign</th>
<th>Malignant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign</td>
<td>80</td>
<td>14</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Malignant</td>
<td>16</td>
<td>40</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>96</strong></td>
<td><strong>54</strong></td>
<td><strong>150</strong></td>
<td></td>
</tr>
</tbody>
</table>

This table was used to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy as displayed at the appendix.

### Calculated Results:

Sensitivity  
$$\frac{TP}{TP + FN} = \frac{40}{40 + 14} = 74.04\%$$

Specificity  
$$\frac{TN}{TN + FP} = \frac{80}{80 + 16} = 83.33\%$$

PPV  
$$\frac{TP}{TP + FP} = \frac{40}{40 + 16} = 71.42\%$$

NPV  
$$\frac{TN}{TN + FN} = \frac{80}{80 + 14} = 85.10\%$$

Accuracy  
$$\frac{TP + TN}{150} = \frac{40 + 80}{150} = 0.8\%$$
### Table 10: Distribution of Sensitivity, Specificity, PPV, NPV & Accuracy

<table>
<thead>
<tr>
<th>Age group (Yrs)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;19 Yrs</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>20 – 29 Yrs</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>30 – 39 Yrs</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>40 – 49 Yrs</td>
<td>100</td>
<td>66.7</td>
<td>73.7</td>
<td>100</td>
<td>0.82</td>
</tr>
<tr>
<td>50 – 59 Yrs</td>
<td>80</td>
<td>81.3</td>
<td>80</td>
<td>81.3</td>
<td>0.80</td>
</tr>
<tr>
<td>60 – 69 Yrs</td>
<td>38</td>
<td>80</td>
<td>83.3</td>
<td>33</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Distribution of results according to age against sensitivity, specificity, PPV, NPV and accuracy.
CHAPTER FIVE
DISCUSSION AND IMPLICATIONS OF RESULTS, CONCLUSION AND AREAS OF FURTHER RESEARCH

5.0 DISCUSSIONS

5.1 Demographic data: The age range of patients with breast diseases reporting for diagnostic imaging in this study was 15-69 years. The mean age was 40 years. This is similar to the result obtained by Ochicha et al. (2002) in which they found the mean age of patients presenting with breast diseases to be 39 years.

Diagnosis of malignancy from histology in this study was peaked at age 50-59 years (27.8%), whereas BI-RADS prediction by sonographypeaked malignancy at age range of 40-49 years. This finding is in agreement with the results of Okobia (2006), and Oluwatosin and Oladepo (2006) where they found malignancy to be from the 4th decade of life.

Benign breast lesion has its highest presentation at the age range of 30-39 years with mean of 34 years. This is similar to the result obtained by Ochicha et al. (2002), Oluwatosin and Oladepo (2006) and Anyikamet al. (2008). The sensitivity, specificity and accuracy of ultrasound were found from this study to be age dependent. This study found out that the denser the breast, the better the diagnostic value of ultrasound. This suggests that the more fatty the breast, the less the specificity and accuracy of ultrasound. This finding is similar to that of Adeyemoye et al. (2006).

Common physical features: This study found breast pain co-existing with lump as the most common symptom/complaint among patients diagnosed with benign lesions while malignant lesions mostly appeared painless at the onset. This finding was
similar to that of Leung et al., (2002) and Oluwatosin and Oladeho, (2006) in which they also found pain co-existing lump as the commonest finding.

5.2 Evaluation of common ultrasonographic features of breast lesions:

BI-RADS descriptors were used to predict the 150 breast lesions. The strict reliable criteria was shape, orientation (Anterior-posterior (AP) diameter/width ratio i.e. size), lesion boundary, posterior acoustic features and surrounding tissues. The common ultrasound features for benign lesions were oval (58.5%) followed by round (36.1%). The lesion orientation was defined with reference to the skin. It was also a very good descriptor to predict either benignity or malignancy. It is described as a parallel” or “non-parallel respectively.

A parallel or “wider than tall” i.e. antero-posterior (AP) diameter/width ratio of size greater than 1.5cm was associated with some benign masses (85.1%). However, the remaining 14.9% of masses with parallel orientation were found to be malignant. In this case, other prominent sonographic features were used to differentiate them appropriately. These features are shape and margin.

The margin is the edge or border of the lesion. A well circumscribed lesion depicts benignity. In this study, 93.6% were accurately described as benign. Margin of the lesion was among the prominent reliable descriptor for BI-RADS prediction and assignment of scores. Lesion boundary was also a very important U/S descriptor. It
described 89.4% of lesion as having an abrupt interface which connotes benignity. These features were among the fine prominent features that correctly differentiated breast lesions. Echo pattern features that described benignity were anechoic and hyperechoic in 37.2% and 43.6% respectively. Posterior acoustic enhancement was accurate in 94.7% of the cases that best described benign lesions. Surrounding tissue changes were mostly seen in malignant lesions than benign lesions.

The ultrasound descriptive features for malignant lesions in this study were irregular shape (66%), non parallel orientation or “Taller than wide” (71.4%), not circumscribed margin in 100% and the halo sign in 83.3%. Also hypoechoic features (76.8%), acoustic shadowing (83.9%) with architectural distorted surrounding tissue in most of the cases. These findings were similar to those observed by Chen et al., (2003), Stravoset. al., (2004), Obajimi (2005), Mubuuke (2010) in their separate studies.

This study identified two calcification out of 150 breast lesions studied. These masses turned out to be sonographically and histologically malignant lesions. However differentiation of calcification in ultrasound improved with the use of higher frequency ultrasound transducers. This opinion was also shared by SOO et al., (2003).
5.3 Test of Proficiency and ability of Sonomammography to discriminate benign and malignant lesions

The BI-RADS lexicons used to categorize the features into different BI-RADS assessment category.

In this study, sonographic features were further described under each BI-RAD’S assessment category;

**B1 Category:** Round/oval, circumscribed margin, greater than 1.5cm (‘wider than tall’) thin edge shadows which was not significant (p =0.16), enhanced sound transmission (posterior enhancement) with normal surrounding tissue.

**B2 Category:** Features same as above, but no thin edge shadows. There was presence of thick isoechoic septations, although isoechoic feature was not significant.

**B3 Category:** Containing 3 or fewer lobulations (macro-lobulated), thin echogenic capsule with circumscribed margin, greater than 1.5cm (‘wider than tall) homogenous, hyperechoic with acoustic enhancement.

**B4 and B5 category:** Irregular in shape with presence of micro-lobulations, non-circumscribed margin, less than 1.5cm (‘taller than wide’), heterogeneous, hypoechoic, presence of hyperechoic rim and distortion of surrounding tissue.

The BI-RADS in this study accurately predicted 94 benign breast lesions and 56 malignant lesion while histology identified 96 breast lesion and 54 malignant lesions. The difference may be attributed to the limitation of relying purely on morphological appearances. This opinion was also highlighted by (Sutton et.al, 2006). However, applying Pearson’s correlation the discrepancy in the histology results with that of BI-RADS prediction from this study, there was no statistically significant
difference (p = 0.056 > 0.05). This implied that the application of BI-RADS lexicon for ultrasound characterization of breast lesion was good with minimal intra-observer variation. Hence, the use of BI-RADS lexicon can provide accurate and consistent description and assessment for breast ultrasound.

This study however concentrated only on symptomatic patients. This practice though previously used by Ibitoye et al. (2003), restricts selecting patients, for sonography and timely biopsy, of the palpable lesion. This study found out that there were some lesions though not palpable but could be seen in ultrasound. However, if a lesion is cancerous and has started spreading without forming a discrete mass, BI-RAD prediction using ultrasound may not properly characterize it. This may resulted in discouraging ultrasound as a screening tool. This view was also espoused by Adeyemoye et al. (2006), Berg et al. (2003) and Ibitoye et al. (2003).

Correlation between sonographic features and histology obtained a sensitivity of 74% in this study. This is less than 76% obtained by Adeyemoye et al. (2006) but may be attributed to variation in the number of patients used for the studies. Adeyemoye et al. (2006) opined in his study that the performance of ultrasound showed high sensitivity but that ultrasound must be used in conjunction with needle biopsy to achieve improve results and avoid unnecessary benign surgical biopsies. Dennis et al. (2001) however advocated avoidance of biopsy based on negative imaging result.
Based on this study, descriptors from the new sonographic BI-RADS lexicon can be useful in differentiating benign from malignant lesions. Also incorporating ultrasound as a standalone greatly depends on the age of the patient, operator’s experience and the type of ultrasound machine used. Hence the need to introduce its use in our screening programme since breast cancer can occur in young age groups.
5.4  CONCLUSION
This study showed that ultrasound has high sensitivity in differentiation of benign and malignant lesions. BI-RADS prediction based on some sonographic features was able to categorize breast diseases. The detection accuracy in this study was 80% and this suggests that biopsy can be deferred if BI-RADS assessment category is strictly followed. However, the ability to use BI-RADS to grade breast carcinoma was not achieved. The sensitivity and accuracy of ultrasound was operator and age dependent. Therefore, ultrasound may not be used as a screening tool but highly recommended as the first line imaging technique in women with breast symptoms who are less than 30 years, lactating or pregnant. Histology still remains the gold standard.

5.6  AREA OF FURTHER RESEARCH
1. Inter observer variation in the interpretation of breast imaging.
2. Analysis of sonographic features in the differentiation of fibroadenoma and Invasive Ductal carcinoma.
3. Diagnostic values of ultrasonography in patients with palpable mammographically non-calcified breast tumour.
REFERENCES


Anyikam A, Nzegwu M. A, Ozumba B. C, Okoye I, Olusina D. B.  


Okoye, I. J; Training Manual for NYSC Cancer Prevention Advocates.


Steven B. Halls (2010). Benign or malignant sonographic characteristics of Solid Breast Nodules.


Table 5. Ultrasound features describing breast lesions

<table>
<thead>
<tr>
<th>S/NO</th>
<th>SONOGRAPHIC FEATURES</th>
<th>BI-RADS ASSESSMENT</th>
<th>TOTAL</th>
<th>P-VALVE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Benign</td>
<td>Malignant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>SHAPE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oval</td>
<td>55</td>
<td>1</td>
<td>56</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>Round</td>
<td>35</td>
<td>4</td>
<td>39</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>Irregular</td>
<td>4</td>
<td>51</td>
<td>55</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>94</td>
<td>56</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>4b</td>
<td>ORIENTATION</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Parallel</td>
<td>80</td>
<td>14</td>
<td>94</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Not Parallel</td>
<td>16</td>
<td>40</td>
<td>54</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>96</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4c</td>
<td>MARGIN:</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Circumscribed</td>
<td>91</td>
<td>6</td>
<td>97</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Not Circumscribed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indistinct</td>
<td>2</td>
<td>19</td>
<td>21</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Angular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microlobulated</td>
<td>1</td>
<td>23</td>
<td>24</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Spiculated</td>
<td>_</td>
<td>8</td>
<td>8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>94</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4d</td>
<td>LESION BOUNDARY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abrupt Interface</td>
<td>84</td>
<td>10</td>
<td>94</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Echogenic Halo</td>
<td>6</td>
<td>50</td>
<td>56</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>90</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4e</td>
<td>ECHO PATTERN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------</td>
<td>------</td>
<td>------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anechoic</td>
<td>35</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hyperechoic</td>
<td>41</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hypoechoic</td>
<td>13</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>94</td>
<td>56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4f</th>
<th>POSTERIOR ACOUSTIC FEATURES</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Posterior features</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Enhancement</td>
<td>62</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Shadowing</td>
<td>1</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Combined Pattern</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>82</td>
<td>68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4g</th>
<th>SURROUNDING TISSUE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duct changes</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Cooper’s ligament changes</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Edema</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Architectural distortion</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Skin thickening</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Skin retraction/ Irregularity</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4h</td>
<td>CALCIFICATIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Macrocalcification</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Microcalcifications of out of mass</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Microcalcification in mass</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4i</th>
<th>Axillary Lymph Node</th>
<th>7</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>
Reference: SHC/REC/0011/2005

22 October, 2005

Dear, Nwachukwu Ifeoma Chisom
Department of Radiology
State House Clinic,
Abuja,

SHC Ethics Reference No: SHC/REC/0011/2005

Please quote this ref on all correspondence

Project Title: Evaluation of the relationship between sonographic features and histological findings in breast lesion at State House Clinic(SHC) Abuja.

Researchers Name(s): NWACHUKWU IFEOMA CHISOM

Thank you for submitting your application and request for ethical clearance for the above-named study which was considered at the SHC Research and Ethics Committee (REC) meeting on 27th July, 2005. The following documents were reviewed:

1. Request for ethical clearance
2. Research Plan
3. Informed Consent Form
4. Participant Information Sheet (PIS)

The State House Clinic Research and Ethics Committee (SHC REC) hereby approve this study from an ethical point of view.

Approval is hereby given. However, if the research has not commenced by 21st October, 2005, a request for an extension must be re-submitted to SHC REC.

You must also inform the SHC REC when the research has been completed. If you are unable to complete your research within the stipulated validation period, you will be required to write to SHC REC.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration must be reported immediately to the SHC REC, for an appropriate Ethical Amendment.

Approval is given on the understanding that the 'NATIONAL CODE OF HEALTH RESEARCH ETHICS' are adhered to.

Yours sincerely,

Dr. Abraham Amlogu
B Pharm, MPA, Pharm D, Pg cert. HE(UK); Mphil(UK); FcPharm.
Secretary, SHC REC

Scanned by CamScanner