Introduction

Breast cancer is the most common female neoplasm (31% of tumors in females), and the second-leading cause of death among women. Breast lesions were first classified as malignant or benign categories***(Catalano et al, 2009)***.

The observation that benign and malignant breast lesions have inherently different firmness has long been used by clinicians during palpation of the breast; harder and less mobile lesions are considered more likely to be malignant. Palpation is known to be subjective, and it lacks sensitivity to small abnormalities that are deep beneath the skin surface ***(Regener et al, 2006).***

Several different imaging methods, including ultrasonographic strain imaging, also known as ultrasound (US) elastography, have been developed to measure relative stiffness of lesions in contrast to the surrounding tissue. The information displayed in the images is a surrogate for that obtained with manual palpation. US strain imaging may allow the differentiation of benign from malignant solid masses on the basis of differences in stiffness ***(Hall et al, 2003).***

The principle of elastography is that tissue compression produces strain (displacement) within the tissue and that the strain is smaller in harder tissue than in softer tissue. Therefore, by measuring the tissue strain induced by compression, we can estimate tissue hardness, which may be useful in diagnosing breast cancer ***(Itoh et al, 2006).***

Elastography has been used clinically to examine a variety of breast lesions in patients, and it has been concluded that this modality allows radiologists to accurately distinguish benign from malignant breast lesions and it could significantly reduce the number of breast biopsies required ***(Zhi et al, 2007).***

Elastography is a potentially attractive new technique for measuring the elastic properties of tissues ***(Rogeweska et al, 2006).***

Elastography is a new ultrasound technique that can provide additional information which was previously not available.Elastography or elasticity imaging (EI) is an imaging modality based on tissue stiffness, rather than anatomy. These images show the relative difference in stiffness among tissue. For thousands of years physicians have used palpation for diagnosis of breast cancer,5 realizing that stiffer masses on palpation were more likely malignancies. Ultrasound elastography has the potential to quantify the stiffness of a lesion ***(Barr RG,2015)***

There are two types of elastography: strain elastography (SE) and shear wave elastography (SWE). Strain elastography produces an image based on the displacement of the tissue from a compression/release force applied by an external force (transducer or acoustic radiation force impulse [ARFI]) or a patient source (breathing and/or heartbeat). This allows for a qualitative assessment of the lesion, that is, a relative assessment of the stiffness compared with other tissues in the field of view. The exact stiffness of the lesion is not obtained. SWE applies a special “push pulse,” ARFI, which results in shear wave propagation that can be measured as a velocity. Because the velocity of the shear wave through tissues is dependent on the “stiffness” of the tissue, a quantitative value of the stiffness can be obtained; that is, a measurement of lesion stiffness is obtained and expressed as a numerical value ***(Barr RG, 2015).***

Aim of the Study

The aim of this study is to highlight the role of ultrasound elastography in evalution of breast lesions.

Chapter (I)
Breast Anatomy

The adult female breast is a modified sebaceous gland that consists mostly of fat, fibrous septa, and glandular structures. The weight range for a “normal,” mature female breast is 30 grams to over 500 grams, depending on the woman’s body habitus. The breast typically comprises 15 to 25 lobes that are divided into multiple lobules,each containing 10–100 terminal milk secreting alveoli. Numerous tiny milk-transporting ductules combine to form a single lactiferous duct that exits each lobule. About 15 to 25 such ducts converge at the nipple **(fig1)**.

The breast is divided into four quadrants (upper outer, upper inner, lower outer and lower inner), taking the nipple as the center, as well as retro-areolar area and an axillary tail. This topographic anatomy is very valuable regarding nodal management and irradiation fields ***(Omar and Contesso, 2001).***

The adult (female) breast lies on the anterior thoracic wall. Its base extends from the 2nd to the 6th rib **(fig 2)**. It lies from the edge of the sternum to almost the mid-axillary line. Part of the superior lateral quadrant is sometimes extended towards the axilla. This is the axillary tail of the `breast***(Lagopoulos, 2007).***

The two mammary glands (mammo=breast) are modified sebaceous glands that produce milk. The superficial fascia splits to contain the breast. The deep layer of the superficial fascia overlies the chest muscles, separated from them by the retro mammary space. The superficial (or subcutaneous) layer lies deep to the dermis. Cords of connective tissue connect the dermis to the ducts of the gland and to the deep layer of the superficial fascia – the suspensory ligaments of Astley Cooper. Contraction of these cords leads to indentation of the skin associated with some tumors **(fig 1).*****(Lagopoulos, 2007).***

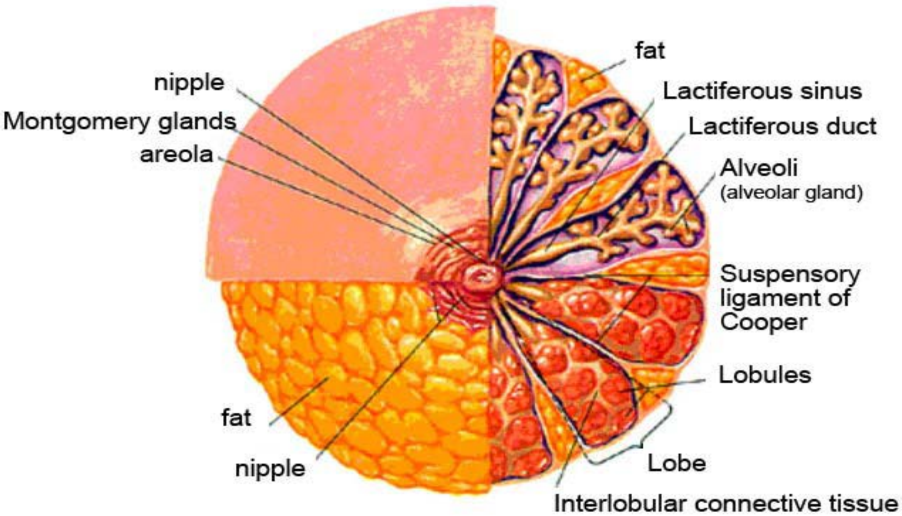

Figure (1): breast architecture **(patasi,2010)**

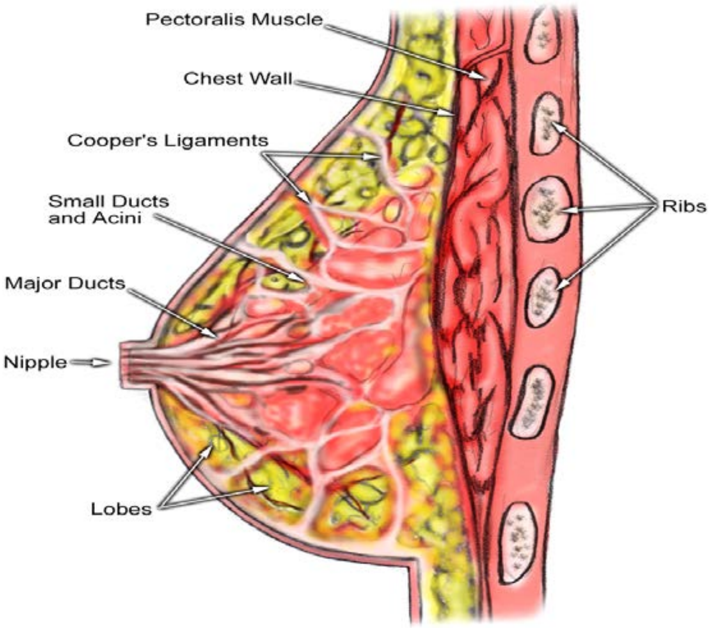

Figure (2):breast profile***(Gabriel and long, 2011)***

The breast lies over the muscles of the anterior thoracic wall. Also, there are muscles associated with the axillary region. Knowledge of these muscles and their blood and nerve supply is important to the surgeon in reconstructive breast surgery. The serratus anterior receives its nerve supply from the long thoracic nerve. The nerve can be damaged during dissection of the axillary lymph nodes ***(Lagopoulos, 2007).***

Breast lobar anatomy

Ductal-lobar organization of human breast tissue:

Better knowledge of human ductal-lobar breast anatomy is essential for understanding the early origins of human breast cancer and rational design and evaluation of endoductal approaches to breast cancer diagnosis and treatment. Vector mapping of structural data from enhanced thick-section techniques would be applicable to autopsy and prophylactic mastectomy studies relevant to breast cancer origins, epidemiology, and breast imaging.

A human breast has many lobes, which are highly variable in size and shape, each with one central duct, its peripheral branches and their associated glandular tissues ***(Going, 2006)***.

Cancer of the breast is epithelial in origin. It develops in the epithelial or cellular layer that defines the ducts in the breast. Therefore, investigation of the mammary epithelium must be given the highest priority in any diagnostic technique. The mammary epithelium is an extremely thin layer, only one or two cells thick, which lines the ducto lobular structures. It is not currently possible to observe and display this 50-μm-thick layer by any physical instrument other than a microscope. Nevertheless, ultrasound imaging, used in a rational way, has shown that even normal, undilated ducts are visible. This has let to a successful method of investigation based on the display of the internal epithelial ducto lobular structures of each mammary lobe within the breast***(Kuhl, 2005).***

The differentiation means that ultrasound is able to display the spatial arrangement of the fluid that fills the ductolobular structures and hence reveals the contours of the ducts. These contours contain the one- to two-cell thick lining of the epithelium which is critical to the early detection of breast cancer. Although this layer of epithelial cells is too thin to be directly visible, its spatial arrangement can be observed because it is the interface which corresponds to the silhouette of the contours of the liquid or gel content of the ductolobular structures. The existence of occult epithelial diseases is apparent as soon as a perceptible alteration in the echographic shape or shade of the ductolobular structures is produced. Moreover, when the epithelium increases in thickness it becomes easily observable and clearly distinguishable from the connective tissue because it happens to show a lower echogenicity. It is a gel. When these two tissues are affected more intensely by pathologies, their difference in echogenicity increases allowing the visually perceivable differentiation between epithelial and connective components in lesions.

These features explain why the normal ductal structures can always be seen and why ultrasound is sensitive to early alterations in these physical structures***(Kuhl, 2005).***

Blood supply of the breast:

The main vessels are the internal thoracic artery, the axillary artery and intercostals arteries. The lateral thoracic artery supplies the upper and lateral borders of the breast. The internal thoracic artery sends branches through the 1st to 4th intercostals spaces. The 2nd and 3rd branches are the largest. They supply the medial aspect of the breast. The posterior intercostal arteries also send small branches. There are variations in the distributions of these vessels. The veins form a superficial plexus (around the nipple) and a deep plexus. From there, blood drains into deep veins that run with the arteries. It should be noted that the posterior intercostal veins can communicate with veins that drain the bony spine**(Fig 3)*****(Lagopoulos, 2007)*****.**

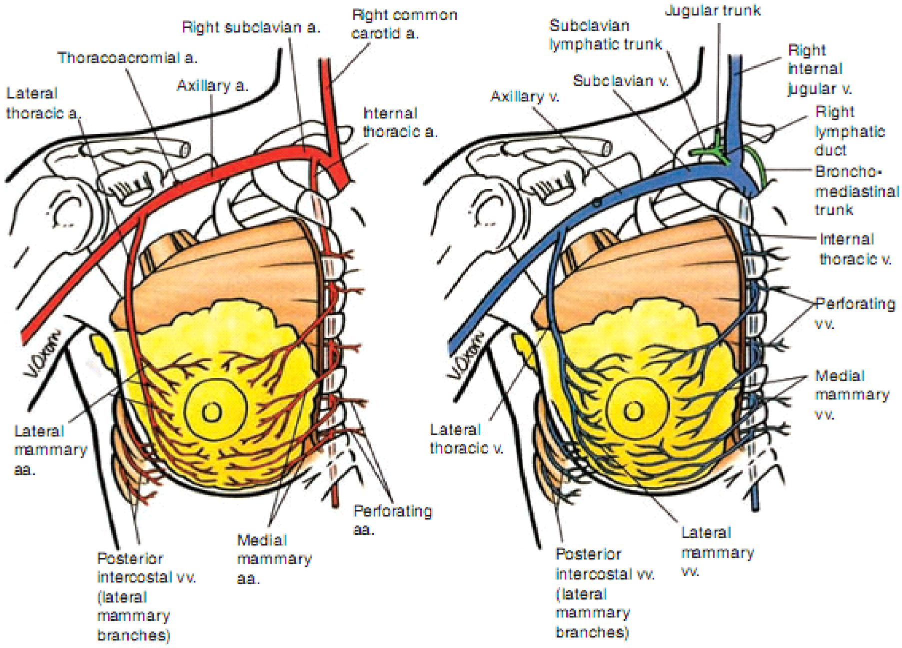

Figure (3): The blood supply and venous drainage of the breast. a, artery; aa, arteries; v, vein; vv, veins***(Moore and Agur, 2002*****).**

Nerve supply of the breast:

The sensory supply of the breast is from branches of the 4th, 5th and 6th intercostals nerves. These nerves also carry afferent sympathetic fibres. The secretory activity of the breast is mainly controlled by the ovarian and pituitary hormones ***(Standring, 2005).***

The lymphatic system of the breast:

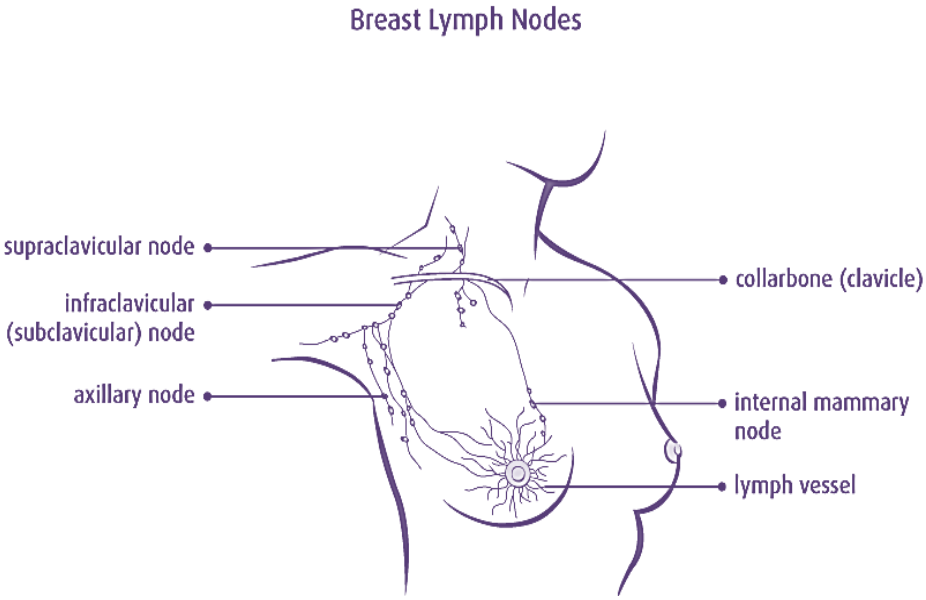

Figure (4): Breast lymph nodes***(Standring, 2005).***

The breast lymph nodes include:

- Supraclavicular nodes – above the collarbone.
- Infraclavicular (or subclavicular) nodes – below the collarbone.
- Axillary nodes – in the armpit (axilla).
- Internal mammary nodes – inside the chest around the breastbone (sternum).

Axillary lymph nodes: There are about 30–50 lymph nodes in the axilla. The number varies from woman to woman***(Martini, 2009).***

Normal breast elastography

The upper 3-5 mm (including the skin) is used to generate the first row of data points for the elastogram. The subcutaneous fat layer just deep to the skin, which is displayed as a dark area on the sonogram, appears as a bright band on the elastogram. This appearance is consistent with the known softness and compressibility of fatty tissue in the breast. The next layer is hyperechoic breast parenchyma. This tissue is firmer and appears on the elastogram as a relatively dark band. The deeper layers show various bands of firmer or softer tissue as dark and bright bands, respectively. Near the bottom of then image, numerous bright dots appear. These are areas where the strain could not be computed accurately because of low signal amplitude**, (Fig. 5)** ***(Itoh, 2007)*****.**

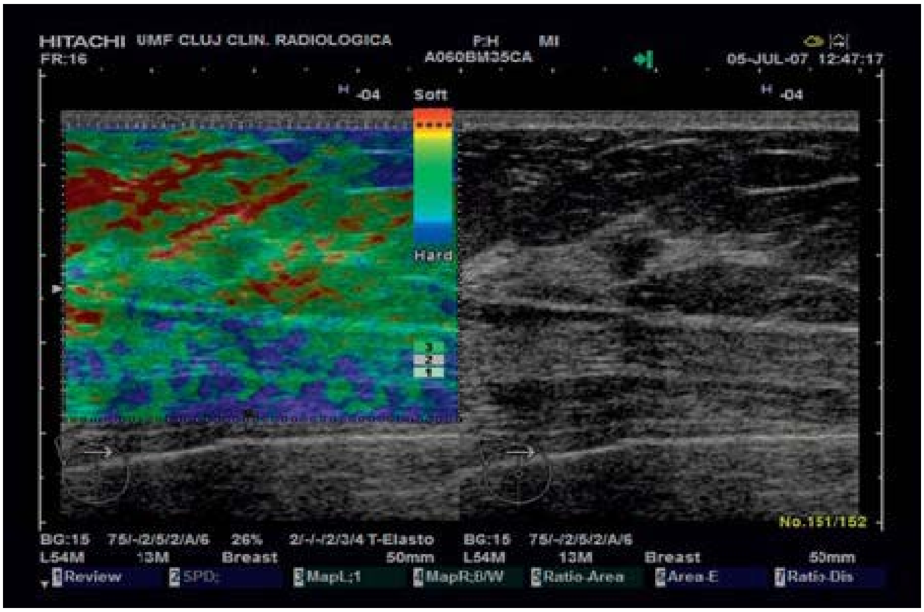

Figure (5): Normal elastogram***(Itoh, 2007)***

Chapter (II)
Pathological considerations of benign and malignant breast lesions

Breast masses have a variety of etiologies, benign and malignant. Fibroadenoma is the most common benign breast mass; invasive ductal carcinoma is the most common malignancy. However most breast masses are benign, breast cancer is the most common cancer and the second leading cause of cancer deaths in women ***(Elsaid. N and Mohamed.H, 2012).***

1- Common Benign Lesions

I-Tumors

II- Inflammation

III-Benign proliferative conditions of the breast

I-Tumors:

1-Fibroadenoma

The term “fibro” implies structural fibrous tissue and “adenoma” means glandular tissue. Being fibrous tissue they are not painful and are usually discovered on breast exam. The physical characteristics of a fibroadenoma are round, solid, rubbery, and movable. They are more common in