The Role of Ultrasound Elastography in Evaluation of Breast Lesions

ESSAY

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Radiology

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To My Family

With Love

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LIST OF ABBREVIATIONS

2D	2 Dimentional
3D	3 Dimentional
ID	A one- dimentional object
ANDI	Aberration of normal development and involution
ACR	American College of Radiology
BGR	Blue-Green-Red
BIRADS	Breast Imaging Reporting and Data System
CAM	Combined autocorrelation
CUS	Conventional ultrasound
CC	Cranio-Caudal
DIC	Ductal invasive carcinoma
ES	Elastography system
FAT	Fatty breast tissue
FOV	Field of view
FIG	Figure
FNAC	Fine needle aspiration cytology
DCIS	Duct carcinoma Insitu
IDC	Intraductal carcinoma
NOS	Invasive duct carcinoma
ILC	Invasive lobular carcinoma
LCIS	Lobular carcinoma insitu
MLO	Mediolateral oblique
NPV	Negative predictive value
PPV	Positive predictive value
ROI	Region of interest
Sono-MX	Sono-mammography
SD	Standard deviation
SR	Strain ratio
USE	The real time ultrasound elastography
US	Ultrasound
WHO	World health organization

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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.

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. 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)***.

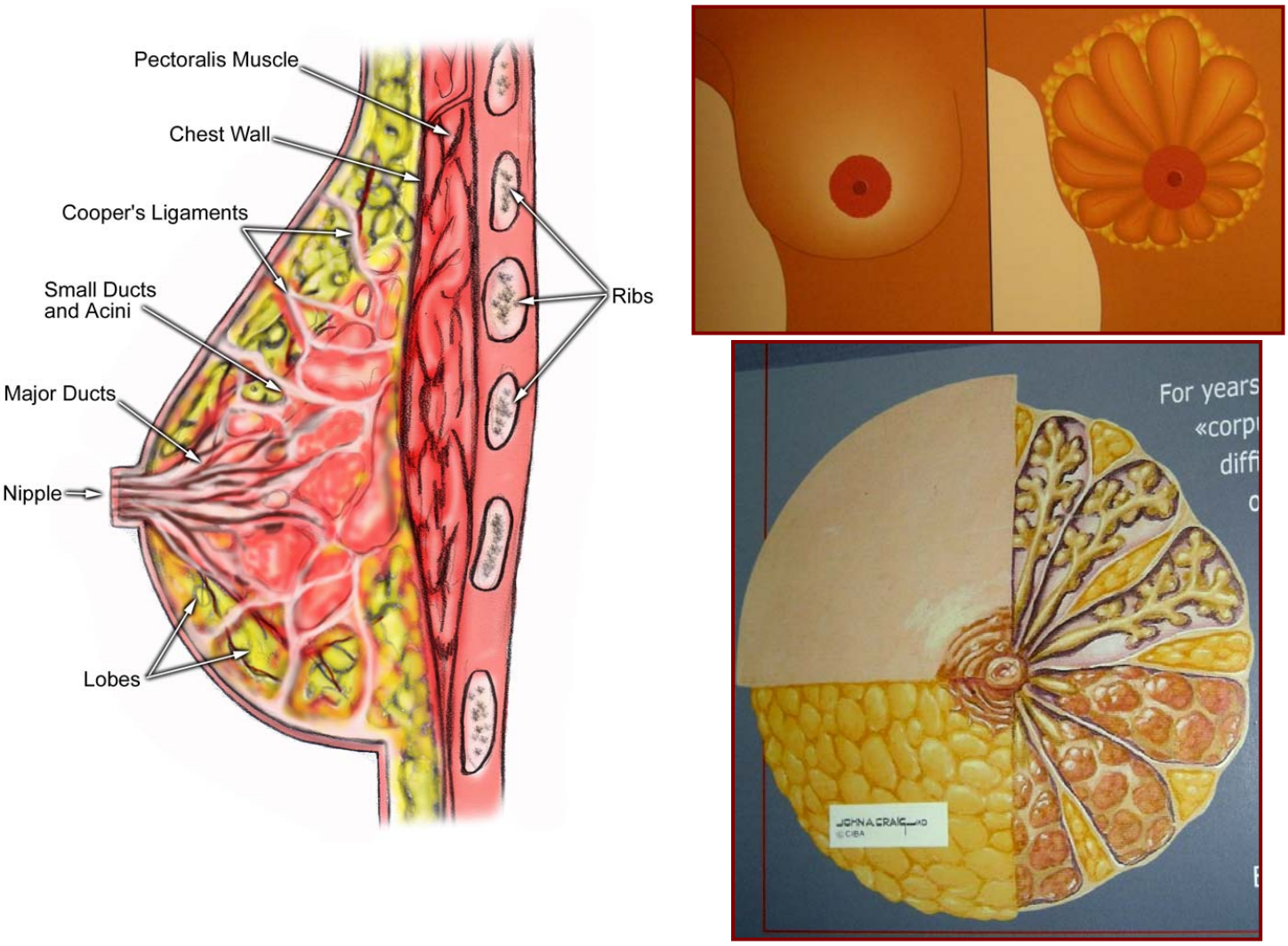


Fig.1: Anatomy of the breast

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).***

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.2) ***(Lagopoulos, 2007).***

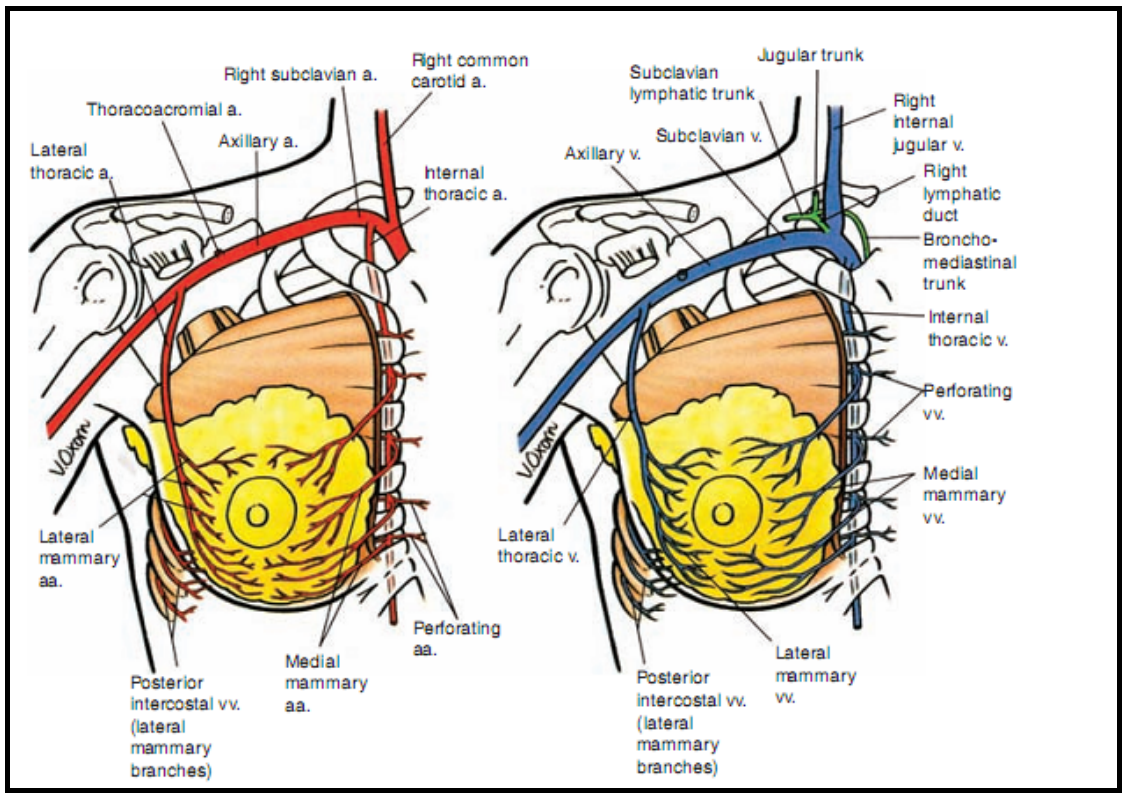


Fig.2 The blood supply and venous drainage of the breast. a, artery; aa, arteries; v, vein; vv, veins ***(Moore and Agur, 2002*)**.

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).***

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)**.

The notion of a ductal system is important and should be clearly explained. The ductal system is not a concrete anatomic organ constructed by an arrangement of solid material, as are vascular systems.

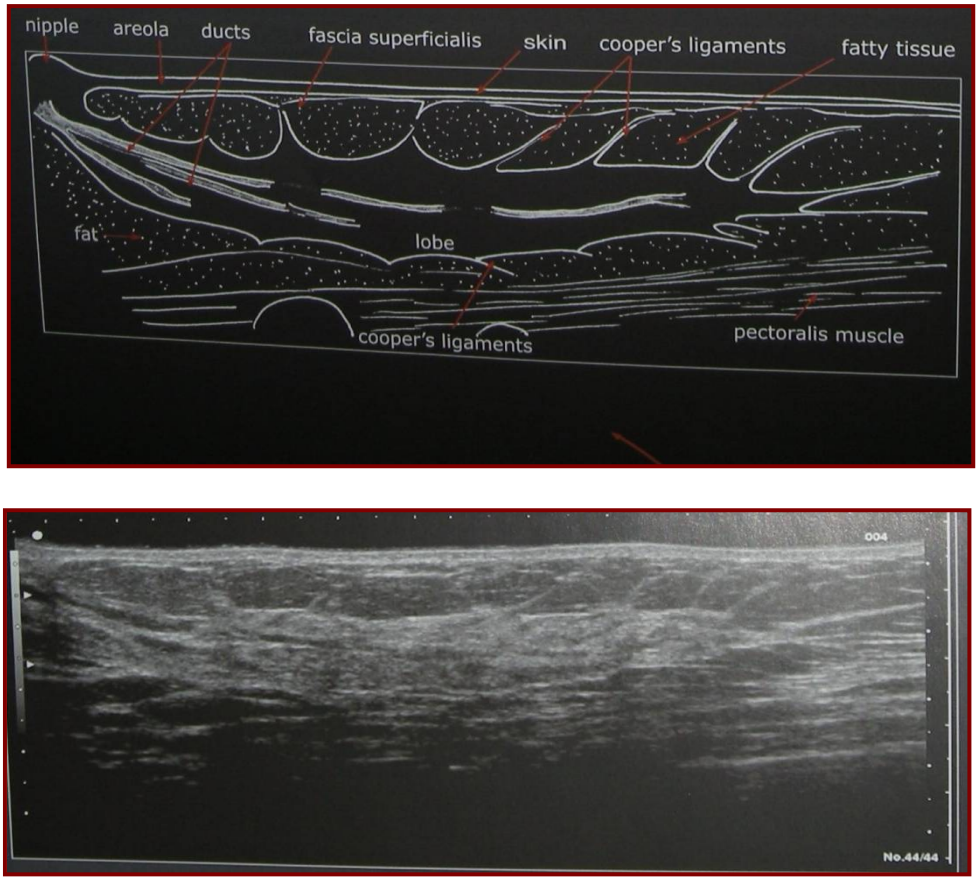
It is a rather more abstract concept, a network bored in the lobe, hollow and theoretical continuation of the air outside the body. This hollow `milk-pipe` network is lined with epithelium tissue that is a continuation of the skin which folds inside the breast through the pores of the nipple. The epithelium is a thin, one to two-cell layer stuck to a thinner `basal membrane` which is itself stuck onto myoepithelial cells, loose connective tissue and fat **(Kuhl, 2005)**.

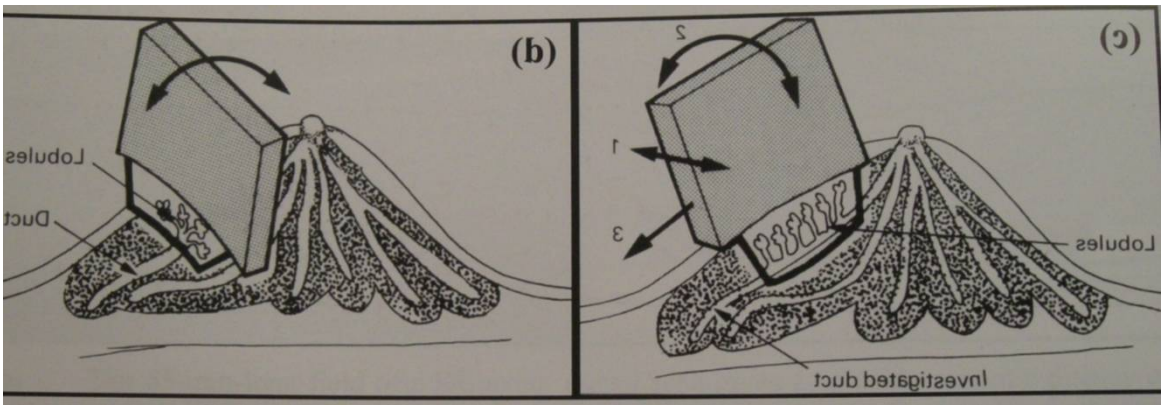
Cancer of the breast is epithelial in origin. It develops in the epithelial or cellular layer that defines the ducts in the breast. Therefore, investigation of the mammary epithelium must be given the highest priority in any diagnostic technique. The mammary epithelium is an extremely thin layer, only 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 connective tissue is described as `loose` but is made of solid collagenous fibers and behaves as a corporal solid body, well delineated by ultrasound from the semiliquid (at body temperature) breast fat on one side and the liquid (organic secretions) containing ductolobular structures on the other (**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).**





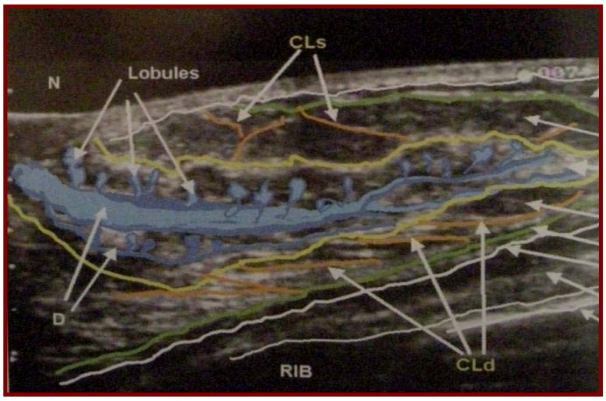


Fig.3 US Breast Anatomy

PATHOLOGY OF COMMON

BREAST LESIONS

- **TUMORS (FOCAL MASSES)**

Benign (harmless) Breast Lesions

Fibroadenoma.

Phyllodes tumour

- Benign
- Borderline
- Malignant

Lipomas and Adenolipomas.

Intraduct benign lesions

Hamartoma

Malignant (cancerous)breast lesions

"WHO" Histologic Classification of Breast Carcinoma:

A - Non-Invasive (Non-Infiltrating) Carcinoma

Carcinoma insitu:

-Intraductal carcinoma in situ (DCIS)

- Comedo type.
- Non-comedo type.

- Lobular carcinoma in situ (LCIS)
- Paget's disease
- Lobular Neoplasia

B- Invasive Carcinoma

-Invasive ductal carcinoma

Most are "not otherwise specified"

The remainders are given subtypes:

- Mixed type carcinoma
- Pleomorphic carcinoma

-Invasive lobular carcinoma

-Tubular carcinoma

-Invasive cribriform carcinoma

-Medullary carcinoma

-Mucinous carcinoma and other tumours with abundant mucin.

- Mucinous carcinoma
- Cystadenocarcinoma and columnar cell mucinous carcinoma
- Signet ring cell carcinoma

-Neuroendocrine tumours

- Solid neuroendocrine carcinoma (carcinoid of the breast)
- Small cell / oat cell carcinoma