Introduction

Breast augmentation and breast reconstruction, are increasingly common operations. All radiologists need to be able to recognize the normal appearances of the more commonly used implants on various imaging modalities, and breast radiologists in particular are facing new challenges when imaging the women involved ***(Glynn and Litherland, 2008).***

It was first described in 1895 when Czerny performed breast reconstruction using autologous fat implantation after excision of a large fibroadenoma. A wide variety of breast augmentation techniques have been developed since, with breast prosthesis implantation being the most commonly performed today ***(Yang and Muradali, 2010).***

Cosmetic breast augmentation is an increasingly common procedure performed. Although breast prosthesis implantation is the most common technique, other unusual techniques are also available ***(Yang and Muradali, 2010).***

Breast reconstruction is now commonly undertaken following mastectomy for breast carcinoma or prophylactic mastectomy for women at high risk of developing malignant breast disease ***(Glynn and Litherland, 2008).***

A wide variety of breast implants are available on the market and are broadly categorized by lumen number, filler type, and surface contour ***(Yang and Muradali, 2010).***

Many women who have undergone breast augmentation present for mammographic screening. Although silicone and saline implants are the most common form of augmentation seen on imaging, there is tremendous variation in surgical techniques and materials throughout the world. Therefore, less common forms of augmentation, such as free silicone injection, polyacrylamide gel, and autologous fat augmentation, may also be seen when evaluating women in a screening or diagnostic setting. Familiarity with all forms of augmentation is important to maximize cancer detection and manage complications related to augmentation procedures ***(Venkataraman et al., 2011).***

Early postoperative complications of breast augmentation include hematoma and infection. Late postoperative complications include capsular contracture, silicone granuloma formation, and implant rupture ***(Yang and Muradali, 2011).***

Rupture is now recognized as an important and common complication of breast implants. Magnetic resonance imaging (MR) is the most accurate method for evaluating implant integrity but requires an understanding of the numerous variations in implant construction that are encountered clinically.

Aim of the Work

To emphasize the role of different imaging modalities in the assessment of breast implants integrity and complications.

Chapter (I): Anatomy of the Breast

The breast is a modified skin gland (modified sweat gland) enveloped in fibrous fascia. The superficial pectoral fascia is located just beneath the skin and in the retro-mammary space.

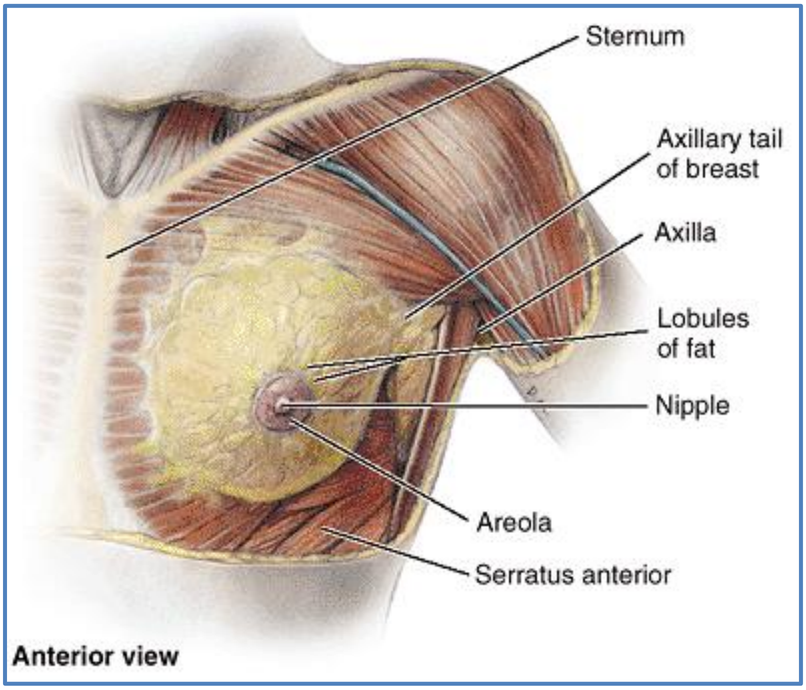

Fig. (1.1): Overview of the breast ***(quoted from Morris and Liberman, 2005)***

The under surface of the breast lies on the deep pectoral fascia although there are fascial layers between the breast proper and the pectoralis major muscle, the breast is not completely separate from the pectoralis major muscle, as there are penetrating lymphatic's and blood vessels ***fig. (1.1) (Morris and Liberman, 2005).***

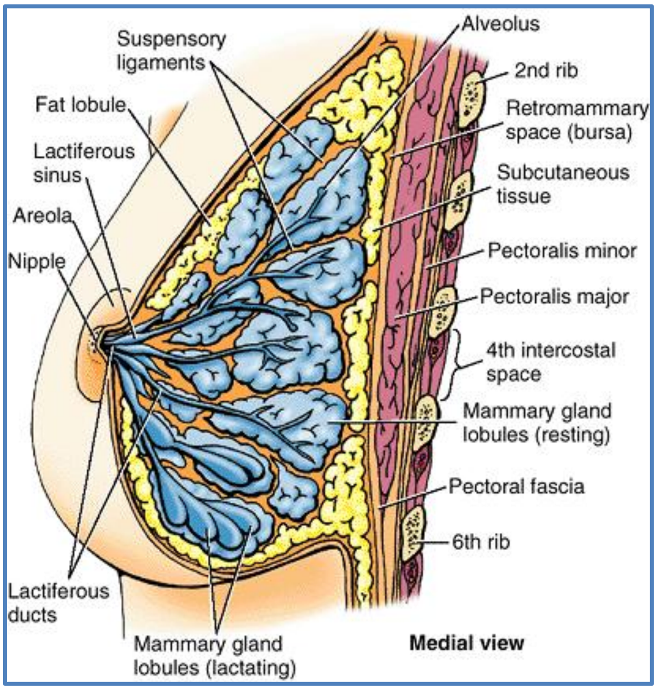

Fig. (1.2): Breast anatomy ***(quoted from Moore et al., 2006)***

Gross anatomy:

The breast is composed of three major structures: skin, subcutaneous tissue, and breast tissue (parenchyma and stroma) ***(Morris and Liberman, 2005).***

The breasts are contained within a fascial sac, which forms when the superficial pectoral fascia splits into anterior (superficial) and posterior (deep) layers. The suspensory Cooper's ligaments are projections of the superficial fascia that run through the breast tissue and connect to subcutaneous tissues and skin ***fig. (1.2) (Butler et al., 2007).***

In young adult females, each breast is a rounded eminence lying within the superficial fascia, chiefly anterior to the upper thorax, the base of the breast (its attached surface) extends vertically from the second or third to the sixth rib ***fig. (1.2) (Bannister, 2005).***

Surface anatomy:

The adult breast lies on the anterior chest wall between the second rib above and the sixth rib inferiorly, and from the sternal edge medially to the mid-axillary line laterally. Breast tissue also projects into the axilla as the axillary tail of Spence. The breasts lie on the pectoral fascia, covering the pectoralis major and minor muscles medially and serratus anterior and external oblique muscles laterally ***fig. (1.1, 1.2) (Butler et al., 2007).***

Mammary gland is supported by strands of fibrous tissue called suspensory ligaments (of Cooper). The nipple usually lies at approximately the level of the fourth inter-costal space and is surrounded by the pigmented areola. Gland lobules drain into lactiferous ducts that open on the nipple surface ***(Hansen & Lambert, 2005).***

Embryology and development:

During the fourth gestational week, paired ectodermal thickenings called mammary ridges (milk lines)

fig. (1.3) develop along the ventral surface of the embryo from the base of the forelimb buds to the hind limb buds. In the human, only the mammary ridges at the fourth inter-costal space will proliferate and form the primary mammary bud, which will branch further into the secondary buds, develop lumina and coalesce to form lactiferous ducts. By term, there are 15-20 lobes of glandular tissue, each with a lactiferous duct. The lactiferous ducts open onto the areola, which develops from the ectoderm layer ***(Butler et al, 2007).***

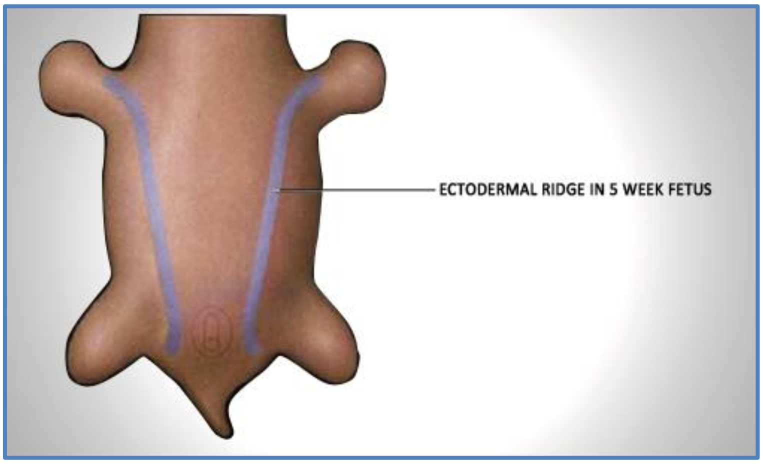

Fig. (1.3): Embryological mammary ridges ***(quoted from Berg et al., 2006)***

The supporting fibrous connective tissue, Cooper's ligaments, and fat in the breast develop from surrounding mesoderm. At birth, the mammary glands are identical in males and females and remain quiescent until puberty, when ductal growth occurs in females under the influence of estrogens, growth hormones and prolactin ***(Butler et al., 2007).***

As the breast grows, the subcutaneous adipose and connective tissues increase in volume and ductal elements proliferate, elongating and extending deeper into the subcutaneous tissues. Over a variable period of time, terminal buds at the ends of the branching ducts differentiate into tufts of blunt-ending ductules that form the glandular acini of the TDLUs ***(Kopans, 2007).***

Skin:

The female breast is covered by typical thin skin of the anterior thoracic wall, and bears fine hairs. Where it covers the nipple, which lacks hairs, and the surrounding areola, the skin is modified. Here, the skin has a convoluted surface, and contains many sweat and sebaceous glands which open directly on to the skin surface. Other areolar glands are intermediate in structure between mammary and sweat glands: they enlarge in pregnancy and lactation as subcutaneous tubercles. Melanocytes are quite numerous in the skin of the nipple and areola, giving them a darker colour than the remainder of the breast. Further darkening of the nipple and areola occurs during the second month of pregnancy, a change that persists to a variable degree ***(Gray's, 2005).***

The nipple is found centrally on each breast and has abundant sensory nerve endings ***(Butler et al., 2007).***

It usually lies at approximately the level of the fourth inter-costal space and is surrounded by the pigmented areola. Gland lobules drain into lactiferous ducts that open on the nipple surface each open separately ***(Hansen, and Lambert, 2005).***

Surrounding the nipple is the areola, which is pigmented and measures 15–60 mm. Near the periphery of the areola are elevations (tubercles of Morgagni) formed by the openings of modified sebaceous glands, whose secretion protect the nipple during breast feeding ***(Butler et al., 2007).***

Internal architecture (parenchyma and stroma):

The breasts are composed of lobes, which contain a network of glandular tissue consisting of branching ducts and terminal secretory lobules in a connective tissue stroma ***fig. (1.4) (Gray's, 2005).***

The glandular tissue and ducts are surrounded by fat and supported by Cooper's ligaments ***(Morris and Liberman, 2005).***

The parenchyma is divided into 15 to 20 lobes or segments that converge at the nipple in a radial arrangement ***(Morris and Liberman, 2005).***

The distribution of lobes is not even as there is a preponderance of glandular tissue in the upper outer quadrant of the breast ***(Morris and Liberman, 2005).***

The ducts from the lobes converge into 6 to 10 major collecting ducts that have openings at the nipple and connect to the outside. Beneath the nipple openings, the lactiferous sinus is visible. The lactiferous sinus is a slight dilation of the ampullary portion of the major duct. The major ducts that converge below the nipple and drain each segment are 2mm in diameter ***(Morris and Liberman, 2005).***

Each duct drains a lobe made up of 20 to 40 lobules. Each lobule contains 10 to 100 alveoli or acini. Each lobule also consists of branching ducts that divide into sub-segmental structures ***(Morris and Liberman, 2005).***

Branching continues until the distal duct ultimately ends in a grouping of blunt-ending ductules (like the fingers of a glove) that form a collection of glandular acini defined as a lobule arrayed at the end and around a terminal duct ***fig.(1.5)*** like hollow grapes in a stem. A portion of the terminal duct and its ductules (acini) is surrounded by the intra-lobular, more loosely organized, specialized connective tissue ***(Kopans, 2007).***

The final branch from the segmental duct as it enters the lobule is termed the extra-lobular terminal duct. The portion of the terminal duct within the lobule is termed the intra-lobular terminal duct. The blunt-ending tubes, or ductules, that extend like fingers into the lobule, form from 10 to 100 acini that empty into the intralobular terminal duct. ***Histologists have termed the extra-lobular terminal duct and its lobule the terminal ductal lobular unit (TDLU)* fig (1.6).** The TDLU is the most important structure in the breast. It is the glandular unit that produces milk, and it is postulated that most cancers arise in the terminal duct either inside or just proximal to the lobule ***(Kopans, 2007).***

Unlike the larger ducts, the lobule contains no elastic tissue. Although most malignant tumours in the breast are epithelial in origin, interest has been focused on the role of the contiguous, nonepithelial elements of the supporting stroma. The complex stromal epithelial interactions and the micronutrients that bathe the terminal duct are thought by some to have a bearing on cell transformation and cancer promotion ***(Kopans, 2007).***

In addition to cancer, most of the benign lesions, such as cysts and fibro-adenomas, that develop in the breast, develop in the TDLU ***(Kopans, 2007).***

<u>The nipple:</u>

Internally the nipple is composed mostly of collagenous dense connective tissue and contains numerous elastic fibres which wrinkle the overlying skin. Smooth muscle cells, arranged in a predominantly circular direction, are present in, and just deep to, the nipple. Their contraction, induced by cold or tactile stimuli (e.g. in suckling), causes erection of the nipple and wrinkling of the surrounding areola ***(Gray's, 2005).***

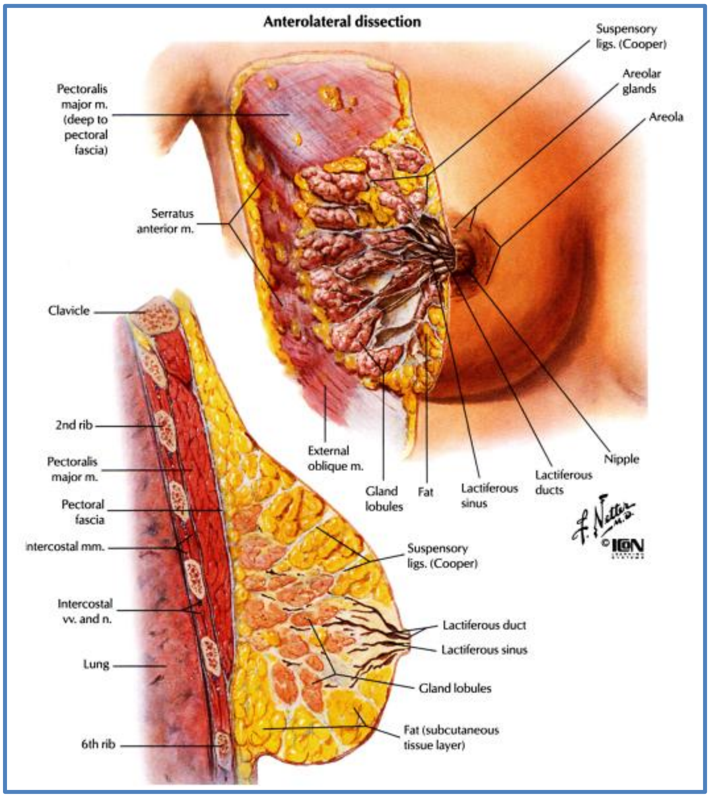

Fig. (1.4): Internal architecture of the breast ***(quoted from Hansen & Lambert, 2005)***

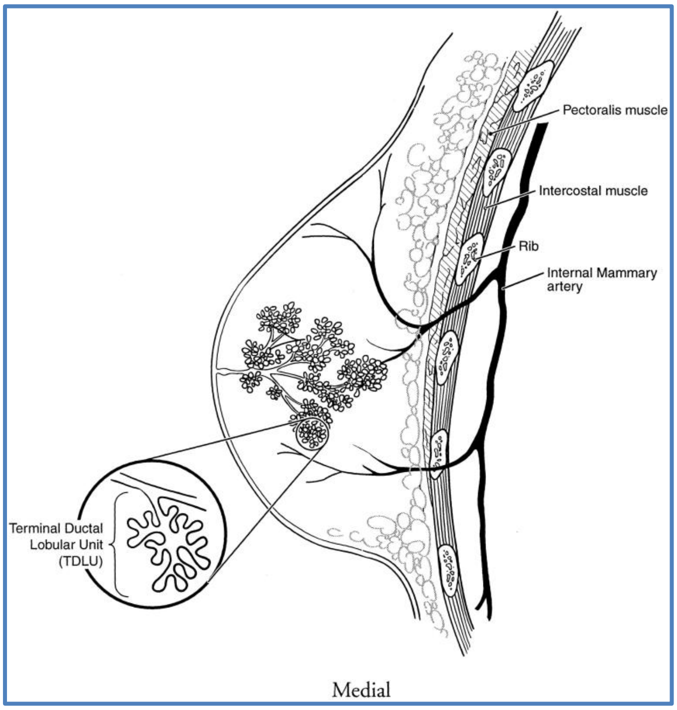

Fig (1.5): TDLUs ***(quoted from Morris and Liberman, 2005)***

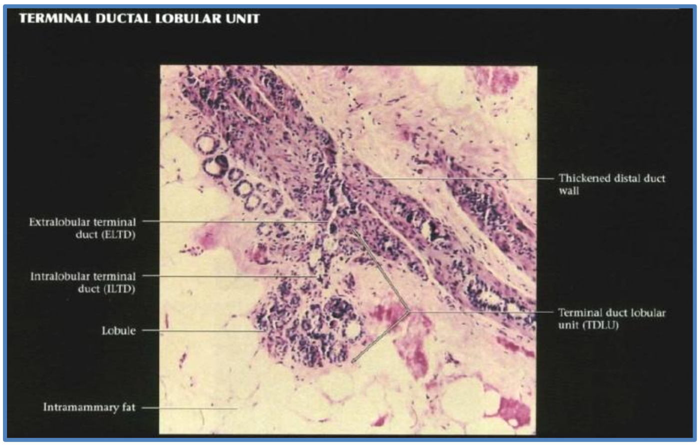

Fig (1.6): TDLUs microscopic view ***(quoted from Berg and Birdwell, 2006)***

Axilla:

It is a wedge shaped fat filled space ***(Anne and Arthur, 2009).***

The most common site of regional involvement of breast cancer is within the axillary lymph nodes ***(Morris and Liberman, 2005).***

Anatomic boundaries:

- *Anterior wall:* formed by pectoralies major, pectoralies minor and fascia.
- *Posterior wall:* formed by latissimus dorsi, teres major, subscapularies muscles and associated tendons.
- *Medial wall:* formed by serratus anterior covering lateral thoracic wall.
- *Lateral wall:* formed by bicipital groove of humerus.

Contents:

- Fat, lymph nodes ***fig. (1.7)***, arteries, veins and nerves.
- Dense connective tissue surrounds the nerves and vessels traversing the axilla.

(Berg and Birdwell et al., 2006)

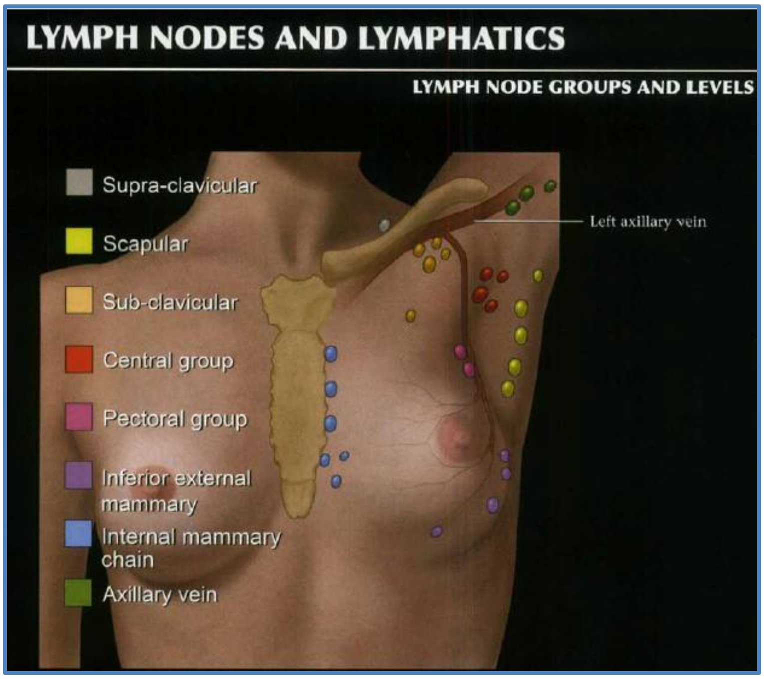

Fig (1.7): Axillary LNs groups ***(quoted from Berg and Birdwell et al., 2006)***

Lymphatic drainage fig. (1.8) & (1.9):

The lymphatic drainage of the breast can be very variable. There are communicating lymphatic plexi in the interlobular connective tissue and the walls of the lactiferous ducts and the sub-areola region. There is also a plexus of minute vessels on the subjacent deep fascia, but it plays little part in normal lymphatic drainage or in early spread of carcinoma. It offers an alternative route when the usual pathways are obstructed ***(Gray's, 2005).***