Introduction

Cancer breast is a leading cause of death and the most common cancer in women, yet we still don't know how to prevent it. Early and accurate diagnosis remains a challenge. The current standards rely on physical examination, mammography and/or ultrasound, and fine needle aspiration. If the breast cancer is found early, prompt treatment could save life ***(Rohren et al., 2004).***

PET/CT as the name implies, combines two scanners PET which shows metabolism and the function of cells, and the CT which shows the detailed anatomy into one ***(Tatsumi et al., 2006).***

Although mammography is the most common performed method of screening the breast, other imaging modalities such as ultrasound, magnetic resonance imaging, computed tomography, and positron emission tomography [PET] may be used to provide additional information to better locate and define abnormal findings. Among these, PET and more recently PET/CT fills certain imaging needs that other modes cannot meet ***(Rohren et al., 2004).***

PET can show whether or not a lump in the breast is benign or malignant. PET may prove to be a very useful addition to mammography. For 70% of all women with suspicious mammograms, the expense and trauma of a breast biopsy for their final diagnosis may be unnecessary because of PET ***(Tatsumi et al., 2006).***

PET is the most useful test in staging or re -staging breast cancer because it is more accurate than any other test in finding local or distant disease. It can detect clusters of tumour cells that have taken hold in other tissues or organs in the body ***(Radan et al., 2006).***

Although PET is not commonly used to evaluate breast lesions at early stages, it is very useful for patients whose tumor markers lesions in the blood are increasing, which may indicate recurrent disease. Rising cancer markers suggests the likehood of a new tumor, but they do not tell where in the body a new tumor may be located .PET and PET /CT can be used in such situations to define the presence of a new tumor or confirm the location of a suspected tumor ***(Piperkova et al., 2007).***

Dual time point FDG-PET/CT improves the discrimination between non-invasive and invasive cancers, and provides superior sensitivity for the detection of small cancers and cancers in dense breast ***(Zytoon et al., 2008).***

Therapy induced changes in tumour metabolism may be helpful in making decisions about continuation, modification or cessation therapy. Therefore, [(18) F] FDG PET-CT appears to be a promising tool for the personalization of breast cancer treatment by its early identification of non responders. The introduction of new PET tracers and the development of new instruments will offer opportunities to improve the role of PET- CT in decision making of therapy in these patients ***(Pons et al., 2009).***

Aim of the Work

To review the role of PET/CT in detection, staging and follow up of breast cancer and its advantages over other modalities used before.

Anatomical Background

Development:

The mammary line (crest, ridge) is an ectodermal (epidermal) thickening that appears during the 4th–5th week of development. It extends from axilla to groin, on each side of the body (Fig.1). Only a small portion of the line persists in the thoracic region ***(Sadler, 2004).***

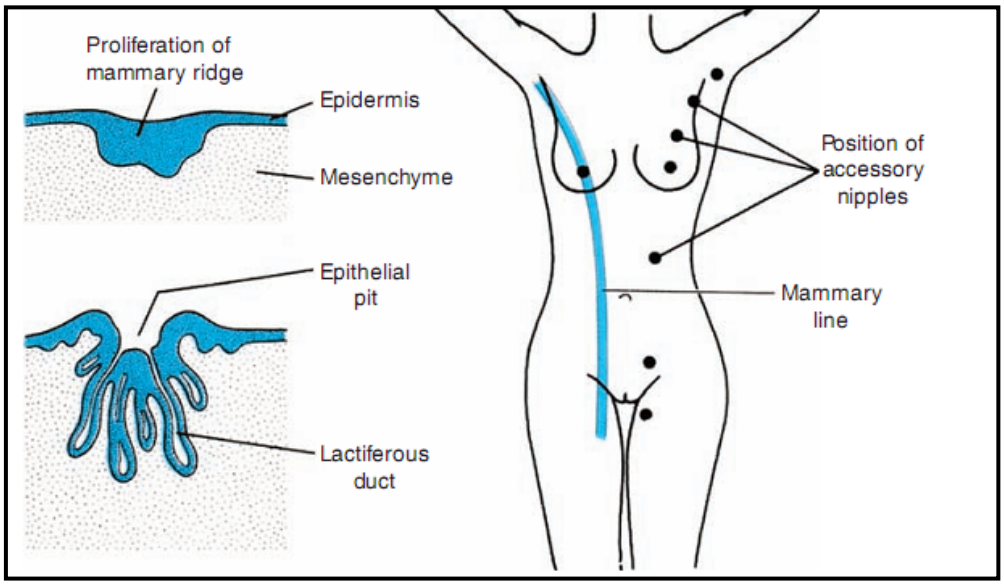

Fig. (1): The position of the mammary line ***(Quoted from Sadler, 2004)***.

Invasion of the underlying mesenchyme (dermis) in the 6th week gives rise to the mammary buds. These lengthen, branch and are canalised to form the lactiferous ducts. The lactiferous ducts come together in a depression on the surface of the skin called the mammary pit. Shortly after birth the pit is converted to the nipple ***(Moore and Persaud, 2003).***

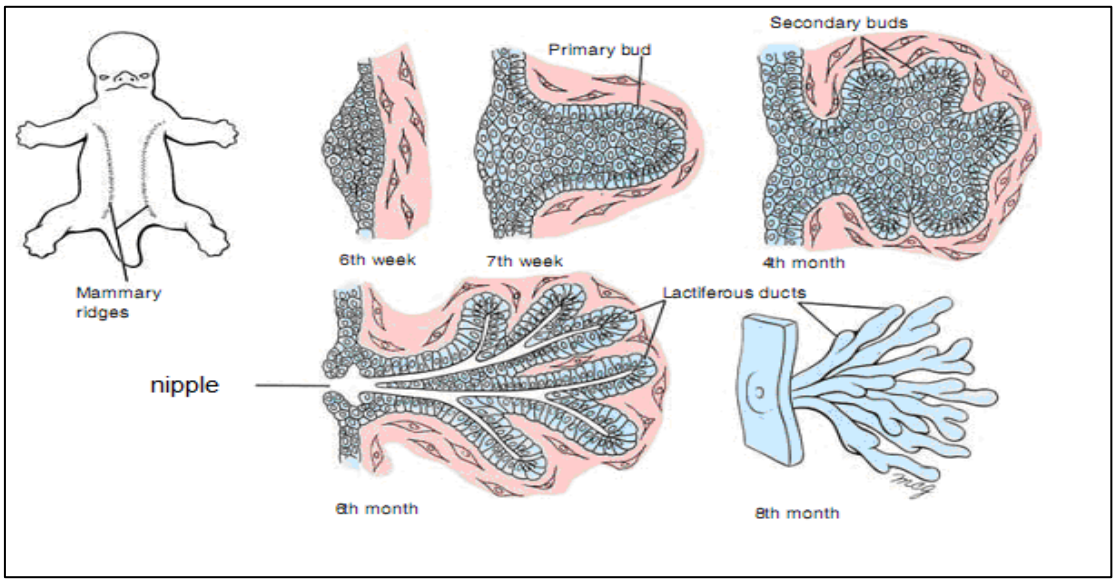

Fig. (2): The development of the mammary gland tissue ***(Quoted from Larsen, 1993)***.

Persistence of remnants of the mammary line may give rise to accessory nipples (polythelia). They are found along of the mammary line and are commonly mistaken for moles. An extra breast develops if a remnant of the mammary line completely develops into a breast (polymastia). Amastia is the congenital absence of the breast. It can be either unilateral or bilateral and is very rare. In amazia there is absence of breast tissue but the nipple is formed ***(Larsen, 1993).***

Anatomy:

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 sudoriferous (sweat) 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 retromammary 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 tumours (Fig.3) ***(Lagopoulos, 2007)***.

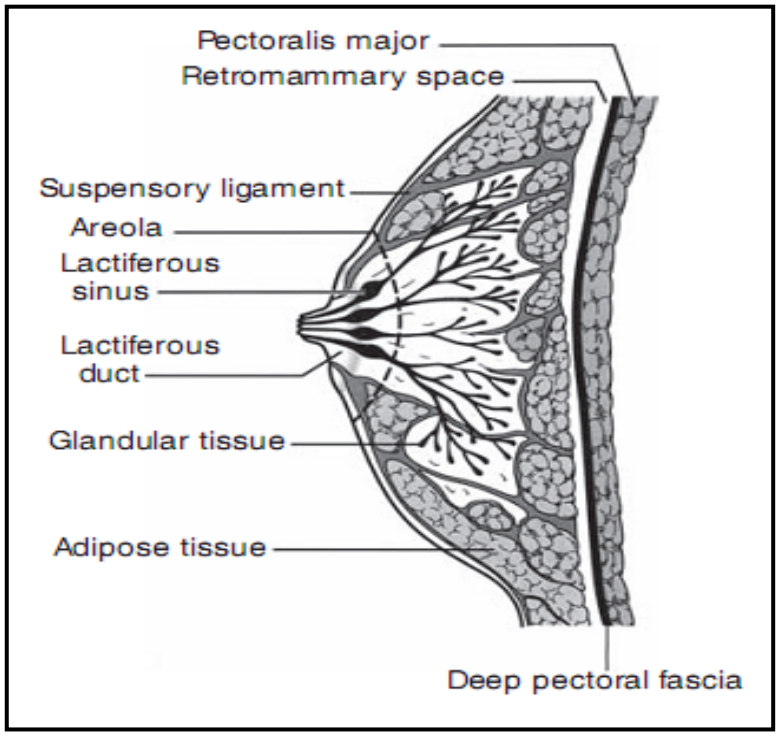

Fig. (3): The suspensory ligaments ***(Quoted from Dudek, 2002).***

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:

Arterial blood supply:

Mainly through the lateral mammary branches of the lateral thoracic artery which is a branch of second part of axillary artery.

Through the internal thoracic artery or the internal mammary artery which originates off the subclavian artery and enters the breast through the second, third, and fourth intercostals spaces medially ***(Strohl, 2004).***

Via small perforating branches arise from the lateral cutaneous branches of the posterior intercostals arteries.

And pectoral branches of the thoraco-acromial artery to supply upper part of the breast.the arteries branch profusely and anastomose with each other ***(Rayan and McNicolas, 2004).***

Venous drainage:

From the breast occurs through a combination of superficial and deep venous systems. The veins course parallel to the arteries to internal thoracic and axillary veins ***(Chummy,1999).***

The venous drainage from a circum-areolar venous plexus and glandular tissue is mainly by deep veins that run with main arteries to internal thoracic and axillary veins. The deep venous drainage is largely via perforating branches of the

internal thoracic vein.The superficial venous complex consists largely of transverse veins corresponding to branches of internal thoracic artery ***(Rosen, 2001).***

The vertebral venous tributaries n (Baston's plexus) may provide a secondary pathway for metastasis of breast cancer. This plexus invests the vertebrae and extends from the base of the skull to the sacrum ***(Bland and Vezeridis, 2001).***

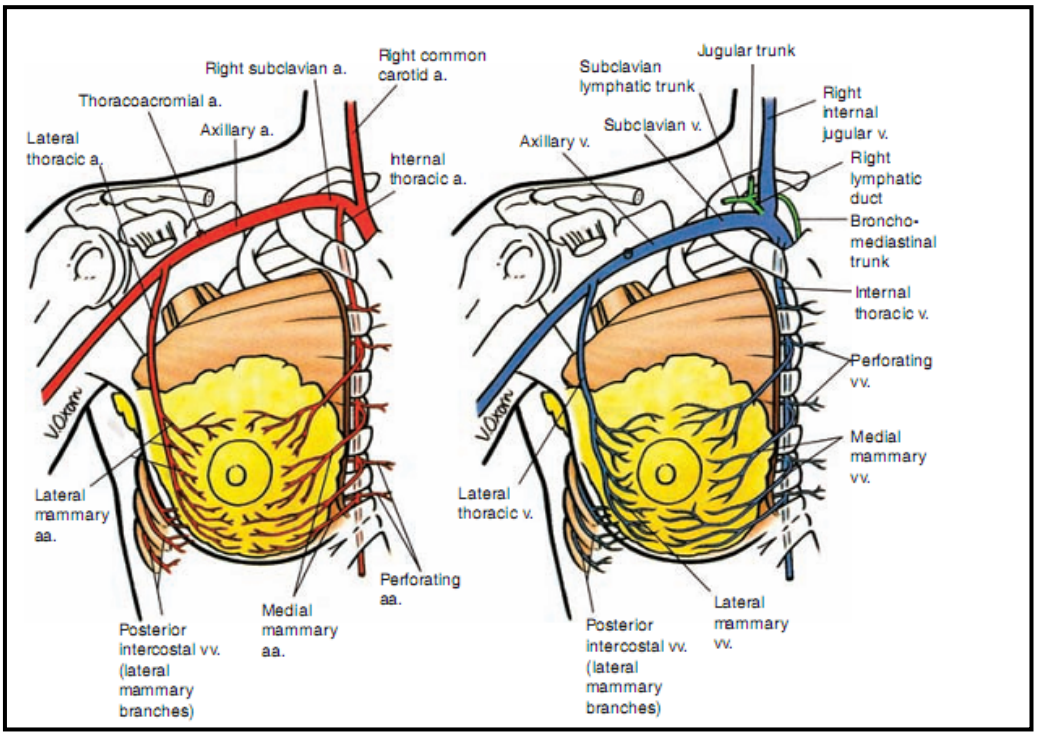

Fig (4): The blood supply and venous drainage of the breast. a, artery; aa, arteries; v, vein; vv, veins ***(Quoted from Moore and Agur, 2002*)**.

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).***

Histology:

The tissue of the breast is composed of about 10–20 lobes separated by connective and adipose tissue. Each lobe opens independently at the nipple. A lobe is made of several lobules. A lobule consists of clusters of milk secreting sacs, the alveoli. Myoepithelial cells lie around the alveoli. Their contraction helps the release of milk. When milk is produced it passes from the alveoli into a complex system of tubules and eventually reaches the intralobular duct. Outside the lobule the intralobular duct becomes the extralobular duct (Figs.5,6) ***(Sinnatamby, 2001)***.

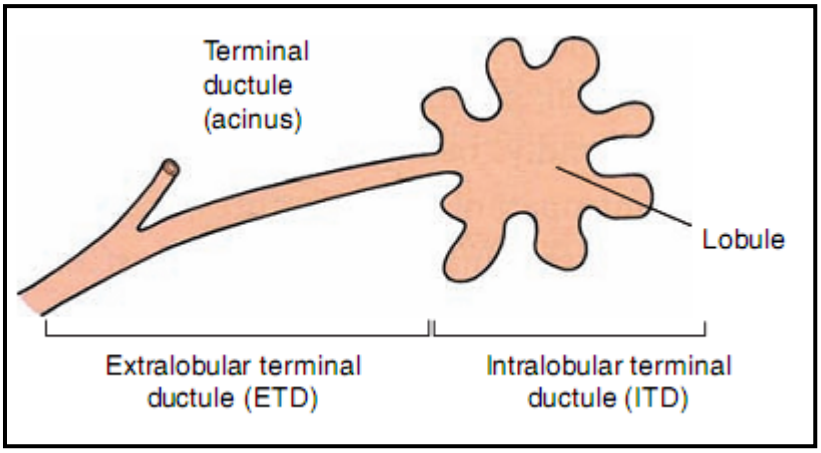

Fig. (5): The intra- and extralobular ducts
(Quoted from Morris and Wood, 2000).

The lactiferous (mammary) duct drains each lobe. Near the nipple it dilates to form the lactiferous sinus. The ducts drain at the nipple, near the tip. The nipple is a raised pigmented area. The areola surrounds the nipple (Fig.7). Near the surface, the lactiferous ducts are lined with squamous stratified epithelium ***(Morris and Wood, 2000).***

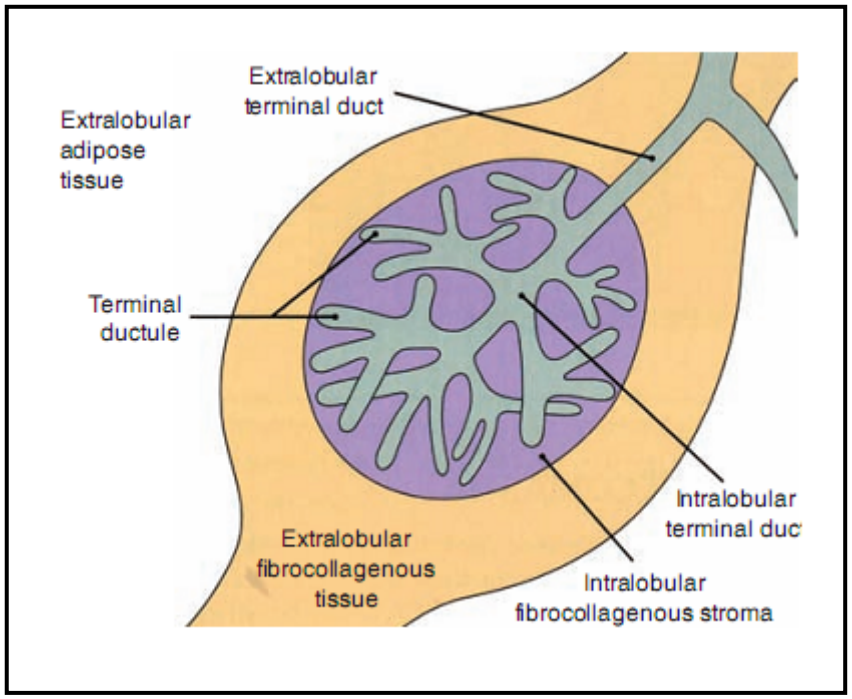

Fig. (6): Histology of a lobule ***(Quoted from Stevens and Lowe, 2005).***

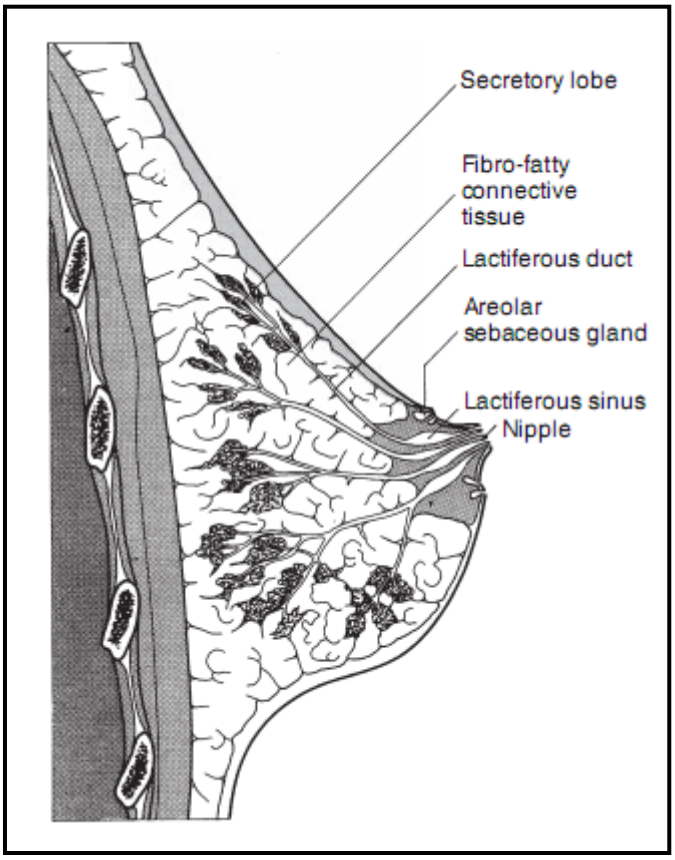

Fig. (7): The ductal system of the breast
(Quoted from Burkitt et al., 1993).

A gradual epithelial transition is seen, from stratified epithelium in the lactiferous ducts to a double layer of cuboidal cells in the lactiferous sinus to a single layer of columnar or cuboidal cells for the rest of the duct system. Changes in the epithelium of the duct system of the breast may give rise to breast cancer ***(Burkitt et al., 1993).***

The axilla:

The axilla is pyramidal in shape. It lies between the arm and the thorax, and communicates with the posterior triangle of the neck. It contains vessels, nerves and lymph nodes. It has an apex and a base (floor), and four walls, anterior, posterior, medial and lateral. The axillary fascia forms the floor. The anterior wall consists of three muscles, pectoralis major and minor, and subclavius. The fascia extends between the clavicle and pectoralis minor muscle. It is pierced by lymphatics, the cephalic vein, the lateral pectoral nerve and branches of the thoraco-acromial axis (a branch of the axillary artery). The posterior wall is formed by the subscapularis and teres major muscles, and the tendon of latissimus dorsi. The medial wall is the chest wall with the upper portion of serratus anterior. The lateral wall is the humerus. It contains the axillary artery and vein, the brachial plexus and lymph nodes ***(Lagopoulos, 2007).***

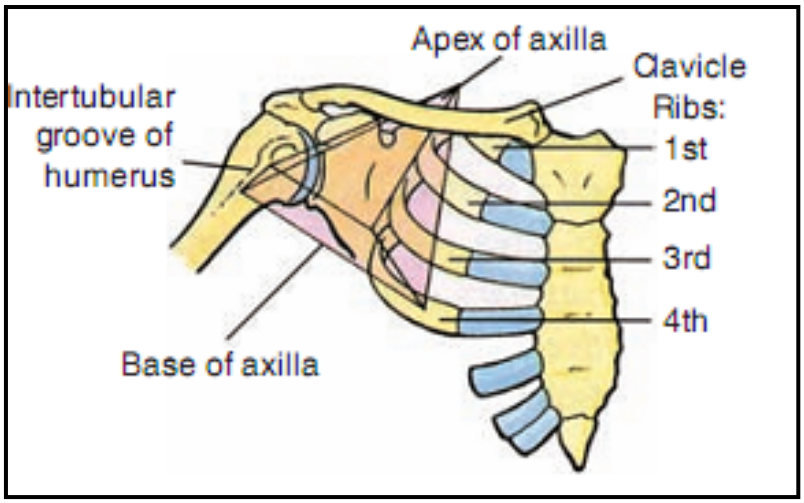

Fig. (8): The boundaries of the axilla
(Quoted from Moore and Agur, 2002).

Lymphatic drainage of the breast:

This is of considerable importance in the spread of breast tumours.The lymph drainage of the breast, as with any other organ, follows the pathway of its blood supply and therefore travels:

1. Along tributaries of the axillary vessels to axillary lymph nodes;

2. Along the tributaries of the internal thoracic vessels, piercing pectoralis major to traverse each intercostal space to lymph nodes along the internal mammary chain; these also receive lymphatics penetrating along the lateral perforating branches of the intercostal vessels ***(Ellis, 2006).***

Although the lymph vessels lying between the lobules of the breast freely communicate, there is a tendency for the lateral part of the breast to drain towards the axilla and the medial part to the internal mammary chain (Fig.9) ***(Ellis, 2006).***

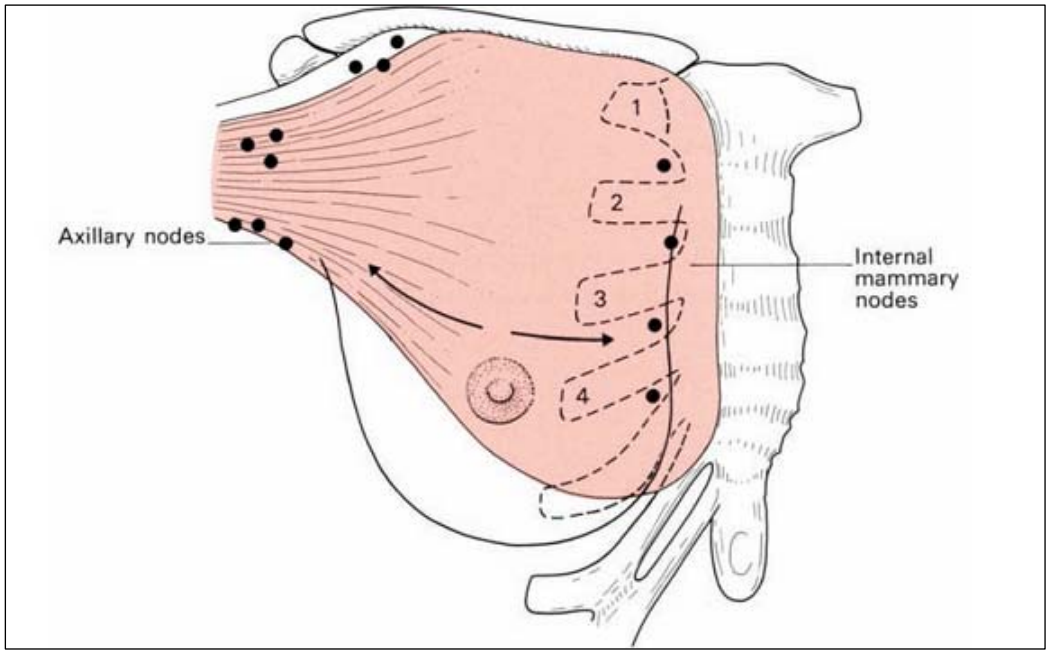

Fig. (9): Diagram of the principal pathways of lymphatic drainage of the breast. These follow the venous drainage of the breast—to the axilla and to the internal mammary chain ***(Quoted from Ellis, 2006).***

A subareolar plexus of lymphatics below the nipple (the plexus of Sappey) and another deep plexus on the pectoral fascia have, in the past, been considered to be the central points to which, respectively, the super-ficial and deep parts of the breast drain before communicating with main efferent lymphatics. These plexuses appear, however, to be relatively un-important, the vessels, in the main, passing directly to the regional lymph nodes ***(Ellis, 2006).***

The axillary lymph nodes (20–30 in number) drain not only the lymphatics of the breast, but also those of the pectoral