Anatomy and physiology of the breast

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Abstract
This article discusses the basic anatomy and physiology of the breast.

Keywords Areola; axillary artery; breast mound; breast physiology; intercostal artery; internal thoracic artery; lymphatics; mammary ridge; nipple; pectoralis major; supraclavicular nodes

Development
In the 5-week-old human fetus, an ectodermal ‘milk streak’—the mammary ridge—develops along the trunk on either side from the axilla to the groin. In many mammals, a series of paired mammary glands develop along this ridge, but in the human it regresses to the definitive site of the adult nipple. Here, this specialized epithelium buds into 15–20 branches. They first consist of solid epithelial columns, but then canalize before birth to form the lactiferous ducts.

Accessory nipples are not uncommon along the milk line; diagnosis is made readily if this condition is borne in mind, and is given away by the characteristic appearance of the lesion and by the fact that it is present from birth.

At the point of invagination of epithelium from the skin, there is initially a small mammary pit, but at about the time of birth it evaginates to form the definitive nipple. Failure to do so results in a congenitally inverted nipple, which may be unilateral or bilateral, and is not uncommon.

The epithelial system becomes surrounded by invading mesenchyme, which develops into the supporting connective tissue and fat of the breast.

Stages of development
From birth until puberty: the breast consists of lactiferous ducts, with no alveoli. At puberty, the ducts start to proliferate, and their terminations form solid masses of cells—the future breast lobules.

During pregnancy: secreting alveoli appear. During the early weeks, ductal sprouting and lobular proliferation occur, with increased nipple and areolar pigmentation. The alveoli now display a lumen surrounded by the secretory cells.

In the last days of pregnancy, the breasts secrete colostrum, a yellow, sticky, serous fluid, which is then replaced by true secretion of milk. When lactation ceases, the glandular tissue returns to its resting state.

After the menopause: the glandular tissue of the breast atrophies, the connective tissue becomes less cellular, and the amount of collagen decreases. In some women, marked fatty infiltration of the breast occurs at this stage; in others, the breasts shrink considerably.

Neonates
Occasionally, gynaecomastia may occur in the neonatal breast, with discharge of a colostrum-like material (‘witch’s milk’).

Topography
The breast mound
The mound of the adult female breast extends from the second rib above to the sixth rib below. Medially, it borders the lateral edge of the body of the sternum, and laterally it reaches the mid-axillary line.

At its superolateral extremity, the breast tissue projects as a tongue into the axilla along the lower border of the pectoralis major—the axillary tail of Spence.

The main bulk of the breast tissue is usually localized to its upper outer quadrant. This quadrant is more often implicated in breast cancer and in most benign lesions of breast tissue.

The nipple
The nipple is usually situated at the level of the fourth intercostal space in nulliparous women, but its position is inconstant in relation to the intercostal space when the breasts are pendulous. The 15–20 lactiferous ducts open on to the nipple. The nipple itself is surrounded by the areola, which contains large sebaceous glands that are often visible to the naked eye—the glands of Montgomery.

Beneath the breast
On its deep aspect, about two-thirds of the breast lies on the pectoralis major. Laterally, the breast overlaps on to the serratus anterior, and inferiorly it abuts on to the upper part of the rectus sheath (Figure 1).

The fascial relationships of the breast are of practical importance. As an ectodermal derivative, the gland lies in a pocket of superficial fascia. The superficial layer lies immediately beneath the dermis and enables superficial flaps to be dissected from the glandular mass of the breast quickly, neatly, and in a relatively avascular plane. Moreover, dissection in this layer also ensures that breast tissue is not left attached to the skin flaps.

Fibrous processes of this layer of fascia extend to the skin and to the nipple and are more developed over the upper part of the breast, where they form the suspensory ligament of Cooper. Contraction of this tissue by malignant infiltration results in the characteristic skin dimpling over a carcinoma of the breast.

The deep layer of the superficial fascia is thicker than the subcutaneous component and covers the deep aspect of the breastplate.

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Beneath this sheath is a layer of filmy areolar tissue that allows the breast to move freely on the underlying fascial covering of the pectoralis major and the serratus anterior. This areolar layer forms the retromammary space. Deep infiltration of a cancer through this space into the underlying pectoralis fascia produces the physical sign of deep tethering of a malignant breast mass. Precise establishment of the plane of the retromammary space enables rapid and relatively bloodless dissection of the deep aspect of the breast in simple mastectomy.

Blood supply

The blood supply of the breast is a rich anastomotic network derived from the axillary, internal thoracic (or internal mammary in the old nomenclature) and intercostal arteries (Figure 2).

The largest vessels arise from the internal thoracic artery, the perforating branches of which pierce the chest wall adjacent to the sternal edge in the first to fourth intercostal spaces. The vessel in the second space is usually the largest of these.

The four branches from the axillary artery are the:

- superior thoracic
- pectoral branch of the acromiothoracic
- lateral thoracic
- subscapular.

They are accompanied by the corresponding veins.

Lymphatic drainage

The importance of lymphatic drainage of the breast and of the anatomy of the axillary and internal thoracic lymph nodes is self-evident.

The axillary lymph nodes vary in number from 20 to 30 and are divided into five not wholly distinctive anatomical groups (Figure 3).

Efferents from the apical nodes unite into the subclavian trunk. On the left side, this trunk usually drains directly into the thoracic duct. On the right side, the subclavian trunk may empty directly into the jugulosubclavian junction or into a common right lymphatic duct. A few efferent channels usually reach the inferior deep cervical nodes directly.

Clinicians and pathologists often define metastatic axillary node spread simply into:

- level I: nodes inferior to pectoralis minor
- level II: nodes behind pectoralis minor
- level III: nodes above pectoralis minor.

The internal thoracic (internal mammary) lymph nodes are small, often only 2–3 mm in diameter, and lie along the internal thoracic vessels 2–3 cm from the sternal edge. Usually three to five of these nodes are found on either side. These nodes drain the anterior chest wall, anterior portion of the diaphragm, upper portion of the rectus sheath and muscle, and the superior portion of the liver, as well as the inner aspect of the mammary gland.

The intercostal nodes lie near the rib heads. They receive deep lymph vessels from the posteromedial aspect of the chest and some drainage from the lateral extremity of the mammary gland.

About 75% of all lymphatic drainage of the breast passes to the axillary nodes. The remainder principally drains to the internal thoracic nodes. Any part of the breast may drain to either group, though there is a greater tendency for tumours situated in the medial part of the breast to disseminate to the internal thoracic nodes than for tumours in the lateral part of the breast to do so.

Involvement of the supraclavicular nodes in breast cancer usually represents retrograde spread along blocked lymphatic channels when the apical axillary nodes are heavily involved. Efferent channels pass directly from these nodes to the inferior deep cervical chain so that involvement of cervical nodes may occur via this route.

Lymphatics do not normally drain to lymphatics across the opposite side of the body; early lymphatic spread of a tumour from one breast to another does not occur. Such bilateral cases represent synchronous or early metachronous double primary tumours. In very advanced cases, extensive blockage of lymphatic channels allows subcutaneous lymphatic permeation to occur to the opposite side.

Physiology of the breast

Prior to puberty there are no discernible differences, functional or structural, between the male and female breast. At the histological level, the prepubertal breast both in males and in females, consists of multiple rudimentary ducts arranged circumferentially, and converging towards the nipple. At the blind end of each rudimentary duct are poorly-developed but potentially secretory acini.

With the onset of puberty, a striking sexual dimorphism becomes manifest as dramatic changes ensue in the morphology and function of the female breast. These changes are the result of the unique response of the breast to various normal hormonal influences. The following account of breast physiology pertains exclusively to the female breast.
The prime function of the female breast is lactation: a term that encompasses synthesis, secretion and ejection of milk. Additionally the female breast is a prominent secondary sexual feature.

The initial growth of the female breast at puberty is affected primarily by oestrogen (oestradiol) which induces proliferation and branching of the duct system and also maturation and prominence of the nipples. However, the development and

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**Arrangement of the principal axillary lymph nodes**

**Lateral group**
- four to six nodes
- posterior and medial to the axillary vein

**Anterior (pectoral) group**
- usually four to five nodes
- along the inferior border of pectoralis minor adjacent to the lateral thoracic vessels

**Posterior (subscapular) group**
- six to seven nodes
- lie along the subscapular vessels

**Central group**
- three or four large nodes
- in the axillary fat pad
- receive efferent lymphatics from the first three groups of nodes
- drain into apical nodes

**Apical group**
- six to twelve nodes
- posterior to and above the pectoralis minor along the medial aspect of the axillary vein
- receive efferents from the other lymph node groups, lymphatics running along the cephalic vein, and some direct drainage from the upper periphery of the breast
proliferation of acini (alveoli) at the ab-areolar ends of the ducts is the result of the combined and synergistic actions of oestrogen and progesterone.

Within the breast tissue there are a number of paracrine factors, some stimulatory and some inhibitory, which influence cell division and differentiation. These paracrine regulators include insulin-like growth factors, epidermal growth factor and transforming growth factor β.

**Lactation**

The endocrine regulation of milk synthesis is complex. After initial conditioning of the mammary secretory tissue by oestrogen and progesterone, there is a specific need for lactogenic hormone alongside the permissive actions of glucocorticoids, insulin and thyroxine for successful milk production.

There are two lactogenic hormones: (i) prolactin which is secreted by the lactotrophs in the anterior pituitary and (ii) human placental lactogen (hPL) which is produced by the maternal placenta. The secretion of the latter reaches a peak during the final weeks of gestation and this prepares the breast for milk production. At this stage there is no significant secretion of milk because the high levels of oestrogen and progesterone in maternal blood have an inhibitory effect on milk production. Soon after childbirth, hPL disappears from the maternal circulation, the levels of oestrogen and progesterone in maternal blood plummet and prolactin functions as the sole lactogenic hormone. Another hormone which plays an important role in lactation is oxytocin, a polypeptide which is synthesized in the hypothalamus and stored in the posterior pituitary (neurohypophysis). The act of nursing (the sucking reflex) stimulates the release of oxytocin which in turn mediates the secretion of prolactin.

The normal, healthy, well-nourished lactating woman forms about 1 litre of milk a day. Lactation can be artificially suppressed by the administration of oestrogen or by administering dopaminergic agents such as bromocriptine which have an inhibitory effect on the synthesis and release of prolactin.

**Menopausal changes**

The onset of menopause is associated with a natural and steep decline in the body’s production of oestrogen and progesterone. This lack of hormonal stimulation results in a progressive decrease in the amount of glandular tissue in the breast, and a concomitant increase in fatty tissue. The consequent reduction in tissue density renders the breast tissue more amenable to mammographic examination. It is for this reason that detection of neoplasms by mammography is easier in a menopausal or perimenopausal woman than in a young, premenopausal woman.