Recent Studies & Advances in Breast Cancer

Chapter 6

Surgical Anatomy of Mammary Gland

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1. Introduction

1.1. Gross Anatomy

The mammary gland is an important accessory organ of the female reproductive system which lies in the superficial fascia of the pectoral region.

The mammary glands constitute secondary sexual features of the females and are a source of nourishment for the neonates.

Breasts (mammary glands) are modified sweat glands which lie in superficial fascia of pectoral region. The mammary gland is separated from underlying deep fascia by retromammary space which is occupied by loose areolar tissue.

1.2. Extent and Relations

VERTICAL-from second to the sixth ribs

HORIZONTAL- From the lateral sternal margin to the mid-axillary line

ANTERIORLY- skin over breast

POSTERIORLY - retromammary space, deep fascia covering mammary bed structures.

The retro mammary space with loose areolar tissue allows free movement. This mobil-

ity is restricted in case of advanced breast carcinoma.

The mammary bed structures include 3 muscles namely pectoralis major, serratus anterior & external oblique abdominis.

The axillary tail of spence is a prolongation from the superolateral quadrant of the gland extending to the level of the third rib in the axilla. It is in close contact with anterior group of axillary lymph nodes. The axillary tail pierces the deep fascia of axilla (axillary fascia) & lies deep to it. The opening in axillary fascia is referred as Foramen of Langer. It lies upon the deep pectoral fascia which in turn lies over the pectoralis major, serratus anterior and external oblique.

The clinical relevance of the axillary tail is that if enlarged it may be mis- diagnosed as a lipoma or axillary lymphadenopathy.

2. Internal Structure

The breast is a compound tubuloalveolar gland & is made up of glandular tissue & fibrofatty stroma. The glandular tissue consists of 15-20 lobes each drained by a separate lactiferous duct. The lobes are arranged in a radial manner like the spokes of the wheel. The lobes are further divided into lobules. The lobule is the basic structural unit of the breast. There are about 10-100 lobules which drain via ductules into a lactiferous duct. Each lactiferous duct is lined by a spiral arrangement of contractile myo-epithelial cells. The lactiferous duct has a dilated portion deep to the areola named as lactiferous sinus which acts as reservoir of milk . As the neonate sucks, compression of the areola and the lactiferous sinus below it expresses the droplets encouraging the neonate to continue sucking. This is referred to as the Milk Let Down reflex which is hormonally controlled.

Studies of myoepithelial cell lines reveal that these cells exhibit a natural tumor suppressor function. Breast cancer and pre cancer cells are influenced by important paracrine regulation from the breast micro environment, which might be a determinant of breast cancer behavior as the specific oncogenic or tumor suppressive alteration occurring within the malignant breast cells.

The knowledge of central and peripheral ductal anatomy is very important for developing the intraductal approach to the breast cancer.

The gland is firmly attached to the overlying skin & underlying pectoral fascia by fibrous bands named as Suspensory ligaments of Cooper. These ligaments are of paramount importance in supporting the lobes and lobules of the mammary gland.

In case of cancer breast, the malignant cells invade these ligaments and lead to contrac-

tion of the strands resulting in dimpling of the skin referred to as Peau de orange appearance.

Further if cancer cells grow along the ligaments of cooper, it attaches the breast to the pectoral fascia causing the breast fixity to the chest wall.

2.1. Nipple

The nipple is a conical projection below the centre of the breast at the level of fourth intercostal space in most young women. The nipples are devoid of fat, sweat glands and hair. The nipple is an erectile tissue containing concentrically and longitudinally arranged smooth muscles.

Its shape varies from conical to flattened depending on various factors such as nervous, hormonal and developmental. Occasionally the nipple may evert during pre natal development and remains permanently retracted thus causing difficulty in suckling.

2.2. Areola

Areola is a pigmented circular area of skin which encircles the nipple and varies in color according to the race ranging from pink to light brown. It contains involuntary muscles arranged in concentric rings as well as radially in the subcutaneous tissue. The areolar epithelium contains numerous sweat glands and sebaceous glands, the latter enlarge during pregnancy and serve to lubricate the nipple during lactation.

3. Blood Supply of the Mammary Gland

The Blood Vessels of the Mammary Gland have the following salient features:

1) Enter from superomedial &superolateral aspects
2) Penetrate deep surface of breast
3) Exhibit extensive branches & anastomosis

Arterial Supply of the Breast is received from the following sources:

- Lateral (mammary) thoracic artery
- Internal (mammary) thoracic artery
- Intercostal arteries (Posterior intercostal arteries-2^{nd}, 3^{rd}, 4^{th} spaces)
- Superior thoracic artery
- Thoracoacromial artery

Internal (Mammary) Thoracic Artery is the major source of arterial supply to the breast especially to the Nipple Areola Complex (NAC). The internal thoracic artery is a branch of subclavian artery. It descends vertically along the posterior aspect of anterior thoracic wall &

supplies anterior thorax & medial aspect of mammary gland, the latter through medial mammary branches. It runs along with internal thoracic vein which is a tributary of brachiocephalic vein.

The Thoracoacromial Artery is a minor source of blood supply to breast. However, the following points of importance for the breast surgeons are as follows:

- It is a branch of second part of axillary artery (under pectoralis minor)
- It gives off 4 branches namely pectoral, clavicular, acromial & deltoid branches supplying corresponding areas
- Its accompanying vein is a tributary of the axillary vein

The venous drainage of the mammary gland

The veins form circulus venosus- a plexus underneath areola, from which venous blood drains into axillary, internal thoracic & intercostal veins.

- All accompanying veins are tributaries of the axillary vein

The venous drainage of the mammary gland is supplemented by the Cephalic Vein.

- Tributary to axillary vein.
- Only major superficial vein in vicinity of breast
- Primarily drains Upper extremity into deltopectoral triangle
- provides superficial venous drainage to the breast partly

3.1. Innervation of the mammary gland

The nerves are derived from anterior & lateral cutaneous branches of 4^{th} to 6^{th} intercostal nerves which convey both somatic & sympathetic fibres. The sensory fibers supply the skin of the breast and sympathetic fibers are mostly vasomotor. The rich neurovascular supply to the nipple course along regularly located suspensory apparatus. The Surgeons should avoid damage to the anterior and lateral branches of the third, fourth and fifth intercostal nerves with a special attention to the fourth intercostal nerve as it is the consistent nerve to the NAC.

The nerves innervating the nipple and areola are best protected if the incisions are made at the base of the breast and at the lateral areolar border.

The Intercostobrachial Nerve deserves a special mention in this regard. It is the Lateral cutaneous branch of T2 spinal nerve.

- Emerges from 2nd intercostal space
- Supplies skin on medial aspect of the arm
- Associated with referred pain from angina or heart attacks
- Heart sympathetic nerves carry afferents back to upper thoracic cord
- Visceral heart pain referred to somatic thoracic nerve.

3.2. Lymphatics of the mammary gland

The lymphatics of the Breast assumes great relevance in the invasion and treatment of the carcinoma breast. The lymph from the nipple, areola and the lobules passes into the subareolar lymphatic plexus of Sappey. Sappey observed that from sub areolar plexus, lymph drains into the axillary lymph nodes.

The axillary lymph nodes receive 75% of the lymph of the breast. The anatomical classification of axillary nodes comprises of 5 groups :

1. Anterior- along the lateral thoracic vessels
2. Posterior- along subscapular vessels
3. Lateral- along axillary vein
4. Central- embedded in axillary fat
5. Apical- lying above the level of pectoralis minor tendon

The anterior group of axillary lymph nodes drain 75% of lymph from mammary gland. The anterior, posterior & lateral groups drain into central group which in turn drains into apical group. The apical group nodes lymph into the supraclavicular drains which in turn drain into the subclavian lymph nodes.

From the surgical point of view the classification of the axillary nodes is in accordance with their relation to the pectoralis minor muscle.

Level 1- lying below the pectoralis minor

Level 2- lying behind the pectoralis minor

Level 3- lying above the pectoralis minor i.e. between the upper border of pectoral minor and lower border of clavicle.

The staging of cancer breast uses the lymphatic mapping with sentinel lymph node biopsy as on of the vital techniques. Involvement of the sentinel node is regarded as a poor prognostic marker and indicates the need for axillary dissection and clearance.

The sentinel lymph node biopsy makes it possible to comprehend and estimate the metastatic risk in breast cancer.

3.3. Modes of spread of breast cancer

1. LOCAL spread- the tumor may involve the skin, pectoral muscles and even chest wall.

2. LYMPHATIC METASTASIS- it occurs primarily to the axillary lymph nodes and even to the internal mammary chain. The lymph node involvement is a marker for the metasatic potential of the tumor.

3. HEMATOGENOUS route- may lead to skeletal involvement and organs such as liver and lungs.

4. Clinical Aspects

4.1. Nipple discharge

The incidence of nipple discharge is only 3-5 %. Additionally all nipple discharges may not have a pathological etiology and galactorrhea needs to be differentiated from physiological and pathological causative factors. Galactorrhea is not a symptom of breast cancer or primary breast pathology. It is usually bilateral, milky and from multiple ducts. Lesions of the hypothalamus, chest, kidney or non pituitary prolactin producing tumor may be the usual causes of galactorrhea.

A pathological discharge may be the warning sign of an underlying intraductal papilloma or duct ectasia or even cancer.

Non lactational, unilateral, spontaneous and bloody discharge is more likely to be of pathological etiology and therefore histopathological diagnosis becomes mandatory.

Usually 5-10% patients with malignancy present with nipple discharge and this fact increases with age.

4.2. Breast Pain

4.2.1. Skin changes

Lesions of the breast include benign conditions like herpes, psoriasis and malignant lesions like Paget's disease, basal and squamous cell carcinoma.

Paget's disease may present with symptoms of nipple itching or discomfort and may be a sign of underlying in situ ductal carcinoma. Diagnosis may be made on the basis of biopsy which shows large cells with clear cytoplasm.

4.2.2. Mastitis

It is cellulitis of the breast and may be puerperal or nonpuerperal in etiology. Puerperal mastitis may be endemic or epidemic. The usual organism responsible for epidemic mastitis is staphylococcal aureus which may involve the lactiferous ducts and glands.

The endemic type of puerperal mastitis is often polymicrobial and periductal in origin. The major difference between the epidemic and endemic is that the latter occurs immediately after delivery.

4.3. Cancer breast

Adenocarcinomas arising from the epithelial cells of the lactiferous ducts are the commonest form of Ca Breast. Metastatic cancer cells usually traverse lymphatic vessel that enters into 2-3 groups of lymph nodes before spreading onto the venous system.

SIGNS

1. Lymphedema- due to interference of the lymphatic supply by cancer cells leading to excessive fluid accumulation in the subcutaneous tissue.

2. Peau ‘d’ orange- Dimpling of the skin along with puffy skin- due to glandular invasion and ensuing fibrosis caused by shortening of the suspensory ligaments.

3. Retraction of the nipple- due to cancer cells infiltrating the lactiferous ducts

4.4. Lymphatic spread

Typically, cancer cells spread via the lymph nodes, primarily the axillary lymph nodes. Communications between the axillary, cervical and para-sternal nodes may result in spread into suparclavicular nodes, contralateral nodes and the abdomen. Early detection of the axillary lymphadenopathy may alter the disease progression of the cancer. Although lack of enlarged axillary lymph nodes may not necessarily mean absence of the cancer as it may have metastasized into other nodes.

4.5. Venous spread

The posterior intercostal veins drain into the Azygous/hemiazygous veins adjacent to the vertebral bodies, communicating with the internal vertebral venous plexus surrounding the spinal cord. Cancer cells metastasize into cranium and brain by these venous routes.

4.6. Invasion into Retro-mammary gland

This invasion causes attachment to the pectoral fascia overlying pectoralis major mus-

cle. Hence elevation of the breast is caused whenever the muscle contracts. This is a clinical sign of advanced cancer.

5. Four Boundaries for Mastectomy

- Clavicle – superior boundary
- Inframammary fold (above rectus sheath) – inferior boundary
- Sternum (midline) – medial boundary
- Latissimus dorsi (ant. border) – lateral boundary

5.1. Simple mastectomy

Breast is removed down to the retro-mammary space.

5.2. Radical mastectomy

Extensive removal of the breast including the pectoral muscles, fat, fascia and axillary lymph nodes. The lymph nodes of the pectoral region are also removed.

Alternatively, a breast conserving approach followed by radiotherapy may be employed by the operating breast surgeon, depending on the stage and grade of the cancer.

6. Investigations

1. Mammography

2. Ultrasound

3. Fine Needle Aspiration Cytology

4. MRI Scan

5. Positron Emission Tomography (PET) - radionuclide imaging method where a tracer labelled with a positron emitter is detected. 18F Fluorodeoxyglucose accumulates in the tumor cells as they have increased glycolytic activity. This method is a very useful tool for detection and staging if the cancer.

7. References

1. Moore Kl & Dalley AF. Clinically oriented Anatomy. 4 th ed, Maryland, Lippincott Williams & Wilkins 1999; pp72-79.

2. Standring Susan. Gray's Anatomy. The anatomical basis of clinical practice. 39 th ed, New York, Elsevier Churchill Livingstone. 2005; pp969-975.

3. Decker CAG, Plessis DJ du. Lee Mcgregor's Synopsis of surgical anatomy, Bristaol, John Wright &b sons. 1999; pp161-171.

4. Russel RCG, Williams NS & Bulstrode JKC. Bailey& love's Short practice of surgery, 24 th ed, London, Arnold publications. 2004; pp824-846

5. Barsky SH, Karlin NJ. Mechanisms of disease: breast tumor pathogenesis and role of myoepithelial cell. Nat Clin Pract Oncol. 2006; 3(3): 138-151.

6. Going JJ, Mohun TJ.Human breast duct anatomy, the sick lobe hypothesis and intra ductal approaches to breast cancer. Breast cancer. 2006; 97(3): 285-291.

7. Van Deventer PV. The blood supply to the nipple-areola complex of the human mammary gland. Aesth Plast Surg. 2004; 28(6): 393.

8. Wuringer E, Mader N, Posch E, Holle J. Nerve and vessel supplying ligamentous suspension of the mammary gland. Plast Reconstr Surg. 1998; 101(6): 1486-1493.

9. Wueringer E, Tschabitscher M. New aspects of the topographical anatomy of mammary gland regarding its neurovascular supply along a regular ligamentous suspension. Eur J Morphol 2002; 40(30: 181-189.

10. Jaspars JJ, Posma AN, Van Immerseel AA, Gittenberger-de Groot AC. The cutenaeous innervation of the female breast and nipple areola complex: implications for surgery. Br J Plast Surg. 1997; 50(4): 249-59.

11. Schlenz I, Kuzbari R, Gruber H, Holle J. The sensitivity of the nipple areola complex: an anatomic study.Plast Reconstr Surg. 2000; 105(3): 905-909.

12. Uren RF. Lymphatic mapping of the breast. In : Uren F, Thompson JF, Howman-Giles RB, eds. Lymphatic drainage of the skin and breast. Amsterdam: Harwood Academic Publishers, 1999;pp 125-37.

13. Turner Warwick RT. The lymphatics of the breast. Br J Surg. 1959; 46: 574-582.

14. Tanis PJ, Nieweg OE, Valdes Olmos RA, Kroon BB.Anatomy aned physiology of the lymphatic drainage of the breast from the perspective of sentinel node biopsy. J Am Coll Surg. 2001; 192(30): 399-400.

15. Olivier JB, Verhaeghe JL, Butarelli M, Marchal F, Houvenaeghel G. Functional anatomy of the lympahitc drainage of the berast: contribution of sentinel lymph node biopsy. Ann Chir 2006; 5

16. Rouesse J, Alberini JL, Wartski M, Gutman F, Collignon MA, Corone C, Pichon MF, Pecking AP.FDG(18 fluorodeoxyglucose) positrion emission tomography and breast cancer. Bull Acad Natl Med. 2005; 189 (50): 963-75.