Anatomy and Physiology of Breastfeeding

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Background

- BSN Medical College Of VA 1978
- MS in Family Health Nursing, Mercy College 1996
- IBCLC 1997 & 2007
- Married with 3 sons and one granddaughter
Learning objectives

- By the end of this presentation the learner will be able to:
  - List three characteristics of normal breast anatomy clinically significant to breastfeeding
  - Describe the development of the breast from embryogenesis through lactation
  - Outline the physiologic functioning of the breast during lactogenesis as it pertains to the principle of supply and demand

Outline: Anatomy

- Gross anatomy of the breast
  - Development
  - Breast
  - Nipple and areola
  - Glandular structures
  - Blood Supply, lymphatics, and innervation
- Histology
- Abnormalities
- Related anatomy
Historical Perspective

Sir Astley Paston Cooper
Current anatomical descriptions of the breast are, to a large degree, based on the meticulous studies and dissections performed by Sir Astley Paston Cooper, during the early 1800’s.

Cooper was a renowned British surgeon of his time and his work was extensively published.

In 1840 he published his study “On the anatomy of the breast” and it is from this study that the basis of our understanding of breast anatomy has been developed.

Historical Perspective

Cooper's Wax Casting
In an example of Cooper's work, he was able to inject hot wax of different colours through the duct openings at the nipple of a lactating breast that had been removed from a cadaver.

Cooper used this technique to observe the ductal architecture of the breast and determined that the breast tissue was separated into lobes and that each lobe exited the breast through one duct.

He determined that there are large reservoirs (sinuses) at the base of the nipple and that there were 15 - 20 ductal openings at the nipple.


Cast of the ductal architecture of the lactating breast made by Sir Astley Cooper more than 150 years ago.
Breast Ultrasound

- Recent ultrasonography of the breast has challenged our beliefs about breast anatomy

Developmental Anatomy

- Development
  - Fetal
  - Pubertal
  - Adult
- Related histology
- Why some abnormalities occur
- Related anatomy
5 Stages of Mammary Development

1. Embryogenesis (fetal)
2. Puberty
3. Pregnancy
4. Lactation
5. Involution

Fetal Breast Development

- 5 weeks gestation: milk streak, or galactic band appears from axilla to groin
- 16 weeks: a shallow epithelial mammary pit forms with the beginning of inversion of 8-15 strips that will be ducts at birth
- 24-32 weeks gestation: maternal hormones can cause colonization of milk-like substances
- Just before birth: the mammary pit elevates
- “Witches milk” in newborns up to 2-3 weeks of age
- Male and female identical
The “milk line”

- Breast tissue or nipples may occur anywhere on the “milk line”

Supernumerary Breasts

*Courtesy Mike Hughey, MD, Brookside Associates, Ltd., [http://obgyn101.org](http://obgyn101.org), c.2000, all rights reserved*
Tanner’s 5 Phases of Breast Development During Puberty

I. Puberty: elevation of the nipple
II. 11 yrs (+ or − 1 yr): subareolar glandular tissue growth
III. 12.2 yrs: increased glandular tissue
IV. 13 yrs: increased separation, size & color of the areola
V. 15 yrs: final adolescent development

Stages of Breast Development From Puberty Through Lactation
Breast Placement

- **Vertical axis**
  - Typical breast covers 2-6 rib
  - Hypoplastic breast covers 3-5 rib
- **Horizontal axis**
  - Typical breast covers from sternum to axilla
  - Hypoplastic breast is widely spaced

The Body of the Breast

- **Corpus mammae**
  - Extends into axilla
  - Partially extends into the epigastric area
- **Parenchyma**
  - Glandular tissue
- **Stroma**
  - Adipose and connective tissue
  - Blood vessels
  - Nerves
  - Lymphatics
External Structure

- Skin
- Areola
  - Montgomery glands
- Nipple
  - Papilla mammae
  - 4-18 milk pores
  - Smooth muscle

Areola

- No fat in areolar area
- Areola consists of smooth muscle
- Tubercles of Montgomery (or Montgomery glands)
  - lubrication
  - bacteriostatic
Montgomery Glands

Internal Structure

Cooper's Ligaments
- Provide a support framework for the breast

Glandular Tissue
- Lobules consist of clusters of alveoli, which are lined with milk-secreting epithelial cells (lactocytes)

Main Milk Ducts
- Branch close to the base of the nipple with no lactiferous sinuses

Subcutaneous Fat
- Thin near the nipple, becoming more substantial further from the nipple

Intraglandular Fat
- Intermingles with the glandular tissue
Subcutaneous (fatty) Tissue

Cooper’s Ligaments
Lobes and Lobules

Duct System
New Developments in Breast Anatomy

OLD
No branching of ducts until deep in the breast

NEW
Branching of ducts close to the nipple

Lactiferous Sinuses

OLD
No Lactiferous Sinuses

NEW
Lactiferous Sinuses

New Developments in Breast Anatomy (cont)
Old/New Comparison

Summary
- Ducts branch closer to the nipple
- No lactiferous sinuses
- Glandular tissue starts closer to the nipple
- Differentiation of fat types
- 2:1 ratio of glandular to fatty tissue
- 65% of glandular tissue within 30 mm of the nipple
- Ductal network, not radial or symmetrical
- 4 to 18 ducts exit the nipple

Recent Anatomical Research Summary

Summary
This image has been developed based on the latest research findings from The University of Western Australia.

Points to note:
1. Complex ductal network, not always in a symmetrical or radial pattern.
2. From 4 to 18 ducts exiting the nipple (average 9).
3. Branching of ducts close to the nipple.
4. Glandular tissue closer to the nipple than previously described.
5. The conventionally described lactiferous sinuses do not exist.
6. 65% of the glandular tissue is within 30 mm of the base of the nipple.
7. The ratio of glandular to fatty tissue is 2:1.
8. Subcutaneous, interstitial, and retroareolar fat are all depicted.
The Alveolus

Individual Alveolus

- Epithelial cells contract to squeeze milk into the duct
Microscopic Alveolus

- Secretory cell
- Myoepithelial cell
- Alveolus
- Lobule
- Lobe
- Duct
Chardonnay Anyone?

- Corpus Mammae
- Stroma
- Parenchyma
- Ducts
- Lobes
- Lobules
- Alveoli

- Vineyard
- Trellis
- Grape plant
- Vines
- Grape clusters
- Grapes
- Grape seeds

Blood Supply to Breast

- Internal mammary artery
  - Also known as the internal thoracic artery
- Lateral Thoracic artery
- Circulus venosus at base of nipple

http://breastinsmuse.org/breast_development.html
Lymph Supply to Breast

- **Lymph**
  - Bearers of immunity
  - Knowledge

- **Lymphatics**
  - Primarily axillary
  - Some transmammary

Nerve Supply to Breast

- **Supply**
  - From the 4th, 5th, and 6th intercostal nerves (4th most critical)

- **Nerve divides into 5 branches**
Abnormalities

- Supernumerary nipples-polythelia
- Hypermastia (2-6%)
- Symmastia - webbing
- Amastia/Amazia
- Hypoplasia/Hyperadenia (no nipple)
- Poland Syndrome

Marked Asymmetry

www.nipplerepair.com
Conical Breasts

- Warning sign for poor milk supply
- Widely spaced breasts

Classification

- Type 1 – Round breasts, normal in physical characteristics
- Type 2 – Hypoplasia of lower medial quadrant
- Type 3 – Hypoplasia of the lower medial and lateral quadrants
- Type 4 – Severe constrictions, minimal breast base

Heimburg DV 1996
Hypoplasia

Type 1  Type 2  Type 3  Type 4

Hypoplastic / Tubular Breasts

Used with permission by the co-author E. Patosk.
Breast Quadrants

- Observe and palpate for breast tissue in each quadrant

Typical Characteristics of Hypoplasia

- High mammary fold
- Narrow (flat) breast base
- Breast tissue cascades over mammary fold producing ptosis even in small breasts
- Central herniation of breast tissue into the areola
- Patchy areas of milk producing tissue
- Little or no prominent veining
Typical Characteristics of Hypolasia

- Large areolas
- Darkly pigmented areolas
- Plump nipples
- Widely spaced breasts
- Marked asymmetry
- Stretch marks
- Little or no growth during pregnancy
- Little or no engorgement
- Normal prolactin levels

Inspect for the Five S’s

1. Symmetry
2. Size
3. Shape
4. Surgery
5. Scars
Notice anything?

Pre-breast Reconstruction

- Tubular appearance of left breast
- Marked asymmetry with smaller right breast
- Wide intramammary space
Nipple Assessment

- Erect nipple
- Small areola
- Montgomery glands
Everted Nipple

Nipple Assessment

- Flat/inverted nipple
  - Difficult latch-on?
  - Special attention to assure adequate intake for baby
Inverted Nipples

- **Grade 1.** Nipples are inverted but evert manually (through touch) or in response to cold
  - They can remain everted for some time
- **Grade 2.** Nipples are inverted and are more difficult to evert
  - The eversion almost never lasts — the nipple returns to the inverted state immediately
- **Grade 3.** Nipples are severely inverted and never evert

Unilateral Inverted Nipple
Bilateral Inverted Nipples

Pinch Test
Flat Nipple

Dimpled Nipple

- Sore from staying moist in fold after feedings
“Accessorizing?”

Doing a Breast Assessment

- Size, shape, symmetry of breasts
- Size, shape of nipple, pinch test
- Previous surgery
- Growth during pregnancy
- Stage of lactation
Outline: Physiology of Lactation

- Lactation
  - Developmental Physiology
  - Lactogenesis
  - Neuroendocrinology
  - Milk synthesis
  - Involution/weaning

Mammogenesis

- Mammary gland undergoes three phases of growth and development *before* pregnancy
  - In utero
  - First 2 years
  - Puberty
    - Estrogen stimulates ductile growth
    - Progesterone stimulates growth of alveoli
Stages of Lactation

- Lactogenesis I
  - Starts about mid-pregnancy (16-20 weeks)
- Lactogenesis II
  - Process begins at birth with delivery of the placenta, defined as “the onset of copious milk production” (day 3-5 postpartum)
- Lactogenesis III
  - Establishment of mature milk
- Involution

Breast Development During Pregnancy

- First trimester
  - ↑ estrogen & progesterone causes lobular proliferation
- Second Trimester
  - Alveoli multiply & nipple/areolar changes due to human placental lactogen (HPL) and prolactin
- Third trimester
  - Final stages of mammary growth & development due to ↑ progesterone
Keeping the Secretory Process in Check

- High circulating plasma levels of progesterone
  - Maintains the pregnancy
  - Interferes with prolactin action at the alveolar cell receptor level

Prolactin Inhibiting Factor (PIF)

- While prolactin is rising during pregnancy, a PIF-Prolactin inhibiting factor, dopamine inhibits the secretion of prolactin from the anterior pituitary gland
Mammary Stimulating Hormones of Pregnancy

- Pituitary
  - Prolactin
  - Growth hormone
  - Thyroid stimulating hormone
- Ovary
  - Estrogen
  - Progesterone
- Placenta
  - Progesterone
  - Estrogen
  - Human Placental Lactogen

Lactogenesis I

- Hormonal influences during pregnancy
  - Prolactin
  - Human Placental Lactogen (HPL)
  - Estrogen
  - Progesterone
  - Growth hormone
Hormonal Influences During Pregnancy, cont.

- Insulin – stimulates stem cells
- Cortisol – assists further formation of alveoli
- Thyroxine stimulates pituitary which affects proper production of prolactin and growth hormone
- Paracrine activity
  - Prolactin
  - Relaxin
  - Epidermal GF

Major Hormones of Pregnancy & Lactogenesis I

- Prolactin: nipple growth
- Human placental lactogen: areolar growth
- Estrogen: ductal system differentiation
- Progesterone: lobes, lobules & alveolar growth
Physiology of Lactation

Metabolic Activity During Lactation

- Huge increase in the metabolic rate of the mammary gland
  - Mammary gland utilizes 30% of the total energy the mother uses
  - Perspective: the brain utilizes 25%
Hormones Necessary for Lactogenesis II

- **Prolactin**
  - Lactose synthesis
- **Oxytocin**
  - Milk ejection reflex
- **Insulin**
  - Lactose synthesis, maintenance/survival of lactocytes
- **Cortisol**
  - Low levels cause more alpha-lactalbumin to be made for lactose synthesis
  - High levels are inhibitory

Neuroendocrine System
Prolactin

- Produced in the anterior pituitary
- 200-400ng/ml at term
- Major role: milk synthesis
- Prolactin Inhibiting Factor (PIF)
  - Dopamine released by the hypothalmus in response to fatigue, depression or stress
  - Blocks the secretion of prolactin
  - Infant suckling can override the inhibing factor & release prolactin

Oxytocin

- Produced in the posterior pituitary
- 50-100mU needed to elicit a milk ejection reflex (MER)
- Major role: milk ejection/release
- Oxytocin release
  - Stimulated by: visual, olfactory or auditory stimuli
  - Inhibited by: fear, fatigue, anxiety
Lactogenesis III

- Shift from endocrine to autocrine control
- Development of prolactin receptors requires frequent stimulation in early post-partum period
- Long term production is controlled in the breast

Milk Synthesis

- Two interacting mechanisms regulate the rate of milk synthesis
  1. Feedback Inhibitor of Lactation (FIL)
  2. Prolactin Receptor theory
Feedback Inhibitor of Lactation (FIL)

- Breastmilk contains a small, active whey protein (FIL)
- Inhibits milk synthesis through negative feedback
  - Alveoli become distended as milk is not removed
  - FIL concentration ↑

Prolactin Receptor Theory

- Lactocyte walls have PRL receptor sites that allow PRL in the blood stream to move in & stimulate milk synthesis
- But when the alveoli are full of milk, the walls expand & alter the shape of the lactocyte receptors so PRL can’t enter & milk synthesis ↓
- As milk empties, PRL receptors return to their normal shape & allow PRL to enter
Involution/Weaning

- **Weaning**
  - volume less than 400ml/day
  - defined as 40 days after the last breastfeed

- **Involution**
  - apoptosis of secretory cells
  - basement membrane degrades

Menopause

- Decreased proliferation of alveoli after age 35
- Decrease in tissue
- Easier self breast exam
Breast Conditions and Abnormalities

Engorgement of Accessory Breast Tissue

*Courtesy Mike Hughey, MD, Brookside Associates, Ltd., [http://obgyn101.org](http://obgyn101.org), c.2000, all rights reserved*
Treatment for Accessory Mammary Tissue

- **Postpartum**
  - Axillary masses can be painful and if associated with a nipple can leak milk
  - Treat with cold/ice compresses and should involute in a few days without affecting milk supply on that side

- **Long term**
  - Surgical excision for persistent pain or swelling (or cosmetic reasons)
  - Same occurrence of cancerous changes as normal breast tissue, so should be managed as such!

Nipple ‘Bleb’

http://www.mother-2-mother.com/nipplepain.htm#MilkBlister
Breast Abnormalities

Breast Lumps

<table>
<thead>
<tr>
<th>Benign</th>
<th>Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth edges</td>
<td>Rough, oddly shaped</td>
</tr>
<tr>
<td>Moveable</td>
<td>Fixed</td>
</tr>
<tr>
<td>Painful</td>
<td>Painless, heaviness</td>
</tr>
<tr>
<td></td>
<td>Distortion of breast or nipple, puckering, ridging, pitting</td>
</tr>
<tr>
<td></td>
<td>Redness, swelling, warmth</td>
</tr>
<tr>
<td></td>
<td>Pink, purplish or bruised skin</td>
</tr>
<tr>
<td>Discharge</td>
<td>Discharge</td>
</tr>
</tbody>
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Always refer to a primary care provider for any suspicious lump
Galactocele

- Similar to a cyst
- Filled with milk
- Round and freely mobile
- Usually occurs after weaning
- Diagnosis and treatment: needle aspiration

Peau d’orange

- French for “orange skin”
- Usually means advanced cancer
- Mastitis does not cause cancer
- Cancer can cause mastitis
Eczema of Breast

- Often bilateral
- Red, scaly
- Blistering
- Itchy
- Commonly, a history of eczema elsewhere on the body
- Responds to topical steroids

Always refer to a primary care provider for any suspicious rash

Paget’s Disease

- Unilateral
- Red, scaly
- Itchy
- Affects nipple first
- Most common at menopause
- Does not respond to topical steroids

Always refer to a primary care provider for any suspicious rash
Anatomy and Physiology of Lactation

Bibliography


Bibliography

Bibliography

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