DIAGNOSIS OF PREGNANCY

PHYSIOLOGICAL CHANGES IN PREGNANCY

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PHYSIOLOGICAL CHANGES IN PREGNANCY
There are profound anatomical, physiological, biochemical and endocrinological changes during pregnancy in almost all body parts. This is to support hormones & genetic factors for below use:

1. Fulfil need of fetus
2. Create favorable condition for fetus development
3. Prepare body for labor & lactation
Changes in – Genital Organs

**VULVA**

- Vascularity ↑, hyperemia ↑, edema on Vulva & Perineum, Varicosities may develop especially in multiparous women, Labia minora become pigmented and hypertrophied

**VAGINA**

- Walls become more hyperemic, swollen & hypertrophied with bluish or violet discoloration (Jacquemier’s or Chadwick’s sign). || Hobnailed appearance
- Vaginal Secretion: Thick white || pH is acidic (helps in yeasts growth & reduces pathological bacteria)
- Vaginal Cytology: Excess navicular cells which are ovoid cells with elongated nuclei due to ↑progesterone

**UTERUS**

- Size ↑, shape , Weight ↑*20 times, Position, Consistency, structure, capacity ↑*500-1k time
- Position (More axial & vertical), Lateral obliquity (dextrorotation), Uterine peritoneum (deepening of pouch of Douglas), Uterine contractility, Nerve Supply, Isthmus, Cervix (stroma, Epithelium, Secretion)

**FALLOPIAN TUBES**

- Disproportionate growth of fundus (fallopian tube is seen halfway up the uterus)
- They become inactive, elongated and more congested due to ↑vascularity
- Slight hypertrophy of musculature but endosalpinx is somewhat flattened

**OVARIRES**

- Both ovaries are enlarged due to ↑vascularity & edema (especially for corpus luteum)
- Corpus luteum (2.5 cm) reaches its maximum at 8 weeks of gestation. After 8 weeks placenta takes over.
- After 12 weeks corpus luteum starts degeneration, become yellow and then white & atretic due to ↓secretion of hCG from the placenta
Breast, Skin, Weight gain & Water metabolism

**Breast**
- **Early Pregnancy** – Breast tenderness & tingling sensation
- **After 2nd Month** – ↑size (due to glands proliferation & fat deposition), delicate veins become visible beneath skin, ↑estrogen causes profound hypertrophy & proliferation, connective tissue stroma is hypertrophied, myoepithelial cells become more prominent,
- **Changes in nipples & areola**: Enlarge nipples, areolae become big & deep (called “Montgomery’s tubercles which are hypertrophic sebaceous glands
- **Breast secretion**: Colostrum (thick, yellowish fluid) after few months

**Skin**
- Pigmentary change in following parts:
  1. Face (Chloasma gravidarum or melisma gravidarum or pregnancy mask: irregular brownish on gace, checks, forehead, eye & neck
  2. Breast: tenderness & tingling sensation
  3. Abdomen: Linea nigra & Strech marks
  4. Other Cutaneous changes: vascular spiders (red elevation on the skin with radial branching) and palmar erythema (redness of palms)

**Weight Gain**

<table>
<thead>
<tr>
<th>BMI</th>
<th>Weight gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (20-25)</td>
<td>11-12 Kg</td>
</tr>
<tr>
<td>Obese (&gt;29)</td>
<td>&lt;7 Kg</td>
</tr>
<tr>
<td>Underweight (&lt;20)</td>
<td>Up to 18 Kg</td>
</tr>
</tbody>
</table>

Weight gain depends on pre-pregnancy BMI

**Note**: Rapid weight gain (>0.5 kg/week or 2 kg/month during trimester) may herald onset of pre-eclampsia. Static or falling weight means growth restriction or intrauterine fetal death

**Water Metabolism**
- ~6.5L extra water retained
  - Fetus + placenta + amniotic fluid – 3.5 L
  - Maternal blood + uterus + breast – 3.0 L
- Main cause for Sodium & fluid ↑:
  - Plasma osmolality ↓ ~10 mOsm/kg
  - Estrogen & progesterone ↑
  - Aldosterone & deoxycorticosterone ↑
  - Enhanced renin angiotensin activity
  - Artrial natriuretic peptide
  - Ressetting osmotic threshold for vasopressin secretion
  - ↓ osmotic threshold for thirst

**Term fetus**
- Blood volume
- Extracellular fluid
- Fat reserves & protein

**Placenta**
- Amniotic fluid
- Uterus
- Breasts

**Amniotic fluid**
- 5.5 kg

**Uterus**
- 5.5 kg

**Breasts**
- 5.5 kg

**Blood volume**
- 11-12 kg

**Extracellular fluid**
- 5.5 kg

**Fat reserves & protein**
- Up to 18 Kg

**Normal (20-25)**
- 11-12 Kg

**Obese (>29)**
- <7 Kg

**Underweight (<20)**
- Up to 18 Kg
Hematological changes

Blood volume
- 40-45% ↑, reaches max in 32-34 weeks
- Hypervolemia helps in
  ✓ Meeting demands of enlarged uterus & its hypertrophied vascular system
  ✓ Provide nutrients to fetus & placenta
  ✓ Protect mother & fetus from hypotension
  ✓ Protect mother on blood loss during delivery

Erythropoietin ↑
- Erythroid hyperplasia in bone marrow results in 2%↑ in reticulocyte count

Hemodilution of pregnancy
- Hemoglobin is down by ~2 g/dl (Because plasma increase by 40% but red cell increase by only 20%).
- This increase iron demand lead to physiological anemia of pregnancy
  ✓ Advantages:
    ✓ decrease blood viscosity helps in optimum gaseous exchange between maternal & fetal circulation
    ✓ protect mother of blood loss during parturition

Leucocytes & immunological function
- Leucocytosis (especially neutrophilic) ↑
- During 3rd trimester –
  ✓ granulocyte & CD3 T lymphocytes ↑
  ✓ CD4 T lymphocytes and monocytes ↓
- Leucocyte alkaline phosphatase, C-reactive protein and complements factors C3 & C4 ↑

Blood coagulation factors
- Pregnancy is a hypercoagulable state with:
  ✓ most clotting factor ↑
  ✓ Anticoagulants & fibrinolytic activity ↓
- Due to significant raise in fibrinogen & globulin & reduction in blood viscosity ESR increase by 3-4 times
- All these changes return to normal withing 2 weeks of delivery
  ✓ Advantages:
    ✓ Useful for placental separation during delivery
    ✓ If coagulation does not occur, owmen can dies of hemorrhage because 500 blood flows throw placental bed / min
  ✓ Disadvantages:
    ✓ 5-6 times risk of thromboembolic accidents like deep vein thrombosis, pulmonary embolism and puerperium

Blood volume, plasma volume, red cell volume

Alteration in blood, plasma red cell volume

IRON METABOLISM
- In pregnancy, Iron is actively transported across the placenta to the fetus
  ✓ Fetus – extra 1 g / day
  ✓ Expanded blood volume – 6-7 mg / day

Note: Normal woman need 2.0 to 2.5 g iron per day
### Cardiovascular system

#### Anatomical changes:
- Heart displaced to left and upward (due to elevation of diaphragm & increased venous fill)
- Rotating slightly along its long axis (giving exaggerated clinical impression of cardiac enlargement)

#### Clinically:
- There may be dyspnea, tachycardia palpitations and extra systoles
- Apex beat is deviated to the fourth intercostal space ~2.5 cm outside the midclavicular line

#### Heart sounds:
- **1st** – Loud and split in 88% of cases (mitral valve closing earlier)
- **2nd** – is normal
- **3rd** – loud due to rapid diastolic filling
- A 4th heart sound may be heard
- Systolic ejection murmurs can be heard in 90% normal cases
- 40% increase in both atrial diameters

#### Cardiac output:
- Cardiac output increases from 6 weeks and reached pick of 40-50% in ~32-34 weeks.
- Cardiac output is maximum in right/left lateral or knee chest position and least in sitting or supine position
- Cardiac output increase 15% more in labor first stage and 50% more in second stage.
- Increase 60-80% immediately after child birth followed by a rapid reduction
- So women with cardiac compromise are at maximum risk in second stage of labor and immediate postpartum period

#### Blood pressure:
- Decreases (↓) and reached minimum at 24-26 weeks then recovers

#### Venous pressure:
- Central venous pressure & antecubital venous pressure is unaffected
- But, femoral venous pressure is raised especially in standing position

#### Supine hypotensive syndrome (postural hypotension or Mengert’s syndrome):
- Observed in few women late in pregnancy in Supine position
- This is due to compression of the inferior vena cava by the enlarged gravid uterus resulting in decrease in venous return and cardiac output and low blood pressure which may cause fainting

#### Central hemodynamic changes:
- There is not change in CVP, MVP & PCWP
- ↑ in Stroke volume, cardiac output & heart rate

#### REGIONAL BLOOD FLOW:
- Uteroplacental blood flow ↑ to about 650 mL/min
- Vascular refractoriness to angiotensin II, endothelin I, adrenaline and noradrenaline
- Pulmonary blood flow 40% ↑ & While renal blood flow 30% ↑
### Metabolic changes & Respiratory system

#### General metabolism
- BMR increase by 30%
- This is to fulfill growing needs of fetus, uterus & overall body

#### Protein metabolism
- 1 kg net increase in protein content

#### Carbohydrate metabolism
- Hyperinsulinemia due to hypertrophy and hyperplasia of β cells of pancreas due to altered hormonal milieu
- Inspire of hyperinsulinemia, there is a postprandial hyperglycemia in order to ensure adequate glucose supply
- Maternal utilization of glucose is reduced. Glycosuria may be observed in 50% of normal pregnant women

#### Fat metabolism
- ~3.5 kg increase in fat content
- Lipid ↑ from 650 to 1k mg/dL
- Cholesterol, LDL, HDL & Triglycerides ↑

#### Mineral metabolism
- ↑ demand for Iron, calcium, phosphate and magnesium

#### Calcium metabolism
- Daily maternal calcium requirement 1-1.5 g
- Fetus contains 20-30 g of calcium in its skeleton, majority of that comes from maternal serum during 3rd trimester
- Loss of calcium from mother during lactation
- Increased calcium absorption due to increase in plasma 1, 25 dihydroxycholecalciferol.

#### Respiratory system

#### Anatomical changes
- Lower ribs flare out with the subcostal angle 68° – 102°
- Transverse diameter increase by 2%
- Diaphragm raise about 4 cm
- Thoracic circumference ↑ by 6 cm
- No change in diaphragm excursion

#### Functional changes
- Induces certain degree of hyperventilation (dyspnea of pregnancy) due to central action of progesterone which lowers the threshold and increase sensitivity of the chemoreflex response to CO₂ and women fell breathless

#### ACID BASE BALANCE
- ↓ PCO₂ & ↑ PO₂ facilitates transfer of oxygen from mother to fetus and carbon dioxide from fetus to mother
- O₂ consumption ↑ by 30-40 mL/min (30%)
- pH raised slight (0.01 – 0.02 unit)
- Decrease the oxygen releasing capacity of maternal blood
**Urinary system**

**Kidney**
- Size ↑ by 1.5 cm
- Renal pelvi-calyceal dilatation average 15 mm on right & 5 mm on left
- Renal plasma flow & glomerular filtration rate ↑ causes reduction in maternal serum levels of creatinine
- Enzyme renin levels (produced in Kidneys) ↑

**Glycosuria**
- It may be observed in 5 normal cases due to increase GFR

**Proteinuria**
- Up to 5% may cases may show orthostatic or postural proteinuria when the women is ambulatory.

**Ureter**
- Ureters (especially right, due to dextrorotation of uterus) become atonic & dilated due to mechanical compress of ureters by gravid uterus and ovarian venous plexus.
- High progesterone causes ureteral dilatation which makes more prone to infection and pyelonephritis

**Bladder**
- Bladder mucosa becomes congested and hyperemic
- Increase frequency of stress urinary incontinence can be seen due to urethra sphincter weakness & decreased bladder capacity

**Gastrointestinal tract**

- Gums become hyperemic and softened and may bleed due to estrogen.
- Highly vascular swelling (epulis) may develop
- Increase salivation (ptyalism)
- Heartburn (pyrosis) is more common during pregnancy. Therefore, before giving anesthesia, it is important to ensure that the stomach is empty to prevent regurgitation and aspiration.

**Indigestion & flatulence**
- May cause due to decreased gastric acidity & gastric motility ↓

**Constipation – due to**
- ↓ mobility of large intestine (progesterone effect), ↑ water absorption from large intestine (aldosterone effect), presume on pelvic colon by pregnant uterus & sedentary life

**Hemorrhoids – due to**
- Mechanical presume on the pelvic veins, laxity of the walls of the veins by progesterone & constipation

**Appendix**
- Is displaced upwards by enlarged uterus

**Liver**
- NO histological change in liver cells, but the liver functions except alkaline phosphatase may be reduced

**Gall bladder**
- Stone are seen is many cases due to gall bladder stasis (atonicity) coupled with ↑ cholesterol & saturation of bile by estrogens
### Nervous system
- Sleep disorders
- During later part of pregnancy, there is compression of median nerve beneath the carpal ligament of the wrist joint due to edema (this may cause burning, numbness and tingling in the inner medial half of one or both hands. This may result into forearm (carpal tunnel syndrome).
- May have numbness, tingling and sensory loss on the antero-lateral surface of the thighs (caused by pressure on lateral cutaneous nerve by edema).

### Musculo-skeletal system
- Progressive lordosis, waddling gait and backache due to weight of enlarged uterus & increase mobility saro-iliac, sacro-coccygeal and pubic joints (hormonal effect)
- Relaxation of pelvic ligaments caused by progesterone and relaxin leads to slight increase in pelvic diameters referred to as the give of the pelvis

### Emotional changes
- Craving for abnormal food articles
- Hyperemesis gravidarum has some psychological elements
- Excitability (in first trimester), depression, anxiety and extreme cases frank psychosis (in late pregnancy)
- Puerperal psychosis can also occur

### Endocrine system
- Hormones play a key role in physiology of reproduction. It is necessary for the maturation of the Graafian follicles, for ovulation and for luteal maintenance of the pregnancy
DIAGNOSIS OF PREGNANCY
Summary of Diagnosis of Pregnancy

Presumptive symptoms
- Amenorrhea of varying period
- Nausea, vomiting (morning sickness)
- Frequency of micturition

Presumptive signs
- Discoloration of vaginal mucosa
- Breast changes
- Skin changes
- Fatigue
- Quickening

Probable signs
- Changes in the size, shape and consistency of uterus
- Softening of cervix
- Various signs described in early pregnancy
- Abdominal enlargement
- Braxton Hicks contractions
- External and internal ballotment

Absolute signs
- Auscultation of fetal heart sound
- Palpation of fetal parts and perception of active fetal movements
- Ultrasonography evidence of gestational sac and embryo in early pregnancy and fetal parts later

Three unequal trimester
1. Early Pregnancy: First 12 weeks
2. Mid pregnancy: 13 – 28 weeks
3. Late pregnancy: 29-40 weeks

The endocrinological, physiological and anatomical changes occurring during pregnancy give rise to various symptoms and signs in different trimesters.
FIRST TRIMESTER

SYMPTOMS

- Amenorrhoea
- Morning sickness
- Salivation changes
- Mood changes & neurological symptoms
- Micturition frequency
- Fatigue
- Warmth & sweating feeling
- Breast discomfort

Early Pregnancy signs (changes)

<table>
<thead>
<tr>
<th>Breast changes</th>
<th>Pelvic organ changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Engorgement of surface veins</td>
<td></td>
</tr>
<tr>
<td>2. Pigmentation of primary areola. Formation of secondary areola</td>
<td></td>
</tr>
<tr>
<td>3. Prominence of Montgomery’s tubercles</td>
<td></td>
</tr>
<tr>
<td>1. Blue or violet colored vagina and cervix (Jacquemier’s or Chadwick’s sign)</td>
<td></td>
</tr>
<tr>
<td>2. Pulsation of the vaginal and uterine arteries can be detected in the vaginal fornices (Osiander’s sign) – 8th week</td>
<td></td>
</tr>
<tr>
<td>3. Lips of cervix softened (Goodell’s sign) – 6th week</td>
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</tr>
<tr>
<td>4. Irregularity in shape of the uterus (Piskacek’s sign) – 8th week</td>
<td></td>
</tr>
<tr>
<td>5. Uterine contractions may be palpable (Palmer’s sign) – 4-8 weeks</td>
<td></td>
</tr>
<tr>
<td>6. The abdominal and vaginal fingers can be apposed below the body of the uterus due to softness of isthmus (Hegar’s sign) – 8-12 weeks</td>
<td></td>
</tr>
<tr>
<td>Tests</td>
<td>Sample</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Biological tests</td>
<td>Urine</td>
</tr>
<tr>
<td>Immunological tests (Slide test)</td>
<td>Urine</td>
</tr>
<tr>
<td>Immunological tests (Tube test)</td>
<td>Urine</td>
</tr>
<tr>
<td>Immunological tests (Latex test)</td>
<td>Urine</td>
</tr>
<tr>
<td>Immunological tests (Direct latex agglutination test)</td>
<td>200</td>
</tr>
<tr>
<td>Home test kits</td>
<td>Urine</td>
</tr>
<tr>
<td>Enzyme-linked immunosorbent assay (ELISA)</td>
<td>Serum</td>
</tr>
<tr>
<td>Radioimmunoassay β subunit of hCG (does not cross react with LH)</td>
<td>Serum</td>
</tr>
<tr>
<td>Immuno-radiometric assay (IRMA) (Sandwich principle)</td>
<td>Serum</td>
</tr>
<tr>
<td>Radio receptor assay (not used as it cross reacts with LH)</td>
<td>Serum</td>
</tr>
</tbody>
</table>

Ultrasonography especially transvaginal ultrasound permits an exquisite view of the gestational sac, yolk sac, amnion and early embryo
SECOND TRIMESTER

- Amenorrhoea continues ✓
- Nausea, vomiting, increased salivation & Micturition frequency vanishes (X)

New symptoms:
- Progressive enlargement of lower abdomen
- Quickening (coming to life) – first fetal movement felt by mother is called quickening

SIGNS

SYMPTOMS

INVESTIGATIONS

• Cutaneous changes
• Changes in the shape and size of uterus
• Fundal height
• Intermittent uterine contractions called Braxton Hicks
• Active fetal movements
• Palpation of fetal parts
• Auscultatory signs (Auscultation, Funic souffle, uterine souffle etc)
• Detection of fetal movements
  - External ballotment (20-26 weeks)
  - Internal ballotment (18-28 weeks)

• Radiological study: Evidence of fetal skeleton by X-ray can be made out by 16-18 weeks and when seen is conclusive evidence of pregnancy. Due to hazards of radiation and availability of USG, X-rays are not used now.
• Ultrasonography: It is usually performed at 18 weeks to see fetal biometry, viability, gestation, well-being of fetus and placental localization. It is also useful in 3rd trimester for fetal well-being and fetal growth

External Ballotment by both hand (A), on hand (B)

Internal Ballotment: A – by examining finger, B – Displaced fetus falling back, C – Touching the fingers
THIRD TRIMESTER (29-40 weeks)

SYSTEMS:
- Amenorrhoea continues
- Enlargement of abdomen
- Frequency of micturition
- Fetal movements
- Lightening (after 36 weeks)

SIGNS:
- The painless uterine contractions persist
- The fetal movements are more easily felt and seen
- Ballotment is generally not elicitable
- The fetal parts are easily palpable
- The fetal heart is heard clearly if the fetus is alive and is best heard in left spino-umbilical line in left occipito-anterior position
- The uterus enlarges progressively till, at term, it fills almost the entire abdomen.
- Symphyseao-fundal height (SFH): it should be measured with the woman in the dorsal supine position after passing urine.
THANK YOU