CHAPTER 5

Physiological Changes During Pregnancy

THE GENITAL SYSTEM

- **The Ovaries:**
  - Both ovaries are enlarged due to increased vascularity and oedema particularly that containing the corpus luteum.
  - Corpus luteum starts to degenerate after the 10th week when the placenta is formed.
  - Corpus luteum secretes oestrogen, progesterone and relaxin.
  - Relaxin is a protein hormone. Its exact role in pregnancy is unknown. It may induce softness and effacement of the cervix.
  - Ovulation ceases during pregnancy due to pituitary inhibition by the high levels of oestrogen and progesterone.

- **The Fallopian Tubes:**
  - The musculature hypertrophies and the epithelium become flattened.

- **The Uterus:**
  1. **Non-pregnant uterus** - weighs about 50g, and measures about 7.5 cm in length
  2. **Uterus at term** - weighs 900-1000 g, and measures about 35 cm in length
  3. **Enlargement** - It is affected by the following factors:
     a. Changes in the muscles -The muscles undergo hypertrophy and hyperplasia under the influence of estrogen and progesterone. They also undergo significant stretching.
     b. There is simultaneous increase in the number and size of the supporting fibrous and elastic tissues.
     c. Arrangement of the muscle fibers - Three distinct layers are present.
        - Outer longitudinal - It follows a hood like arrangement over the fundus.
        - Intermediate - It is the thickest and strongest layer arranged in criss-cross fashion through which the blood vessels run. Apposition of two double curve muscle fibers gives the figure of 8 form. Thus, when the muscles contract, they occlude the blood vessels running through the fibers and hence called living ligature.
        - Inner circular - It is scanty & has sphincter-like arrangement, around the tubal orifices & internal os.
  4. **Weight** -The increase in weight is due to the increased growth of the uterine muscles, connective tissues and vascular channels.
  5. **Relation**
     a. Shape
        1) Early months - non-pregnant pyriform shape maintained
        2) 12 weeks - globular
        3) 28 weeks - oval
        4) 36 weeks - spherical
     b. Position - Normal anteverted position is exaggerated up to 8 weeks. Thus, the enlarged uterus may lie on the bladder. Afterwards, it becomes erect, and the long axis of the uterus conforms to the axis of the inlet. As the term approaches, especially in multiparae with lax abdominal wall, there is a tendency of anteversion. But in primigravidae with good tone of the abdominal muscles, it is held firmly against the maternal spine.
     c. Lateral obliquity - As the uterus enlarges to occupy the abdominal cavity, it usually rotates on its long axis to the right (dextro-rotation). This is due to the occupation of the recto-sigmoid in the left posterior quadrant of the pelvis. The cervix is deviated to the left side (levo-rotation), bringing it closer to the ureter.
  6. **Contractions (Braxton-Hicks)**
     a. These contractions are irregular, infrequent and painless without any effect on dilatation of the cervix.
     b. From early weeks of pregnancy, uterus undergoes spontaneous contraction
     c. This can be felt during bimanual palpation in early weeks or during abdominal palpation when the uterus feels firmer at one moment and soft at another. Although spontaneous, the contractions may be excised by rubbing the uterus.
     d. Near term, the contractions become frequent with increase in intensity so as to produce some discomfort to the patient. Ultimately, it merges with the painful uterine contractions of labour.
     e. In abdominal pregnancy, Braxton-Hicks contraction is not felt.
     f. During contraction, there is complete closure of the uterine veins with partial occlusion of the arteries in relation to intervillous space resulting in stagnation of blood in the space. This diminishes the placental perfusion, causing transient fetal hypoxia which leads to fetal bradycardia coinciding with the contraction.
The Cervix:

1. **Stroma**
   a. There is hypertrophy and hyperplasia of the elastic and connective tissues.
   b. Fluids accumulate inside and in between the fibers.
   c. Vascularity is increased especially beneath the squamous epithelium of the portio vaginalis which is responsible for its bluish coloration.
   d. All these lead to marked softening of the cervix (Goodell's sign) which is evident as early as 6 weeks. It begins at the margin of the external os and then spreads upwards.
   e. It provides diagnostic aid in pregnancy and also facilitates cervical dilatation during labour.

2. **Epithelium** - There is marked proliferation of the endocervical mucosa with downward extension beyond the squamo-columnar junction. This gives rise to clinical appearance of cervical erosion. These changes are estrogen-induced and regress spontaneously after delivery.

3. **Secretion** - This is known as physiological leucorrhoea of pregnancy. It is copious and tenacious. It is due to the effect of progesterone. The mucus fills up the glands and forms a thick plug effectively sealing the cervical canal.

4. **Anatomical** - The length of the cervix remains unaltered but becomes bulky. The cervix is directed posteriorly but after the engagement of the head, directed in line of vagina. There is unfolding of the isthmus, beginning 12 weeks onwards and takes part in the formation of the lower uterine segment. Variable amount of effacement is noticed near term in primigravidae. In multiparae, the canal is slightly dilated.

The Vagina:

1. Vaginal walls become hypertrophied, oedematous and more vascular.
2. Jacquemier's sign (or Chadwick's sign) - increased blood supply of the venous plexus surrounding the walls gives the bluish colouration of the mucosa.
3. Length of the anterior vaginal wall is increased.
4. Secretion - It becomes copious, thin and curdy white. The pH becomes acidic.
5. Cytology - There is preponderance of navicular cells in cluster.

The Vulva:

1. Becomes oedematous and hyperemic.
2. Superficial varicosities may appear, especially in multiparae.
3. Labia minora are pigmented and hypertrophied.

The Breasts

- The changes in the breasts are best evident in primigravida. In multipara who has once lactated, the changes are not clearly defined.

**Size**

1. Increase in size becomes evident even in early weeks. This is due to marked hypertrophy and proliferation of the ducts (estrogen) and the alveoli (estrogen and progesterone) which are marked in the peripheral lobules. There is also hypertrophy of the connective tissue stroma.
2. Myoepithelial cells become prominent.
3. Vascularity is increased which results in appearance of bluish veins running under the skin.
4. Axillary tail becomes enlarged and painful.
5. There may be evidence of striation due to stretching of the cutis.

**Nipples and Areola**

1. Nipples become larger erectile and deeply pigmented.
2. Montgomery's tubercles - These are formed when sebaceous glands (5-15 in number), which remain invisible in the non-pregnant state in the areola, become hypertrophied. These are placed surrounding the nipples. Their secretion keeps the nipple and the areola moist and healthy.
3. Secondary areola - This is an outer zone of less marked and irregular pigmented area. It appears in second trimester.

**Secretion**

1. Secretion can be squeezed out of the breast at about 12 weeks.
2. Later on, by 16th week, it becomes thick and yellowish.
3. The demonstration of secretion from the breast of a woman who has never lactated is an important sign of pregnancy.
4. In latter months, colostrum may be expressed from the nipples.
CUTANEOUS CHANGES

- **Pigmentation**
  1. Face (chloasma gravidarum or pregnancy mask) - It is an extreme form of pigmentation around the cheeks, forehead and around the eyes. It may be patchy or diffuse. It disappears spontaneously after delivery.
  2. Breast - already described above.
  3. Abdomen
     a. Linea nigra
        1) It is a brownish black pigmented area in the midline stretching from the xiphi sternum to the symphysis pubis.
        2) It is probably due to MSH from the anterior pituitary.
        3) Estrogen and progesterone may be related to it as similar changes are observed in women taking oral contraceptives.
        4) The pigmentation disappears after delivery.
     b. Striae gravidarum
        1) These are slightly depressed linear marks with varying length and breadth.
        2) They are predominantly found in the abdominal wall below the umbilicus, over the thighs and breasts.
        3) These represent the scar tissues in the deeper layer of the cutis.
        4) Initially these are pinkish. But after the delivery, they become glistening white in appearance and are called striae albicans.
        5) The responsible factors are stretching of the skin and increased aldosterone production during pregnancy.
        6) Controlled weight gain during pregnancy and massaging the abdominal wall by lubricant like olive oil may be helpful in reducing their formation.
        7) Apart from pregnancy, it may form in cases of generalized edema, marked obesity or in Cushing’s syndrome.

   - **Other Cutaneous Changes**
     1. Vascular spider and palmar erythema which are due to high estrogen level.
     2. Mild degrees of hirsutism may be observed and in puerperium, excess hair is lost.

HAEMATOLOGIC CHANGES

- **Blood Volume.**
  - The total blood volume increases steadily from early pregnancy to reach a maximum of 35-45% above the non-pregnant level at 32 weeks.
  - Plasma volume increases by 40% whereas red cell mass increases by 20% leading to haemodilution (Physiological anaemia).

- **Blood Indices:**
  1. Erythrocytes: decrease during pregnancy from 4.5 millions to 3.7 millions /mm³ relative to the increase in plasma volume. Its content 2, 3 diphosphoglycerate increase which competes for oxygen binding sites in the haemoglobin molecule thus release more O₂ to the fetus.
  2. Haemoglobin concentration: falls from 14 g/dl to 12 g/dl.
  3. Leucocytes: increases from 7,000/mm³ to 10,500/mm during pregnancy and up to 16,000/mm³ during labour.
  4. Fibrinogen: increases from 200-400 mg/dl to 400-600 mg/dl.
  5. Erythrocyte sedimentation rate: increases from 12 to 50 mm/hour.

CARDIOVASCULAR SYSTEM

- **Heart:**
  1. Position: As the diaphragm is elevated progressively during pregnancy the apex is displaced upwards and to the left so that it lies in the 4th intercostal space outside the midclavicular line.
  2. Rate: The resting pulse rate increases by 10-15 beats per minute during pregnancy.
  3. Cardiac output: increases mainly by increased stroke volume rather than increased heart rate reaching a maximum of 40% above the non-pregnant level at 20 weeks to be maintained till term.

- **Arteries:**
  - Arterial blood pressure usually declines during the second trimester due to peripheral vasodilatation caused by oestrogens and prostaglandins.
• The posture of the pregnant woman affects arterial blood pressure. Typically, it is highest when she is sitting, lowest when lying in the lateral recumbent position and intermediate when supine.
• Supine hypotensive syndrome may develop in some women late in pregnancy in supine position. This is due to compression of the inferior vena cava by the large pregnant uterus resulting in decrease venous return, decrease cardiac output and low blood pressure that fainting may occur.

> **Veins:**
Varicosities in the lower limbs and vulva may occur due to:
(1) Back pressure from the compressed inferior vena cava by the pregnant uterus.
(2) Relaxation of the smooth muscles in the wall of the veins by progesterone.

**RESPIRATORY SYSTEM**

Dyspnoea may occur due to:
(1) Increased sensitivity of the respiratory center to CO₂ possibly due to high progesterone level.
(2) Elevation of the diaphragm by the pregnant uterus.

**GASTROINTESTINAL TRACT**

1) **Gingivitis:** There is increased vascularity and tendency for bleeding as well as hypertrophy of the interdental papilla.
2) **Ptyalism:** It is excessive salivation and more common in association with oral sepsis.
3) **Nausea and vomiting:** Nausea (morning sickness) and vomiting (emesis gravidarum) occur in early months.
4) **Appetite changes** (longing or craving): The pregnant woman dislikes some foods and odours while desires others. Reduced sensitivity of the taste buds during pregnancy creates the desire for markedly sweet, sour or salt foods. Deviation may be so extreme to the extent of eating blackboard chalk, coal or mud (pica).
5) **Indigestion and flatulence:**
   This is probably due to:
   (i) decreased gastric acidity caused by regurgitation of alkaline secretion from the intestine to the stomach.
   (ii) decreased gastric motility.
6) **Heartburn:** due to reflux of the acidic gastric contents to the oesophagus.
7) **Constipation:** due to:-
   i. Reduced motility of large intestine (progesterone effect),
   ii. increased water reabsorption from the large intestine (aldosterone effect),
   iii. pressure on the pelvic colon by the pregnant uterus,
   iv. sedentary life during pregnancy.
8) **Gall stones:** More tendencies to stone formation due to atony and delayed emptying of the gall bladder.
9) **Haemorrhoids:** due to:
   i. Mechanical pressure on the pelvic veins,
   ii. laxity of the veins walls by progesterone,
   iii. constipation.

**URINARY SYSTEM**

> **Kidney:**
Renal blood flow and glomerular filtration rate increases by 50%.

> **Ureters:**
Dilatation of the ureters and renal pelvis due to:
   i. relaxation of the ureters by the effect of progesterone.
   ii. pressure against the pelvic brim by the uterus particularly on the right side.

> **Bladder:**
Frequency of micturition in early pregnancy due to:
   i. pressure on the bladder by the enlarged uterus.
   ii. congestion of the bladder mucosa.
Urinary stress incontinence may develop for the first time during pregnancy and spontaneously relieved later.

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