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CHAPTER

Normal Labor

Intrapartum Care for a Positive Child Birth Experience (WHO)

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LABOR

DEFINITION: Series of events that take place in the genital organs in an effort to expel the viable products of conception (fetus, placenta and the membranes) out of the womb through the vagina into the outer world is called 'labor'. It may occur prior to 37 completed weeks, when it is called the preterm labor. Labor is characterized by the presence of regular uterine contractions with effacement and dilatation of the cervix with fetal descent. A parturient is a patient in labor and parturition is the process of giving birth. **Delivery** is the expulsion or extraction of a viable fetus out of the womb. It is not synonymous with labor; delivery can take place without labor as in elective cesarean section. Delivery may be vaginal, either spontaneous or aided, or it may be abdominal.

NORMAL LABOR (EUTOCIA): Labor is called normal if it fulfils the following criteria:

1. Spontaneous in onset and at term
2. With vertex presentation
3. Without undue prolongation
4. Natural termination with minimal aids
5. Without having any complications affecting the health of the mother and/or the baby.

ABNORMAL LABOR (DYSTOCIA): Any deviation from the definition of normal labor is called abnormal labor. Thus, labor in a case with presentation other than vertex or having some complications even with vertex presentation affecting the course of labor or modifying the nature of termination or adversely affecting the maternal and/or fetal prognosis is called abnormal labor.

DATE OF ONSET OF LABOR: It is very much unpredictable to foretell precisely the exact date of onset of labor. It is not only varies from case to case but even in different pregnancies of the same individual. Calculation based on Naegele's formula can only give a rough guide. **Based on the formula, labor starts approximately on the expected date in 4%, 1 week on either side in 50%, 2 weeks earlier and 1 week later in 80%, at 42 weeks in 10%, and at 43 weeks plus in 4%.**

CAUSES OF ONSET OF LABOR

The precise mechanism of initiation of human labor is still obscure. Endocrine, biochemical and mechanical stretch pathways as obtained from animal experiments, however, put forth the following hypotheses.

- **Uterine distension:** Stretching effect on the myometrium by the growing fetus and liquor amnii can explain the onset of labor at least in twins or polyhydramnios. **Uterine stretch** increases gap junction proteins, receptors for oxytocin and specific Contraction Associated Proteins (CAPs).
- **Fetoplacental contribution:** Cascade of events activate **fetal hypothalamic-pituitary-adrenal axis** prior to onset of labor → increased CRH → increased release of ACTH → fetal adrenals → increased cortisol secretion → accelerated production of estrogen and prostaglandins from the placenta **(Fig. 13.1)**.
- **Estrogen:** The probable mechanisms are:
  - **Increases** the release of oxytocin from maternal pituitary.
  - **Promotes** the synthesis of myometrial receptors for oxytocin (by 100–200 folds), prostaglandins and increase in gap junctions in myometrial cells.
  - **Accelerates** lysosomal disintegration in the decidual and amnion cells resulting in increased prostaglandin ($PGF2\alpha$) synthesis.

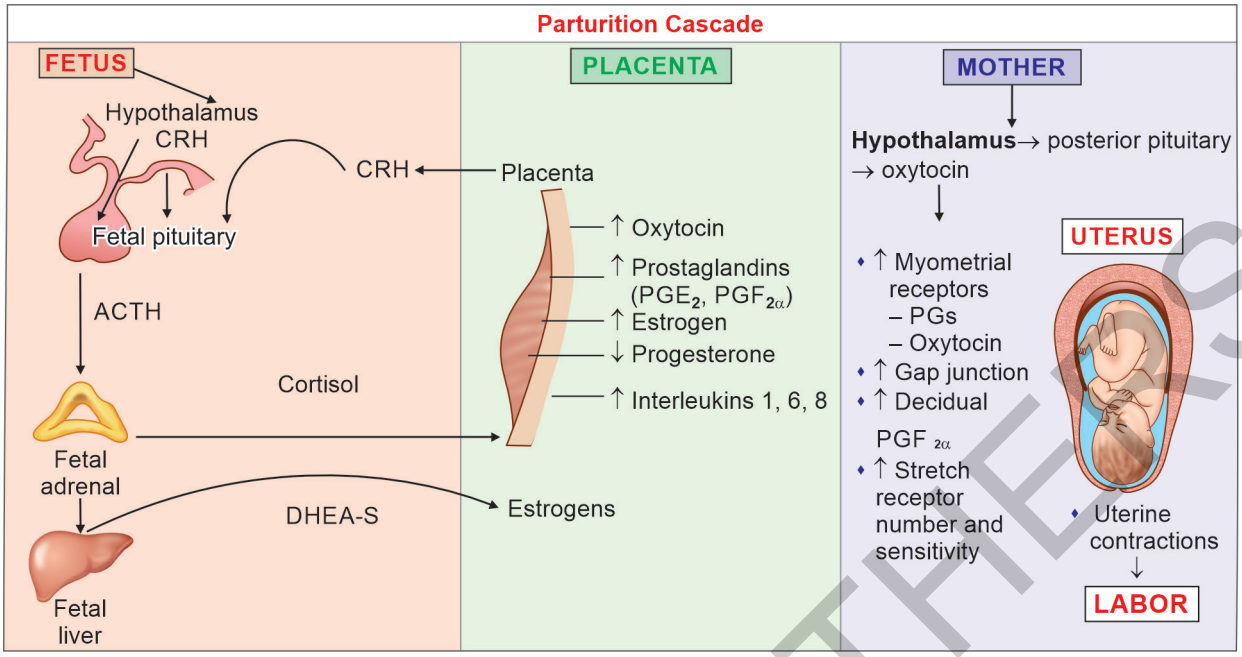


Fig. 13.1: Initiation of parturition.

— **Stimulates** the synthesis of myometrial contractile protein—actomyosin through cAMP.
— **Increases** the excitability of the myometrial cell membranes.

- **Progesterone:** Increased fetal production of Dehydroepiandrosterone Sulfate (DHEA-S) and cortisol inhibits the conversion of fetal pregnenolone to progesterone. Progesterone levels therefore fall before labor. **It is the alteration** in the estrogen-progesterone ratio rather than the fall in the absolute concentration of progesterone, which is linked with prostaglandin synthesis.
- **Prostaglandins:** They are the important factors, which initiate and maintain labor. **The major sites of synthesis of prostaglandins are**—amnion, chorion, decidual cells and myometrium. **Synthesis is triggered by**—rise in estrogen level, glucocorticoids, mechanical stretching in late pregnancy, increase in cytokines (IL–1, 6, TNF), infection, vaginal examination and separation or rupture of the membranes. Prostaglandins enhance gap junction (intramembranous gap between two cells through which stimulus flows) formation.

Biochemical Mechanisms Involved in the Synthesis of Prostaglandins (Flowchart 13.1)

Phospholipase A_2 in the lysosomes of the fetal membranes near term → esterified arachidonic acid → formation of free arachidonic acid → synthesis of prostaglandins through prostaglandin synthetase. Prostaglandins (E_2 and $F_{2\alpha}$) diffuse in the myometrium → act directly at the sarcoplasmic reticulum → inhibit intracellular cAMP generation → increase local free calcium ions → uterine contraction. Once the arachidonic acid cascade is initiated, prostaglandins themselves will activate lysosomal enzyme systems. **The prostaglandin synthesis reaches a peak** during the birth of placenta probably contributing to its expulsion and to the control of postpartum hemorrhage.

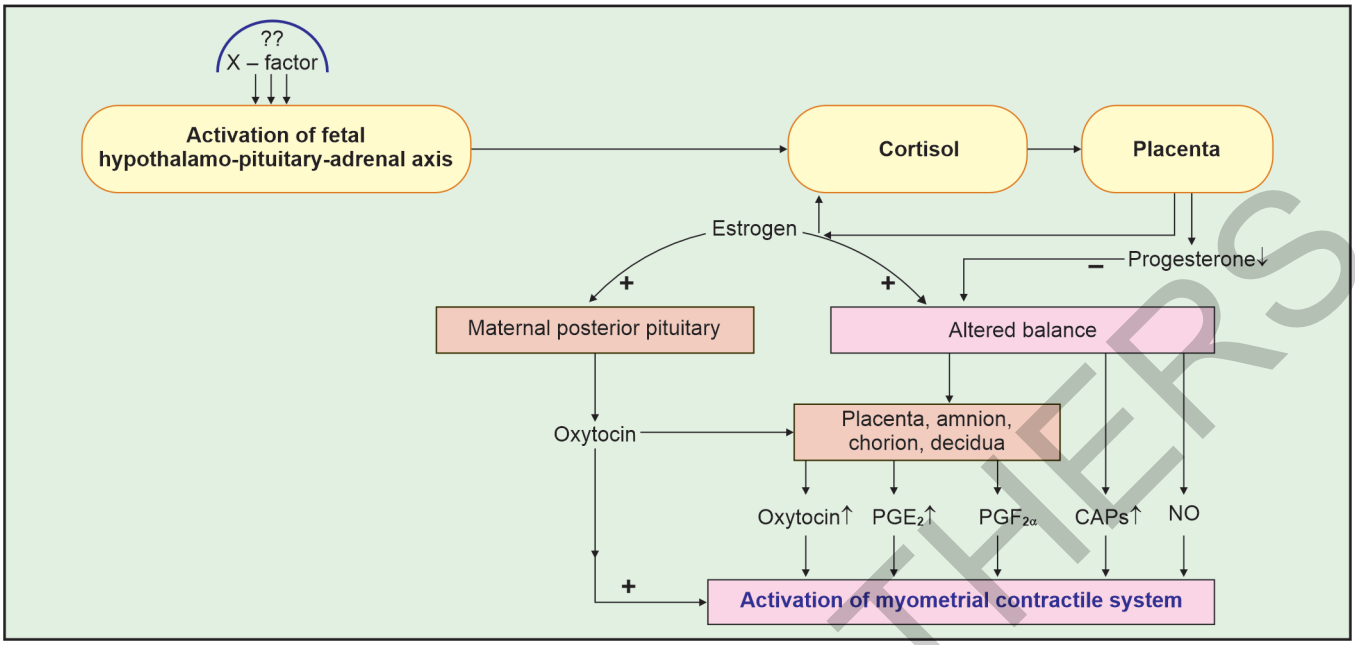
- ***Oxytocin and myometrial oxytocin receptors:***
  (i) Large number of oxytocin receptors are present in the fundus compared to the lower segment and the cervix.
  (ii) **Receptor number increases during pregnancy reaching maximum during labor.**
  (iii) Receptor sensitivity increases during labor.
  (iv) Oxytocin stimulate synthesis and release of PGs (E_2 and $F_{2\alpha}$) from amnion and decidua. Vaginal examination and amniotomy (stretching of the lower genital tract), cause rise in maternal plasma oxytocin level (Ferguson reflex). *Fetal plasma oxytocin* level is found increased during spontaneous labor compared to that of mother. Its role in human labor is not yet established.
- ***Neurological factor:*** **Although labor may start in denervated uterus, labor may be also initiated through nerve pathways. Both α and β adrenergic receptors are present in the myometrium; estrogen causing the α receptors and progesterone the β receptors to function predominantly.** The contractile response is initiated through the α receptors of the postganglionic nerve fibers in and around the cervix, and the lower part of the uterus. This is based on observation that onset of labor occurs following stripping or low rupture of the membranes.

CONTRACTILE SYSTEM OF THE MYOMETRIUM

The basic elements involved in the uterine contractile systems are: (a) Actin, **(b)** myosin, **(c)** adenosine triphosphate (ATP), **(d)** the enzyme myosin light chain kinase (MLCK) and **(e)** Ca^{++}.

Structural unit of a myometrial cell is myofibril which contains the proteins—**actin and myosin.** The interaction of myosin and

Flowchart 13.1: Possible mechanism in initiation of labor.



(CAPs: Contraction Associated Proteins; NO: Nitric Oxide; PGE_2: Prostaglandin E_2)

actin is essential for muscle contraction. The key process in actin-myosin interaction is myosin light chain phosphorylation. This reaction is controlled by **Myosin Light Chain Kinase (MLCK).** Oxytocin acts on myometrial receptors and activates phospholipase C, which increases intracellular calcium level. Calcium is essential for the activation of MLCK and binds to the kinase as **calmodulin–calcium** complex. Intracellular calcium levels are regulated by two general mechanisms: **(1)** Influx across the cell membrane and **(2)** release from intracellular storage sites. Calcium is stored within the cells in the sarcoplasmic reticulum and in mitochondria. Progesterone and cAMP promote calcium storage at these sites. $PGF_{2\alpha}$, E_2 and oxytocin on the other hand stimulate its release.

- Intracellular Ca^{++} → calmodulin Ca^{++} → MLCK → phosphorylated myosin + actin → myometrial contraction.
- Decrease of intracellular Ca^{++} (or its shift to the storage sites) → dephosphorylation of myosin light chain → inactivation of myosin light chain kinase → myometrial relaxation.

Uterine muscles have two types of adrenergic receptors—(1) α receptors, which on stimulation, produce a decrease in cyclic AMP (adenosine monophosphate) and result in contraction of the uterus and **(2) β receptors**, which on stimulation, produce rise in cyclic AMP and result in inhibition of uterine contraction.

FALSE PAIN *(Synonym: false labor, spurious labor):* It is found more in primigravidae than in parous women. **It usually appears prior to the onset of true labor pain by 1 or 2 weeks in primigravidae and by a few days in multiparae**. Such pains are probably due to stretching of the cervix and lower uterine segment with consequent irritation of the neighboring ganglia.

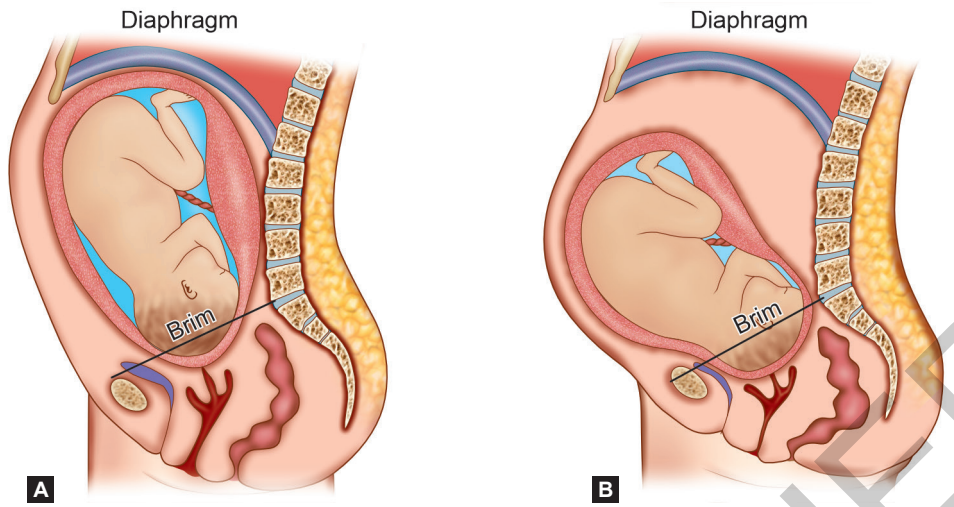
PRELABOR *(Synonym: premonitory stage)*: The premonitory stage may begin 2–3 weeks before the onset of true labor in primigravidae and a few days before in multiparae.

The features are inconsistent and may consist of the following:

- ***Lightening:*** A few weeks prior to the onset of labor especially in primigravidae, the presenting part sinks into the true pelvis. It is due to active pulling up of the lower pole of the uterus around the presenting part. It signifies incorporation of the lower uterine segment into the wall of the uterus. This diminishes the fundal height and hence minimizes the pressure on the diaphragm **(Figs. 13.2A and B)**. The mother experiences a sense of relief from the mechanical cardiorespiratory embarrassment. There may be frequency of micturition or constipation due to mechanical factor—pressure by the engaged presenting part. **It is a welcome sign** as it rules out cephalopelvic disproportion and other conditions preventing the head from entering the pelvic inlet.
- ***Cervical changes*:** A few days prior to the onset of labor, cervix becomes ripe. **A ripe cervix is (a)** soft, **(b)** 80% effaced (<1.5 cm in length), **(c)** admits one finger easily, and **(d)** cervical canal is dilatable.
- ***Appearance of false pain*** (see next page).

True labor pain is characterized by:

(i) Painful uterine contractions at regular intervals.
(ii) Frequency of contractions increase gradually.
(iii) Intensity and duration of contractions increase progressively.
(iv) Associated with 'show'.
(v) Progressive effacement and dilatation of the cervix.
(vi) Descent of the presenting part.



Figs. 13.2A and B: Showing phenomenon of 'lightening': **(A)** Before; **(B)** After lightening.

(vii) Formation of the 'bag of forewaters'.
(viii) Not relieved by enema or sedatives.

False labor pain is characterized by:

(i) Dull in nature.
(ii) Confined to lower abdomen and groin.
(iii) May be associated with hardening of the uterus.
(iv) They have no other features of true labor pain as discussed above.
(v) Usually relieved by analgesic.

Labor pain: Throughout pregnancy, painless Braxton-Hicks contractions with simultaneous hardening of the uterus occur. The contractions are irregular and do not increase in frequency or regularity. These contractions change their character, become more powerful, intermittent and are associated with pain. Pain more often felt in front of the abdomen or radiating toward the thighs.

Show: With the onset of labor, there is profuse cervical mucoid discharge. Simultaneously, there is slight oozing of blood from rupture of capillary vessels of the cervix and from the raw decidual surface caused by separation of the membranes due to stretching of the lower uterine segment. **Expulsion of cervical mucus plug mixed with blood is called 'show'.**

Dilatation of internal os: With the onset of labor pain, the cervical canal begins to dilate more in the upper part than in the lower, the former being accompanied by corresponding stretching of the lower uterine segment.

Formation of 'bag of waters': Due to stretching of the lower uterine segment, the membranes are detached easily because of its loose attachment to the poorly formed decidua. With the dilatation of the cervical canal, the lower pole of the fetal membranes becomes unsupported and tends to bulge into the cervical canal. As it contains liquor, which has passed below the presenting part, it is called 'bag of waters'. During uterine contraction with consequent rise of intra-amniotic pressure, this bag becomes tense and convex. After the contractions pass off, the bulging may disappear completely. **This in association with regular contractions and cervical changes are signs of onset of labor.** However, in some cases the membranes are so well applied to the head that the finding may not be detected.

STAGES OF LABOR: Conventionally, events of labor are divided into three stages:

- ***First stage:*** It starts from the onset of true labor pain and ends with full dilatation of the cervix. It is, in other words, the 'cervical stage' of labor. Its average duration is 12 hours (WHO) in primigravidae and 6 hours (WHO-10 hours) in multiparae.
- ***Second stage:*** It starts from the full dilatation of the cervix (not from the rupture of the membranes) and ends with expulsion of the fetus from the birth canal. It has got two phases: **(1) The propulsive or passive phase**—starts from full dilatation up to the descent of the presenting part to the pelvic floor. **(2) The expulsive or active phase** is distinguished by maternal bearing down efforts and ends with delivery of the baby. Its average duration is 2 hours (WHO-3 hours) in primigravidae and 30 minutes (WHO-2 hours) in multiparae .
- ***Third stage:*** It begins after expulsion of the fetus and ends with expulsion of the placenta and membranes (afterbirths). Its average duration is about 15 minutes in both primigravidae and multiparae. The duration is, however, reduced to 5 minutes in active management.
- ***Fourth stage:*** It is the stage of observation for at least 1 hour after expulsion of the afterbirths. During this period maternal vitals, uterine retraction and any vaginal bleeding are monitored. Baby is examined. These are done to ensure that both the mother and baby are well.

PHYSIOLOGY OF NORMAL LABOR

During pregnancy there is marked **hypertrophy** and **hyperplasia** of the uterine muscle and the enlargement

of the uterus. At term, the length of the uterus measures about 35 cm including cervix. The fundus is wider both transversely and anteroposteriorly than the lower segment. The uterus assumes pyriform or ovoid shape. The cervical canal is occluded by a thick, tenacious and mucus plug.

UTERINE CONTRACTION IN LABOR: Throughout pregnancy there is irregular involuntary spasmodic uterine contractions which are painless (Braxton-Hicks) and have no effect on dilatation of the cervix (p. 43). The character of the contractions changes with the onset of labor. The **pacemaker of the uterine contractions** is situated in the region of the tubal ostia from where waves of contractions spread downward. While there are wide variations in frequency, intensity and duration of contractions, they remain usually within normal limits in the following patterns.

- There is good synchronization of the contraction waves from both halves of the uterus and also between upper and lower uterine segments.
- There is fundal dominance of contractions that diminish gradually in duration and intensity through midzone down to lower segment. It takes about 10–20 seconds.
- The waves of contraction follow a regular pattern.
- The upper segment of the uterus contracts more strongly and for a longer time than the lower part.
- Intra-amniotic pressure rises beyond 20 mm Hg during uterine contraction.
- Good relaxation occurs in between contractions to bring down the intra-amniotic pressure to less than 8 mm Hg. Contractions of the fundus last longer than that of the midzone.

During contraction, uterus becomes hard and somewhat pushed anteriorly to make the long axis of the uterus in line with that of pelvic axis. Simultaneously, the patient experiences pain which is situated more on the hypogastric region, often radiating to the thighs. **Probable causes of pain are: (a)** Myometrial hypoxia during contractions (as in angina), **(b)** stretching of the peritoneum over the fundus, **(c)** stretching of the cervix during dilatation, **(d)** stretching of the ligaments surrounding the uterus and **(e)** compression of the nerve ganglion. **Pain of uterine contractions is distributed along the cutaneous nerve distribution of T_{10} to L_1.** Pain of cervical dilatation and stretching is referred to the back through the sacral plexus.

Tonus: **It is the intrauterine pressure in between contractions.** During pregnancy, as the uterus is quiescent (inactive), the tonus is of 2–3 mm Hg. During the first stage of labor, it varies from 8 to 10 mm Hg. It is inversely proportional to relaxation. **The factors which govern the tonus are: (i)** Contractility of uterine muscles, **(ii)** intra-abdominal pressure, and **(iii)** overdistension of uterus as in twins and hydramnios.

Intensity: **The intensity of uterine contraction describes the degree of uterine systole.** The intensity gradually increases with advancement of labor until it becomes maximum in the second stage during delivery of the baby. **Intrauterine pressure is raised to 40–50 mm Hg during first stage and about 100–120 mm Hg in second stage of labor during contractions. In spite of diminished pain in third stage, the intrauterine pressure is probably the same as that in the second stage.** The diminished pain is due to lack of stretching effect.

Duration: In the first stage, the contractions last for about 30 seconds initially but gradually increase in duration with the progress of labor. **Thus in the second stage, the contractions last longer than in the first stage**.

Frequency: In the early stage of labor, the contractions come at intervals of 10–15 minutes. The intervals gradually shorten with advancement of labor until in the second stage, when it comes every 2–3 minutes.

It is important to note that all the features of uterine contractions mentioned are very effective only when they are in combination.

RETRACTION: It is a phenomenon of the uterus in labor in which the muscle fibers are permanently shortened. Unlike any other muscles of the body, **the uterine muscles have this property to become shortened once and for all**. Contraction is a temporary reduction in length of the fibers, which attain their full length during relaxation. In contrast, retraction results in permanent shortening and the fibers are shortened once and for all **(Fig. 13.3)**.

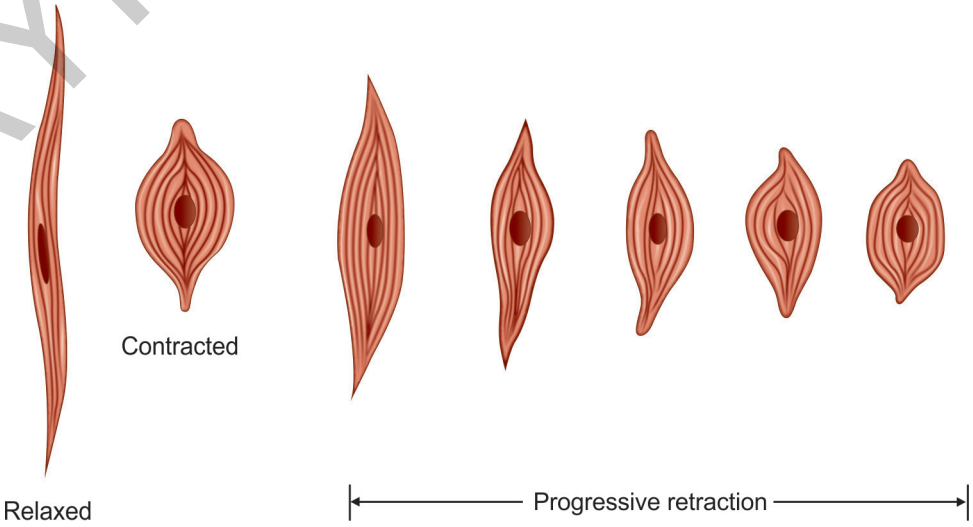


Fig. 13.3: Showing phenomenon of contraction and retraction of uterine muscle fibers during labor.

The net effects of retraction in normal labor are:

- Essential property in the formation of lower uterine segment and dilatation and effacement of the cervix.
- To maintain the descent of the presenting part made by the uterine contractions and to help in ultimate expulsion of the fetus.
- To reduce the surface area of the uterus favoring separation of placenta.
- Effective hemostasis after the separation of the placenta.

EVENTS IN FIRST STAGE OF LABOR

The first stage is chiefly concerned with the preparation of the birth canal so as to facilitate expulsion of the fetus in the second stage. **The main events that occur in the first stage are—(a)** dilatation and effacement of the cervix and **(b)** full formation of lower uterine segment.

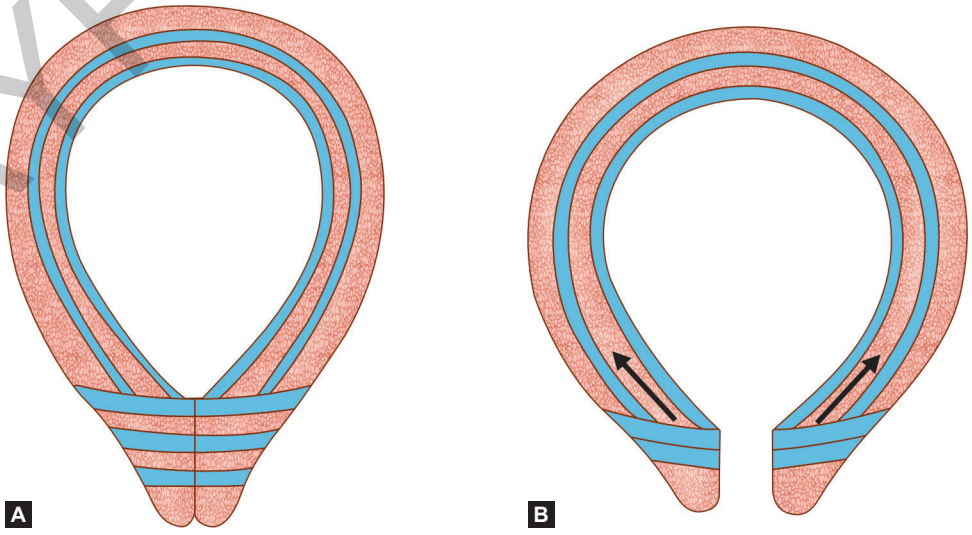
DILATATION OF THE CERVIX: Prior to the onset of labor, in the prelabor phase (phase-1) there may be a certain amount of dilatation of cervix, especially in multiparae and in some primigravidae. **Important structural components of the cervix are—(a)** smooth muscle (5–20%), **(b)** collagen and **(c)** the ground substance. **Predisposing factors which favor smooth dilatation are:**

a. Softening of the cervix.
b. Fibromusculoglandular hypertrophy.
c. Increased vascularity.
d. Accumulation of fluid in between collagen fibers.
e. Breaking down of collagen fibrils by enzymes collagenase and elastase.
f. Change in the various glycosaminoglycans (e.g., increase in hyaluronic acid, decrease in dermatan sulfate) in the matrix of the cervix.

These are under the action of hormones—estrogen, progesterone and relaxin. Too much fibrosis as in chronic cervicitis or prolapse or organic lesion in the cervix as in carcinoma, results in deficiency of these factors. As a result, cervix may fail to dilate.

Actual Factors Responsible are:

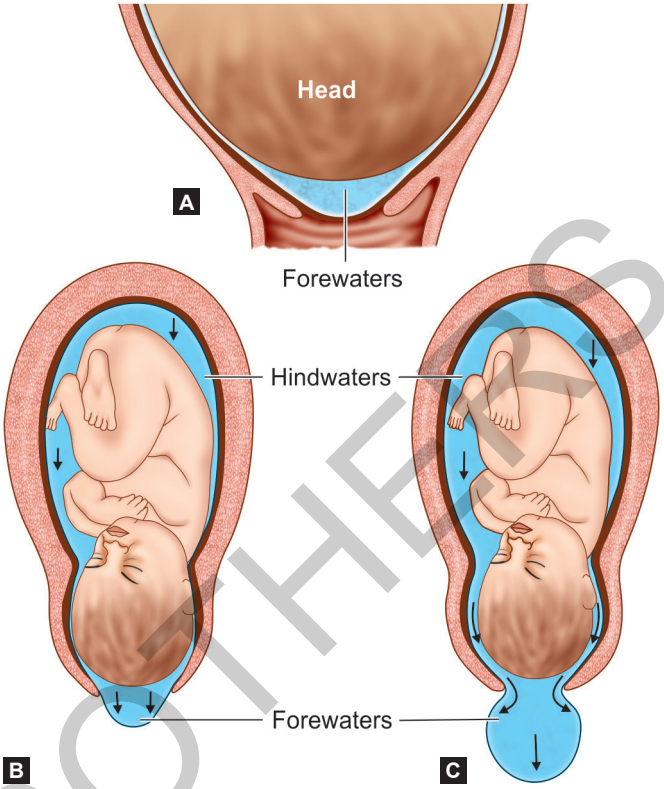
- ***Uterine contraction and retraction:*** The longitudinal muscle fibers of the upper segment are attached with circular muscle fibers of the lower segment and upper part of the cervix in a bucket-holding fashion **(Figs. 13.4A and B)**. Thus, with each uterine contraction, not only the canal is opened up from above down but also it becomes shortened and retracted. There is some coordination between fundal contraction and cervical dilatation called **'polarity of uterus'.** While the upper segment contracts, retracts and pushes the fetus, the lower segment and the cervix dilate in response to the forces of contraction of upper segment.
- ***Fetal axis pressure:*** In labor with longitudinal lie and with well-fitted (flexed) fetal head on the cervix, fetal vertebral column is straightened by the contractions of the circular muscle fibers of the body of the uterus. This allows the fundal strong contraction force to be transmitted through the fetal podalic pole and vertebral column to the well-fitted fetal head. This causes mechanical stretching of the lower segment and opening up (dilatation) of the cervical canal. With each uterine contraction, there is elongation of the uterine ovoid and decrease in the transverse diameter. In transverse lie fetal axis pressure is absent. With progressive contraction and retraction, the upper segment becomes shorter and thicker while the lower segment becomes thinner and wider. The cervical canal starts dilating.
- ***Bag of membranes:*** The membranes (amnion and chorion) are attached loosely to the decidua lining the uterine cavity except over the internal os. In vertex presentation, the girdle of contact of the head (that part of the circumference of the head which first comes in



Figs. 13.4A and B: Diagrammatic representation showing dilatation of the cervix by the pull of the longitudinal muscles of the uterus: **(A)** Before labor; **(B)** After labor.

contact with the pelvic brim) being spherical, may well fit with the wall of the lower uterine segment. Thus, the amniotic cavity is divided into two compartments **(Figs. 13.5A to C)**. The part above the girdle of contact contains the fetus with bulk of the liquor called **hindwaters**, and the one below it containing small amount of liquor called **forewaters**. With the onset of labor, the membranes attached to the lower uterine segment are detached and with the rise of intrauterine pressure during contractions there is herniation of the membranes through the cervical canal. **There is ball-valve like action** by the well-flexed head. Uterine contractions generate hydrostatic pressure in the forewaters that in turn dilate the cervical canal like a wedge. When the bag of forewaters is absent (PROM) the pressure of the presenting part pushes the cervix centrifugally.

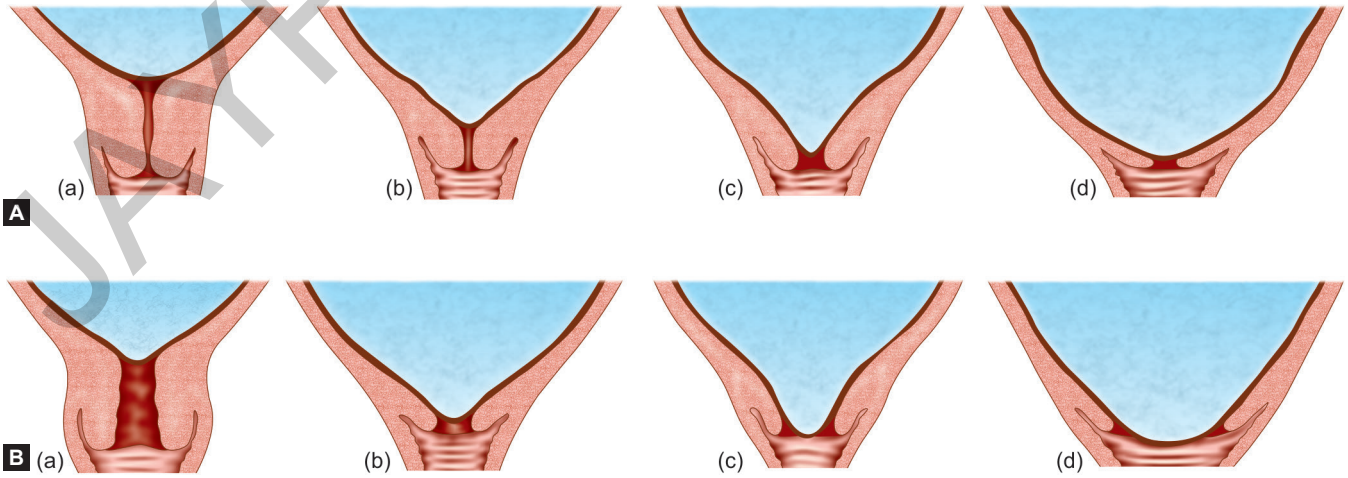
- ***Vis-a-tergo*:** The final phase of dilatation and retraction of the cervix is achieved by downward thrust of the presenting part of the fetus and upward pull of the cervix over the lower segment. This phenomenon is lacking in transverse lie where a thin cervical rim fails to disappear.



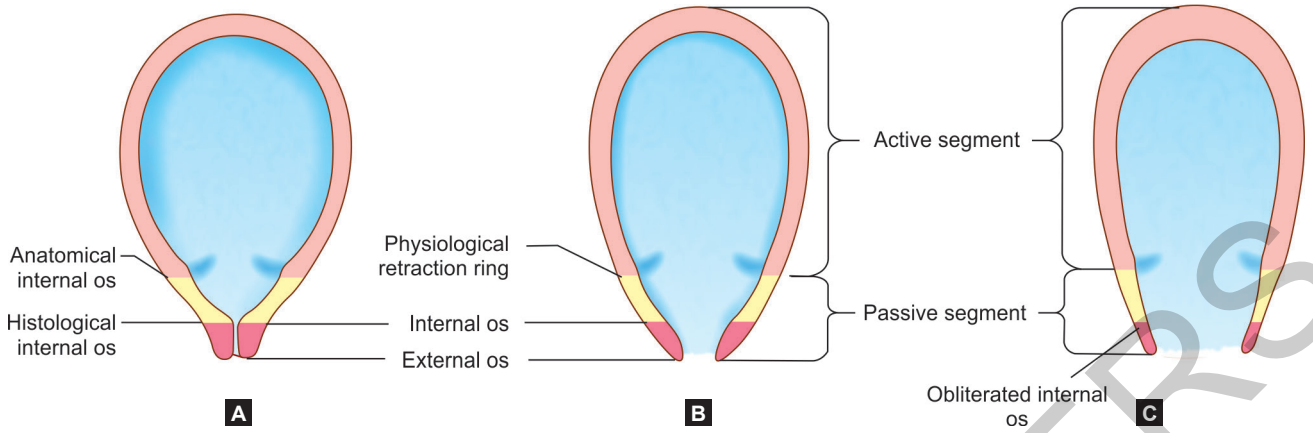
Figs. 13.5A to C: (A) Formation of bag of membranes and forewaters; **(B)** Well-fitting presenting part dividing the forewaters from hindwater; **(C)** Ill-fitting presenting part allows the hindwaters to force into the bag of membranes during contraction which may lead to its early rupture.

EFFACEMENT OR TAKING UP OF CERVIX: Effacement is the process by which the muscular fibers of the cervix are pulled upward and merges with the fibers of the lower uterine segment. The cervix becomes thin during first stage of labor or even before that in primigravidae. **In primigravidae**, effacement precedes dilatation of the cervix, **whereas in multiparae**, both occur simultaneously **(Figs. 13.6A and B)**. Expulsion of mucus plug is caused by effacement.

LOWER UTERINE SEGMENT: Before the onset of labor, there is no complete anatomical or functional division of the uterus. During labor the demarcation of an active upper segment and a relatively passive lower segment is more pronounced. The wall of the upper segment becomes progressively thickened with progressive thinning of the lower segment **(Figs. 13.7A to C)**. This is pronounced in late first stage, especially after rupture of the membranes and attains its maximum in second stage. A distinct ridge is produced at the junction of the two, called **physiological retraction ring** which should not be



Figs. 13.6A and B: Diagrammatic representation of the dilatation and 'taking up' of the cervix in—**(A)** Primigravida; **(B)** Multipara: **(A)**—(a) cervix before labor; (b and c) progressive `taking up' of the cervix without much dilatation; (d) cervix completely taken up with external os still remaining undilated; **(B)**—(a) cervix before labor, to note the patulous cervix; (b and c) progressive and simultaneous dilatation and `taking up' of the cervix; (d) taking up and dilatation of the external os occur simultaneously.



Figs. 13.7A to C: Sequence of development of the active and passive segments of the uterus: **(A)** Uterus at term; **(B)** In early labor; **(C)** Late second stage.

Table 13.1: Lower Segment (LS) of uterus and the clinical significance.

Anatomical features	*Clinical significance*
▪ **LS is developed from the isthmus** of the (nonpregnant) uterus, which is bounded above anatomical and below by histological internal os. ▪ **In labor, LS is bounded** above by the physiological retraction ring and below by the fibromuscular junction of cervix and uterus. ▪ This segment is formed **maximally during labor** and the **peritoneum is loosely attached anteriorly.** ▪ **It measures 7.5–10 cm** when fully formed and becomes cylindrical during the second stage of labor **(Figs. 13.7B and C)**. ▪ **The wall becomes gradually thin** due to: (i) Relaxation of the muscle fibers to allow elongation, (ii) the muscle fibers are drawn up by the muscle fibers of the upper uterine segment by contraction and retraction during labor and (iii) descent of the presenting part causes further stretching and thinning out of wall. ▪ **This segment has got poor retractile property** compared to the upper segment.	▪ The phenomenon of receptive relaxation enables expulsion of the fetus by **formation of complete birth canal** along with the fully dilated cervix **(Fig. 13.17)**. ▪ **Implantation of placenta** in lower segment is known as **placenta previa**. ▪ **It is through this segment** that **cesarean section** is performed. ▪ Poor decidual reaction in this segment facilitates **morbid adherent placenta**, once the placenta is implanted here. ▪ **In obstructed labor,** the lower segment is very much stretched and thinned out and ultimately **gives way (ruptures)** especially in multiparae. ▪ **It is entirely the passive segment** of the uterus. Because of poor retractile property, there is chance of postpartum hemorrhage if placenta is implanted over the area.

confused with the **pathological retraction ring**—a feature of obstructed labor (p. 344). Lower segment of uterus is characterized by following features **(Table 13.1)**.

EVENTS IN SECOND STAGE OF LABOR

The second stage begins with the complete dilatation of the cervix and ends with the expulsion of the fetus. **This stage is concerned with the descent and delivery of the fetus through the birth canal.**

Second stage has two phases:

1. **Propulsive**—from full dilatation until head touches the pelvic floor.
2. **Expulsive**—since the time mother has irresistible desire to *'bear down'* and push until the baby is delivered.

With the full dilatation of the cervix, the membranes usually rupture and there is escape of good amount of liquor amnii. The volume of the uterine cavity is thereby reduced. Simultaneously, uterine contraction and retraction become stronger. The uterus becomes elongated during contraction, while the anteroposterior and transverse diameters are reduced. **The elongation is partly due to the contractions of the circular muscle fibers of the uterus to keep the fetal axis straight**.

Delivery of the fetus is accomplished by the downward thrust offered by uterine contractions supplemented by voluntary contraction of abdominal muscles **(Fig. 13.8)** against the resistance offered by bony and soft tissues of the birth canal. There is always a tendency to push the fetus back into the uterine cavity by the elastic recoil of the tissue of the vagina and the pelvic floor. **This is effectively counterbalanced by the power of retraction**. Thus, with increasing contraction and retraction, the upper segment becomes more and more thicker with corresponding thinning of lower segment. **Endowed with power of retraction, the fetus is gradually expelled from the uterus against the resistance offered by the pelvic floor**. After the expulsion of the fetus, the uterine cavity is permanently reduced in size only to accommodate the afterbirths.

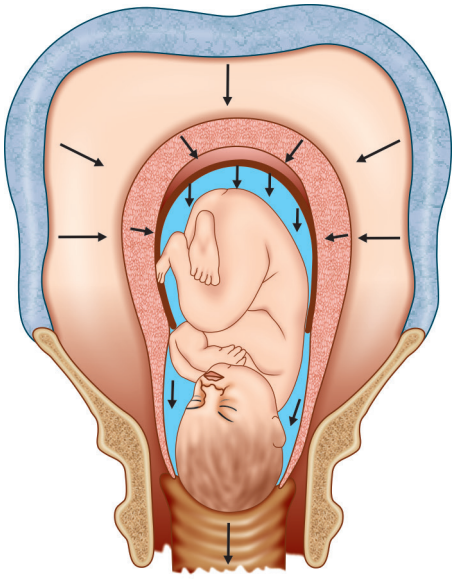


Fig. 13.8: Diagram showing the expulsive forces in the second stage. Increased intra-abdominal pressure augments the downward expulsive force of uterine contraction.

The expulsive force of uterine contractions is added by voluntary contraction of the abdominal muscles called '**bearing down' efforts**. For details, p. 124.

EVENTS IN THIRD STAGE OF LABOR

The third stage of labor comprises the phase of **placental separation**; its descent to the lower segment and finally its **expulsion** with the membranes.

PLACENTAL SEPARATION: **At the beginning of labor, the placental attachment roughly corresponds to an area of 20 cm (8") in diameter**. There is no appreciable diminution of the surface area of the placental attachment during first stage. During the second stage, there is slight but progressive diminution of the area following successive retractions, which attains its peak immediately following the birth of the baby.

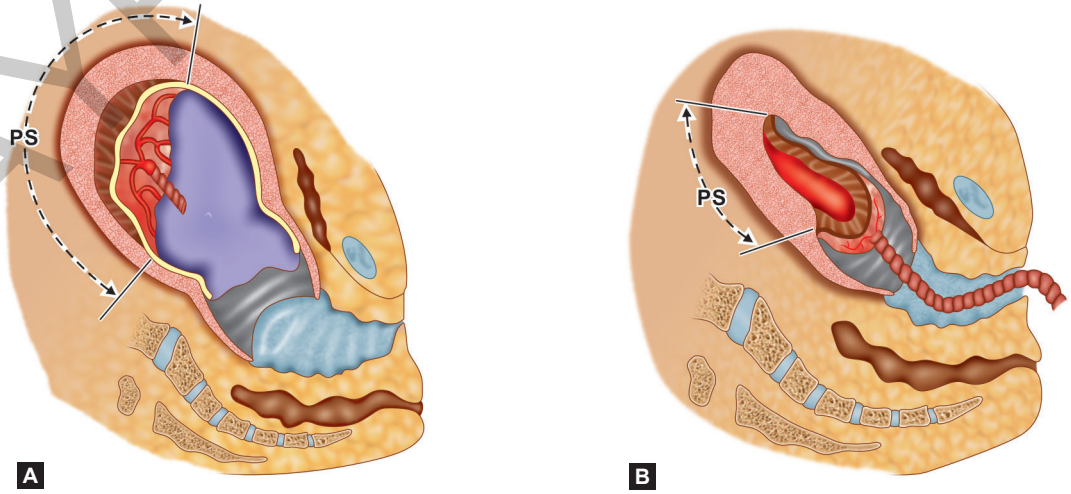
After the birth of the baby, the uterus measures about 20 cm (8") vertically and 10 cm (4") antero-posteriorly, the shape becomes discoid. The wall of the upper segment is much thickened while thin and flabby lower segment is thrown into folds. The cavity is much reduced to accommodate only the afterbirths.

Mechanism of separation: Marked retraction reduces effectively the surface area at the placental site to about its half. But as the placenta is inelastic, it cannot keep pace with such an extent of diminution resulting in its buckling **(Figs. 13.9A and B)**. A shearing force is instituted between the placenta and the placental site which brings about its ultimate separation. **The plane of separation runs through deep spongy layer of decidua basalis** so that a variable thickness of decidua covers the maternal surface of the separated placenta. **There are two ways of separation of placenta (Figs. 13.10A and B).**

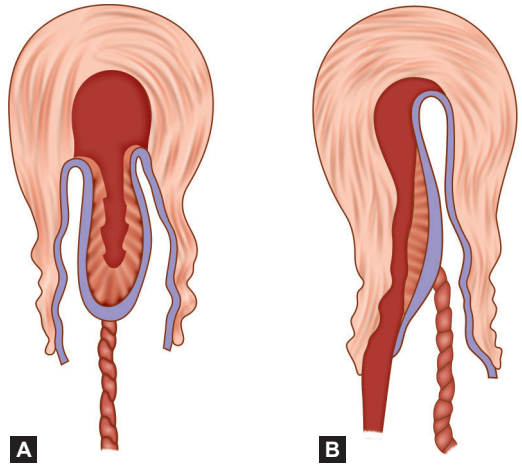
(1) **Central separation (Schultze):** Detachment of placenta from its uterine attachment starts at the center resulting in opening up of few uterine sinuses and accumulation of blood behind the placenta (retroplacental hematoma). With increasing contraction, more and more detachment occurs facilitated by weight of the placenta and retroplacental blood until whole of the placenta gets detached.

(2) **Marginal separation (Mathews-Duncan):** Separation starts at the margin as it is mostly unsupported. With progressive uterine contraction, more and more areas of the placenta get separated. Marginal separation is found more frequently.

SEPARATION OF THE MEMBRANES: The membranes, which are attached loosely in the active part, are thrown into multiple folds. Those attached to the lower segment are already separated during its stretching. **The separation is facilitated partly** by uterine contraction and



Figs. 13.9A and B: Diagram showing area of placental site: **(A)** Before the delivery of the baby; **(B)** After the delivery of the baby. ***Note:*** The reduction of the surface area of the placental site resulting in buckling of the placenta.
(PS: Placental Surface)



Figs. 13.10A and B: Types of separation of the placenta: **(A)** Schultze method; **(B)** Mathews-Duncan method.

mostly by weight of the placenta as it descends down from the active part. The membranes so separated carry with them remnants of decidua vera giving the outer surface of the chorion its characteristic roughness.

EXPULSION OF PLACENTA: After complete separation of the placenta, it is forced down into the flabby lower uterine segment or upper part of the vagina by effective contraction and retraction of the uterus. Thereafter, it is expelled out either by voluntary contraction of abdominal muscles (bearing down efforts) or by manual procedure (p. 132).

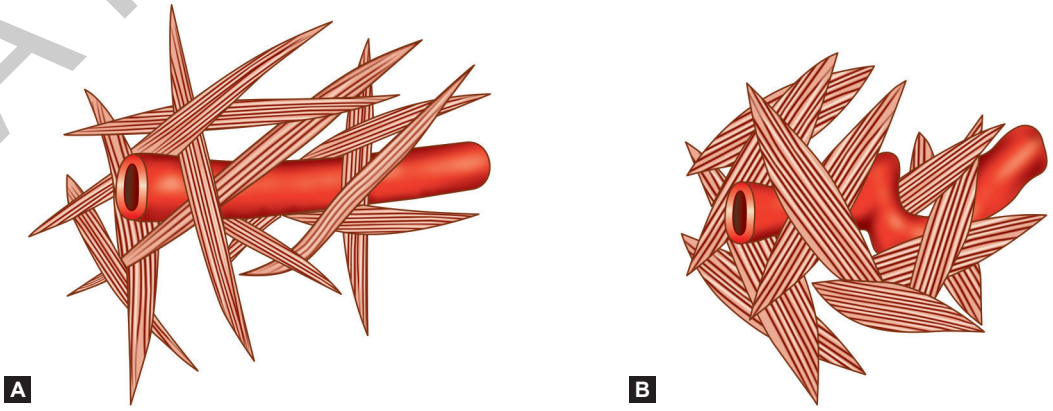
Mechanism of control of bleeding: After placental separation, innumerable torn sinuses which have free circulation of blood from uterine and ovarian vessels have to be obliterated. **The occlusion is affected by complete retraction** whereby the arterioles, as they pass tortuously through the interlacing intermediate layer of the myometrium, are literally clamped **(Figs. 13.11A and B)**. **It (living ligature) is the principal mechanism of hemostasis**. However, **thrombosis** occurs to occlude the torn sinuses, a phenomenon, which is facilitated by hypercoagulable state of pregnancy. **Apposition of the walls of the uterus** following expulsion of the placenta (myotamponade) also contributes to minimize blood loss.

MECHANISM OF NORMAL LABOR

DEFINITION: The series of movements that occur on the head in the process of adaptation during its journey through the pelvis is called mechanism of labor (Flowchart 13.2). It should be borne in mind that while the principal movements are taking place in the head, the rest of the fetal trunk is also involved in it, either participating in or initiating the movement.

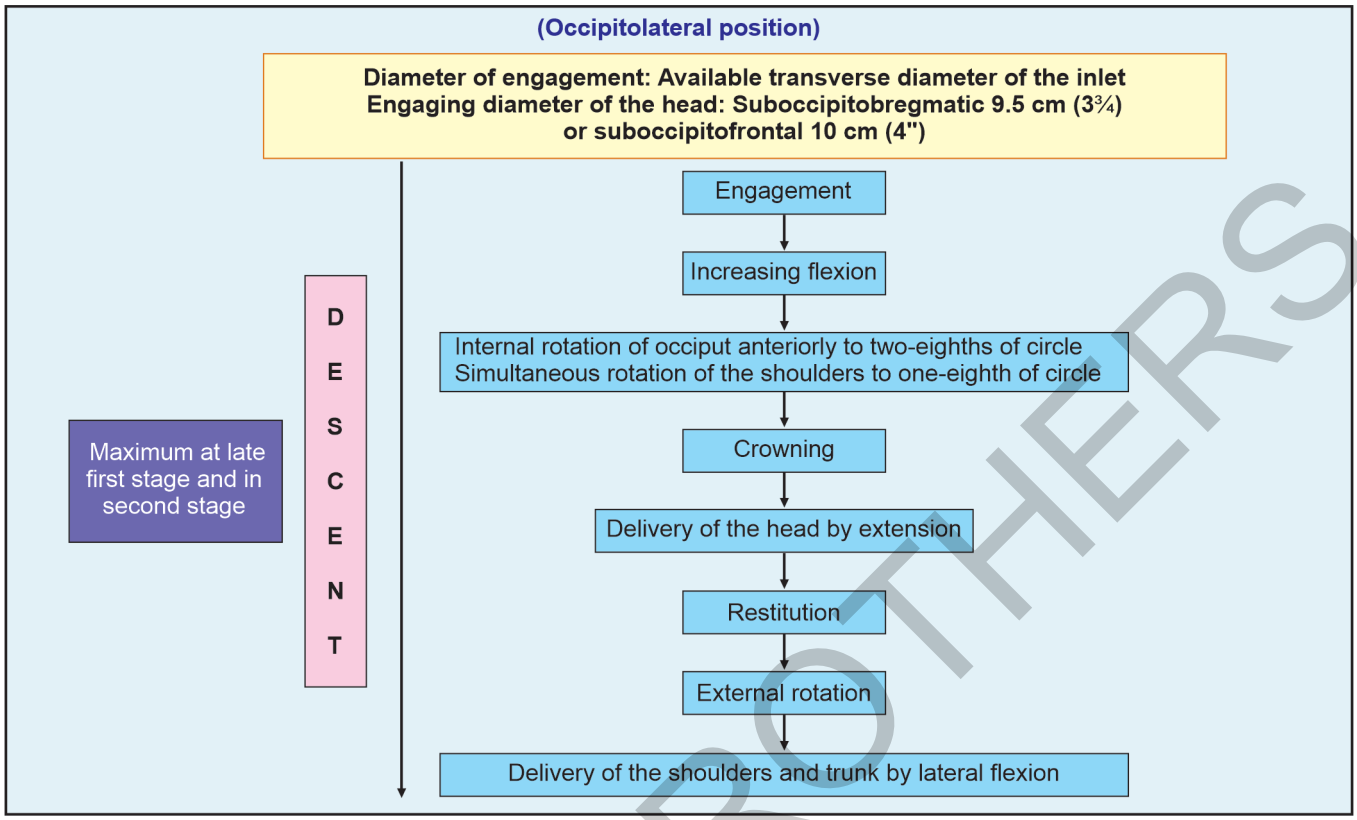
MECHANISM: In normal labor, the head enters the brim more commonly through the available transverse diameter (70%) and to a lesser extent through one of the oblique diameters. Accordingly, the position is either occipitolateral or oblique occipitoanterior. Left occipitoanterior is little more common than right occipitoanterior as the left oblique diameter is encroached by the rectum. **The engaging anteroposterior diameter** of the head is either suboccipitobregmatic 9.5 cm (3¾") or in slight deflexion—the suboccipitofrontal 10 cm (4"). **The engaging transverse diameter is biparietal 9.5 cm (3.74"). As the occipitolateral position is the most common, the mechanism of labor in such position will be described. The principal movements are: (1)** Engagement, **(2)** descent, **(3)** flexion, **(4)** internal rotation, **(5)** crowning, **(6)** extension, **(7)** restitution, **(8)** external rotation and **(9)** expulsion of the trunk. Although the various movements are described separately but in reality, the movements at least some, may be going on simultaneously.

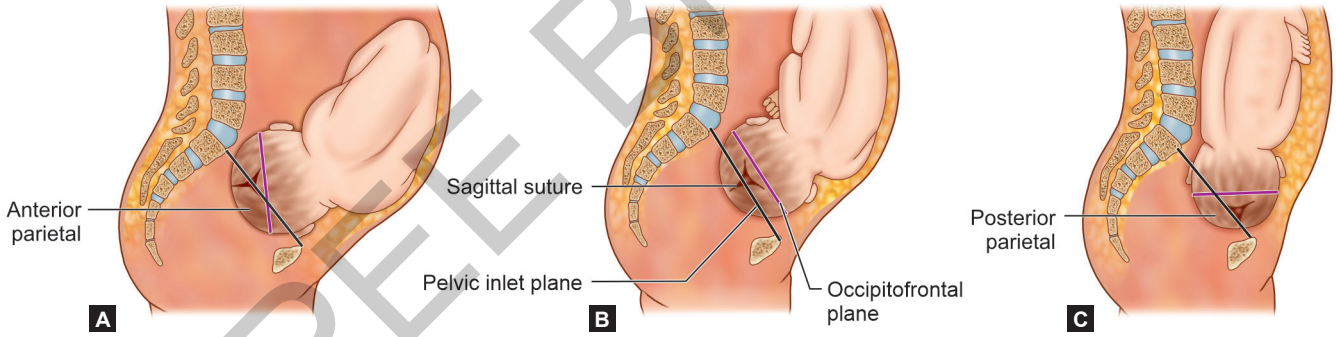
Engagement: Head brim relation prior to the engagement as revealed by imaging studies shows that due to lateral inclination of the head, the sagittal suture does not strictly correspond with the available transverse diameter of the inlet. Instead, it is either deflected anteriorly toward the symphysis pubis or posteriorly toward the sacral promontory **(Figs. 13.12A to C)**. Such deflection of the head in relation to the pelvis is called **asynclitism**.



Figs. 13.11A and B: Blood vessels: **(A)** Running through the interlacing muscle fibers; **(B)** Literally clamped due to effective retraction of the uterine muscles.

Flowchart 13.2: Summary of mechanism of labor.





Figs. 13.12A to C: Head brim relation prior to engagement: **(A)** Anterior parietal presentation; **(B)** Head in synclitism; **(C)** Posterior parietal presentation.

Box 13.1: Advantages of asynclitism.

- Engagement of head with asynclitism, the two parietal eminences cross the brim one at a time. This helps lesser diameter (super subparietal: 8.5 cm), to cross the pelvic brim instead of larger biparietal diameter (9.5 cm) for engagement in synclitism.
- Asynclitism is beneficial in the mechanism of engagement of head.
- Marked and persistent asynclitism is abnormal and indicates cephalopelvic disproportion.

When the sagittal suture lies anteriorly, the posterior parietal bone becomes the leading presenting part and is called **posterior asynclitism or posterior parietal presentation (Lizman obliquity)**. This is more frequently found in primigravidae because of good uterine tone and a tight abdominal wall.

In others, the sagittal suture lies more posteriorly with the result that the anterior parietal bone becomes the leading presenting part and is then called **anterior parietal presentation or anterior asynclitism (Negele's obliquity)**. It is more commonly found in multiparae.

Mild degrees of asynclitism are common but severe degrees indicate cephalopelvic disproportion (Box 13.1).

Posterior lateral flexion of the head occurs to glide the anterior parietal bone past the symphysis pubis in posterior parietal presentation. Lateral flexion in the reverse direction occurs to glide the posterior parietal

bone past the sacral promontory in anterior parietal presentation. **After this movement which occurs early in labor, not only the head enters the brim but also synclitism occurs**. However, in about 25% of cases, the head enters the brim in synclitism, i.e., the sagittal suture corresponds to the diameter of engagement.

In primigravidae, engagement occurs in a significant number of cases before the onset of labor **while in multiparae**, the same may occur in late first stage with rupture of the membranes.

Descent: **Provided there is no undue bony or soft tissue obstruction, descent is a continuous process**. It is slow or insignificant in first stage but pronounced in second stage. It is completed with the expulsion of the fetus. In primigravidae, with prior engagement of the head, there is practically no descent in first stage; while in multiparae, descent starts with engagement. Head is expected to reach the pelvic floor by the time the cervix is fully dilated. **Factors facilitating descent are—(1)** uterine contraction and retraction, **(2)** bearing down efforts and **(3)** straightening of the fetal ovoid especially after rupture of the membranes.

Flexion: While some degree of flexion of the head is noticeable at the beginning of labor but complete flexion is rather uncommon. As the head meets the resistance of the birth canal during descent, full flexion is achieved. Thus, if the pelvis is adequate, **flexion is achieved either due to the resistance offered by the unfolding cervix, the walls of the pelvis or by the pelvic floor**. It has been seen that flexion precedes internal rotation or at least coincides with it. Flexion is essential for descent, since it reduces the shape and size of the plane of the advancing diameter of the head.

Flexion is explained by the two-arm lever theory— the fulcrum represented by the occipitoallantoid joint of the head, the short arm extends from the condyles to the occipital protuberance, and the long arm extends from condyles to the chin. When resistance is encountered, by ordinary law of mechanics, the short arm descends and the long arm ascends resulting in flexion of the head **(Figs. 13.13A and B)**.

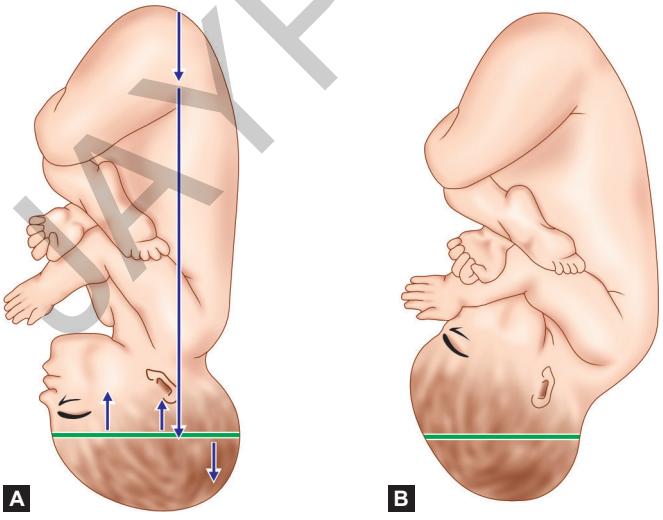
Internal rotation: It is a movement of great importance without which there will be no further descent. The mechanism of internal rotation is very complex, although easy to describe. **The theories which explain the anterior rotation of the occiput are:**

— ***Slope of pelvic floor*:** Two halves of levator ani form a gutter and viewed from above, the direction **of the fibers is backward and toward the midline**. Thus, during each contraction, the head, occiput in particular, in well-flexed position, stretches the levator ani, particularly that half which is in relation to the occiput. After the contraction passes off, elastic recoil of the levator ani occurs bringing the occiput forward toward the midline. The process is repeated until the occiput is placed anteriorly. **This is called rotation by law of pelvic floor (Hart's rule)**.

— ***Pelvic shape*:** Forward inclination of the side walls of the cavity, narrow bispinous diameter and long anteroposterior diameter of the outlet result in putting the long axis of the head to accommodate in the maximum available diameter, i.e., anteroposterior diameter of the outlet leaving behind the smallest bispinous diameter.

— ***Law of unequal flexibility (Sellheim and Moir)*:** The internal rotation is primarily due to inequalities in the flexibility of the component parts of the fetus.

In occipitolateral position, there will be anterior rotation by two-eighths of a circle of the occiput **(Fig. 13.14)** whereas in oblique anterior position, rotation will be one-eighth of a circle forward, placing the occiput behind the symphysis pubis. There is always an accompanying movement of descent with internal rotation.



Figs. 13.13A and B: Lever action producing flexion of the head reducing the engaging diameter of the head from occipitofrontal **(A)** to suboccipitobregmatic **(B)**.

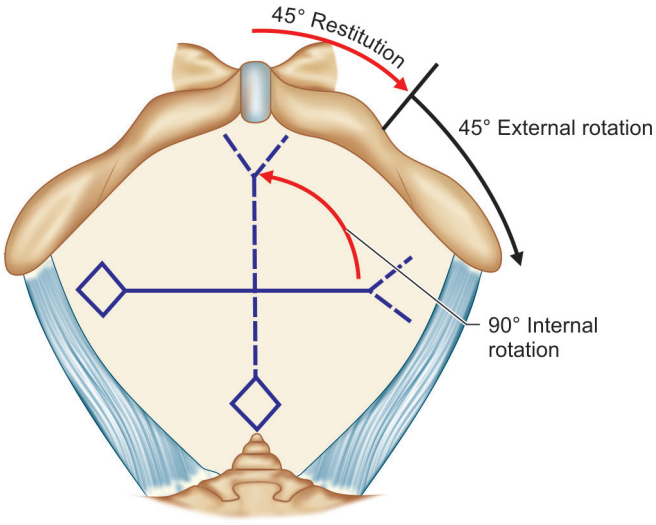


Fig. 13.14: Degree of internal rotation, restitution and external rotation of the head in left occipitolateral position.

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