CHAPTER 22: Normal Labor

It follows that some process of adaptation or accommodation of suitable portions for the head to the various pelvic planes is necessary to insure the completion of childbirth. This is brought about by certain movement of the presenting part, which belong to what is termed the mechanism of labour.

—J. Whitridge Williams (1903)

INTRODUCTION

Labor is the process that leads to childbirth. It begins with the onset of regular uterine contractions and ends with delivery of the newborn and expulsion of the placenta. Pregnancy and birth are physiological processes, and thus, labor and delivery should be considered normal for most women.

MECHANISMS OF LABOR

Pelvic Floor Changes

Many adaptive changes are required for pregnancy and for labor and delivery. According to Nygaard (2015), vaginal delivery is a traumatic event. To assess this in part, Staer-Jensen and colleagues (2015) obtained transperineal sonographic measurements of the pelvic floor muscles at 21 weeks' and 37 weeks' gestation, and again at 6 weeks, 6 months, and 12 months postpartum. In 300 nulliparas, they measured bladder neck mobility and the area within the urogenital hiatus during Valsalva. This hiatus is the U-shaped opening in the pelvic floor muscles through which the urethra, vagina, and rectum pass (Chap. 2, Perineum). In this study, the levator hiatus area was significantly larger at 37 weeks' gestation and at 6 weeks postpartum compared with earlier pregnancy. Then, by 6 months postpartum, the hiatus had improved and narrowed to return to an area comparable to that at 21 weeks' gestation. However, no further improvement was noted by 12 months postpartum. Of note, hiatal area enlargement was only seen in those who delivered vaginally.

These findings demonstrate antepartum changes in pelvic floor structure that may reflect adaptations needed to permit vaginal delivery (Nygaard, 2015). Additional pelvic floor changes are discussed in Chapter 4 (Fallopian Tubes), and the contributions of pregnancy and delivery to later pelvic organ prolapse and incontinence are described in Chapter 30 (Cesarean Delivery Risks).

Fetal Lie

At the onset of labor, the position of the fetus with respect to the birth canal is critical to the route of delivery and thus should be determined in early labor. Important relationships include fetal lie, presentation, attitude, and position.

Fetal lie describes the relationship of the fetal long axis to that of the mother. In more than 99 percent of labors at term, the fetal lie is *longitudinal.* A *transverse lie* is less frequent, and predisposing factors include multiparity, placenta previa, hydramnios, and uterine anomalies (Chap. 23, Brow Presentation). Occasionally, the fetal and maternal axes may cross at a 45-degree angle, forming an *oblique lie.* This is unstable and becomes longitudinal or transverse during labor.

Fetal Presentation

The presenting part is the portion of the fetal body that is either foremost within the birth canal or in closest proximity to it. It typically can be felt through the cervix during vaginal examination. Accordingly, in longitudinal lies, the presenting part is either the fetal head or the breech, creating *cephalic* and *breech presentations*, respectively. When the fetus lies with the long axis transversely, the *shoulder* is the presenting part. Table 22-1

describes the incidences of these various presentations.

TABLE 22-1

Fetal Presentation in 68,097 Singleton Pregnancies at Parkland Hospital

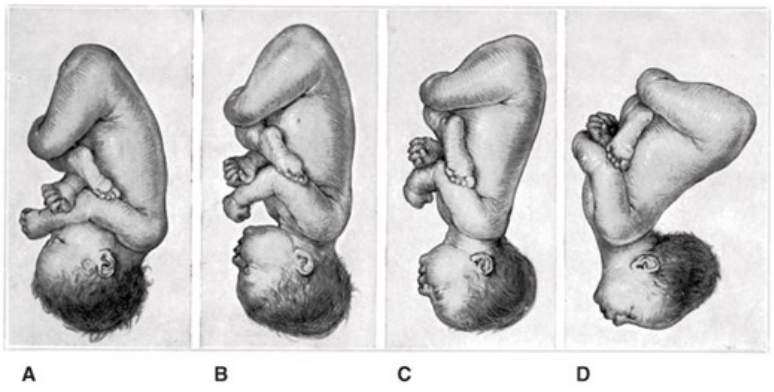
Presentation	Percent	Incidence
Cephalic	96.8	—
Breech	2.7	1:36
Transverse lie	0.3	1:335
Compound	0.1	1:1000
Face	0.05	1:2000
Brow	0.01	1:10,000

Cephalic Presentation

These presentations are classified according to the relationship between the head and body of the fetus (Fig. 22-1). Ordinarily, the head is flexed sharply so that the chin contacts the thorax. The occipital fontanel is the presenting part, and this presentation is referred to as a *vertex* or *occiput presentation.* Much less often, the fetal neck may be sharply extended so that the occiput and back come into contact, and the face is foremost in the birth canal—*face presentation.* The fetal head may assume a position between these extremes. When the neck is only partly flexed, the anterior (large) fontanel may present—*sinciput presentation.* When the neck is only partially extended, the brow may emerge—*brow presentation.* These latter two are usually transient. As labor progresses, sinciput and brow presentations almost always convert into vertex or face presentations by neck flexion or extension, respectively. Failure to do so can lead to dystocia, discussed in Chapter 23 (Brow Presentation).

FIGURE 22-1

Longitudinal lie. Cephalic presentation. Differences in attitude of the fetal body in **(A)** vertex, **(B)** sinciput, **(C)** brow, and **(D)** face presentations. Note changes in fetal attitude in relation to fetal vertex as the fetal head becomes less flexed.



The term fetus usually presents with the vertex, most logically because the uterus is piriform or pear shaped. Although the fetal head at term is slightly larger than the breech, the entire *podalic pole* of the fetus—that is, the breech and extremities—is bulkier and more mobile than the cephalic pole. The *cephalic pole* is composed of the fetal head only. Until approximately 32 weeks, the amniotic cavity is large compared with the fetal mass, and the fetus

is not crowded by the uterine walls. Subsequently, however, the ratio of amnionic fluid volume declines relative to the growing fetal mass. As a result, the uterine walls are apposed more closely to the fetal parts. The fetus orients its polarity to make use of the roomier fundus for its bulkier and more mobile podalic pole. The high incidence of breech presentation in hydrocephalic fetuses is in accord with this theory, as the larger fetal cephalic pole requires more room than its podalic pole.

Breech Presentation

The incidence of breech presentation drops with gestational age and approximates 3 percent at term.

When the fetus presents breech, the three general configurations are *frank, complete,* and *footling presentations,* described in Chapter 28 (Classification of Breech Presentations). Breech presentation may result from circumstances that prevent normal version from taking place. One example is a septum that protrudes into the uterine cavity (Chap. 3, Diethylstilbestrol Reproductive Tract Abnormalities (Class VII)). Variances of fetal attitude, particularly extension of the vertebral column as seen in frank breeches, also may prevent the fetus from turning. If the placenta is implanted in the lower uterine segment, it may distort normal intrauterine anatomy and result in a breech presentation.

Fetal Attitude

In the later months of pregnancy, the fetus assumes a characteristic posture described as attitude or habitus (see Fig. 22-1). As a rule, the fetus forms an ovoid mass that corresponds roughly to the shape of the uterine cavity. The fetus becomes folded upon itself to create a convex back. The head is sharply flexed; the chin is almost in contact with the chest; the thighs are flexed over the abdomen; and the legs are bent at the knees. In all cephalic presentations, the arms usually lie across the thorax or parallel to the sides. The umbilical cord fills the space between the extremities. This characteristic posture results from the mode of fetal growth and its accommodation to the uterine cavity.

Abnormal exceptions to this attitude occur as the fetal head becomes progressively more extended from the vertex to the face presentation. This results in a progressive change in fetal attitude from a convex (flexed) to a concave (extended) contour of the vertebral column.

Fetal Position

Position refers to the relationship of an arbitrarily chosen portion of the fetal presenting part to the right or left side of the birth canal. Accordingly, with each presentation, there may be two positions—right or left. The fetal occiput, chin (mentum), and sacrum are the determining points in vertex, face, and breech presentations, respectively (Figs. 22-2 to 22-6). Because the presenting part may be in either the left or right position, there are left and right occipital (LO and RO), left and right mental (LM and RM), and left and right sacral (LS and RS) designations.

FIGURE 22-2

Longitudinal lie. Vertex presentation. **A.** Left occiput anterior (LOA). **B.** Left occiput posterior (LOP).

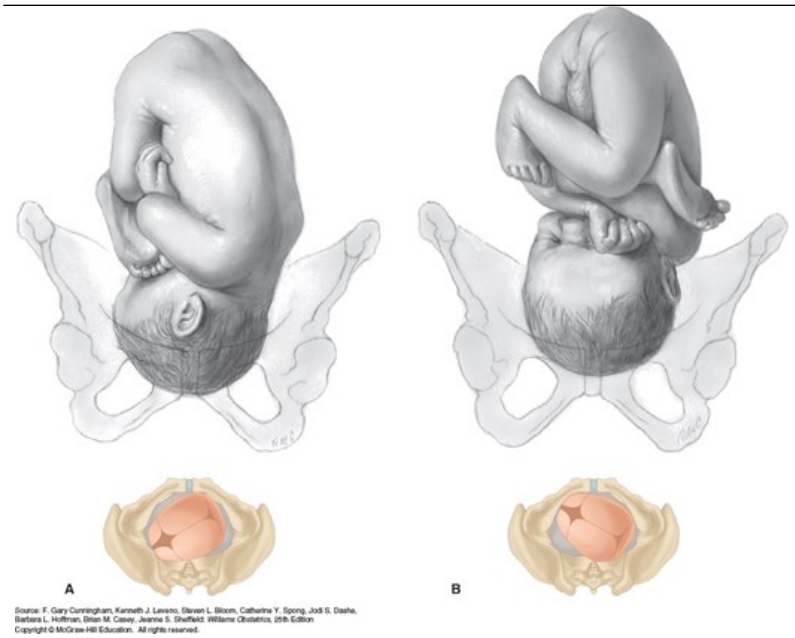


FIGURE 22-3

Longitudinal lie. Vertex presentation. **A.** Right occiput posterior (ROP). **B.** Right occiput transverse (ROT).

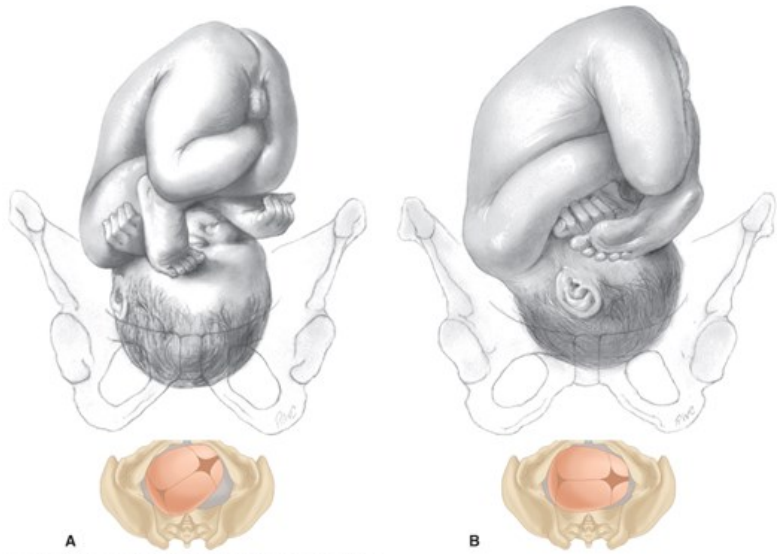


FIGURE 22-4

Longitudinal lie. Vertex presentation. Right occiput anterior (ROA).

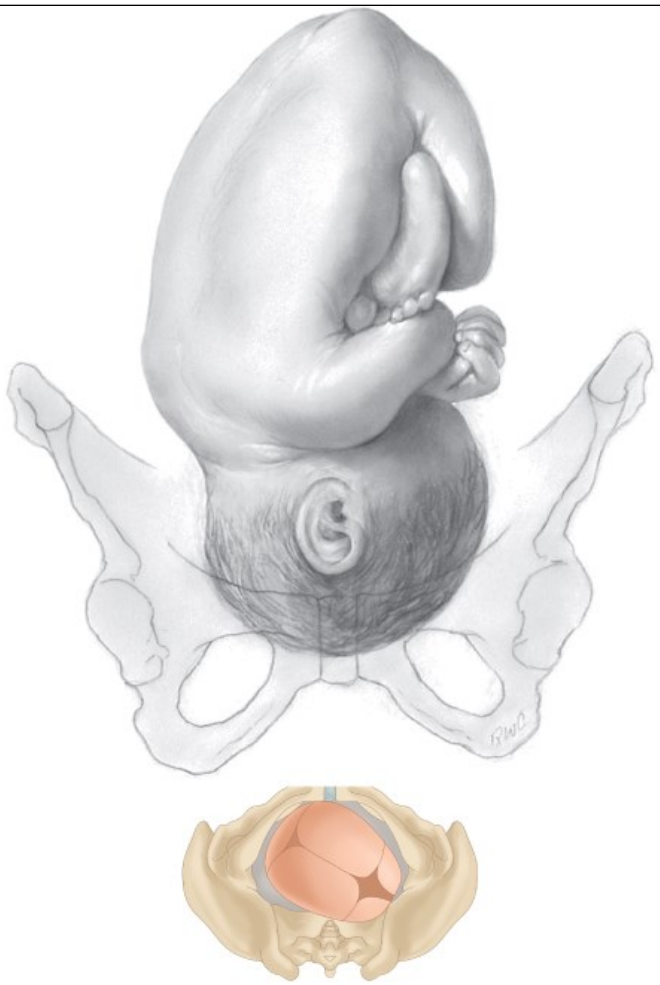


FIGURE 22-5

Longitudinal lie. Face presentation. Left and right mentum anterior and right mentum posterior positions.

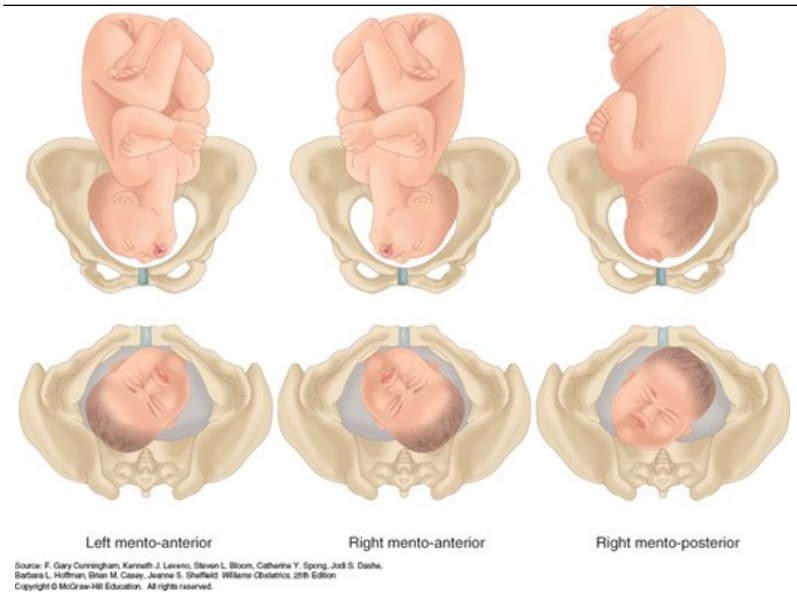
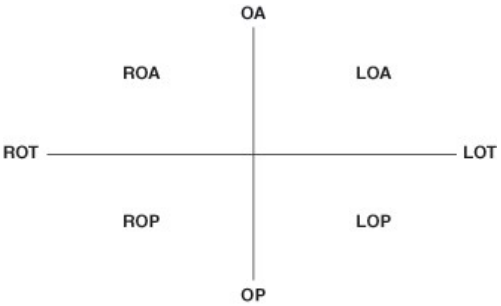


FIGURE 22-6

Longitudinal lie. Breech presentation. Left sacrum posterior (LSP).

Further, the relationship of a given portion of the presenting part to the anterior (A), transverse (T), or posterior (P) portion of the maternal pelvis is considered. As shown in Figures 22-2 to 22-6, there are six varieties of each of the three presentations. Thus, in an occiput presentation, the presentation, position, and variety may be abbreviated in clockwise fashion as:

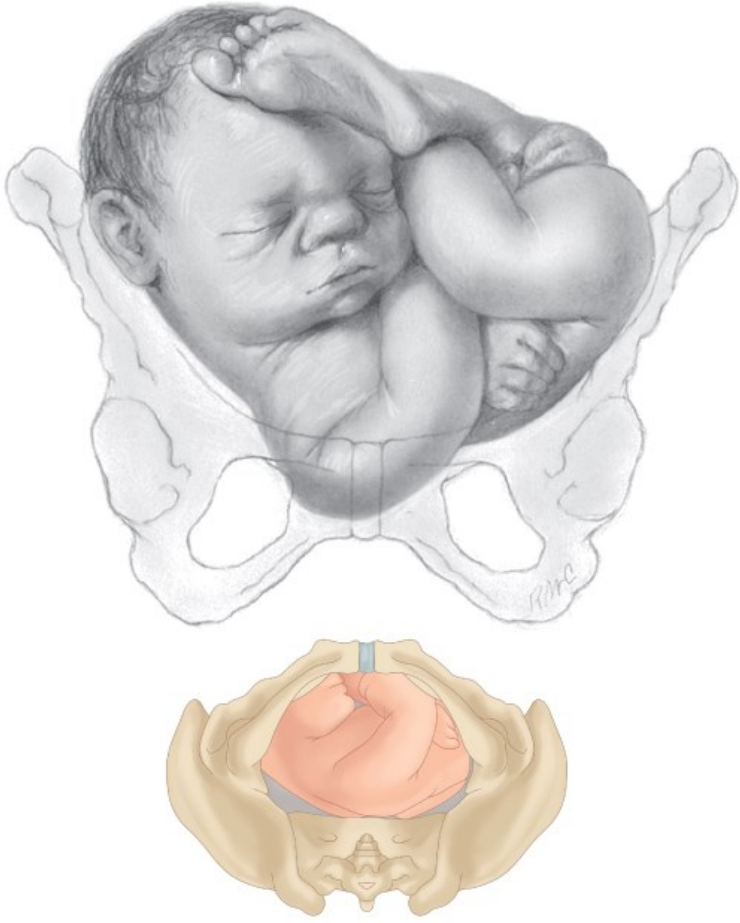


Approximately two thirds of all vertex presentations are in the left occiput position, and one third in the right.

In shoulder presentations, the acromion (scapula) is the portion of the fetus arbitrarily chosen for orientation with the maternal pelvis. One example of the terminology sometimes employed for this purpose is illustrated in Figure 22-7. The acromion or back of the fetus may be directed either posteriorly or anteriorly and superiorly or inferiorly. Because it is impossible to differentiate exactly the several varieties of shoulder presentation by clinical examination and because such specific differentiation serves no practical purpose, it is customary to refer to all transverse lies simply as *shoulder presentations.* Another term used is *transverse lie,* with *back up* or *back down*, which is clinically important when deciding incision type for cesarean delivery (Chap. 23, Etiology).

FIGURE 22-7

Transverse lie. Right acromiodorsoposterior (RADP). The shoulder of the fetus is to the mother's right, and the back is posterior.



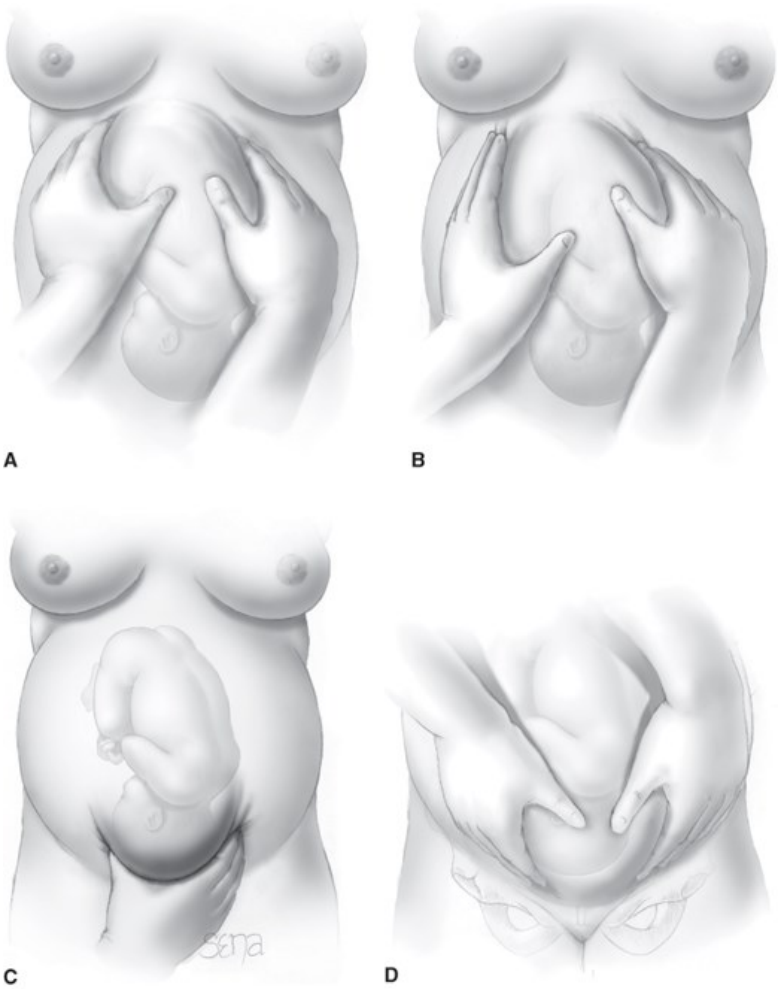
Diagnosis

Leopold Maneuvers

Several methods can be used to diagnose fetal presentation and position. Abdominal examination can be conducted systematically employing the four maneuvers described by Leopold in 1894 and shown in Figure 22-8. The mother lies supine and comfortably positioned with her abdomen bared. These maneuvers may be difficult if not impossible to perform and interpret if the patient is obese, if amnionic fluid volume is excessive, or if the placenta is anteriorly implanted.

FIGURE 22-8

Leopold maneuvers **(A–D)** performed in fetus with a longitudinal lie in the left occiput anterior position (LOA).



The first maneuver assesses the uterine fundus. It permits identification of fetal lie and determination of which fetal pole—that is, cephalic or podalic—occupies the fundus. The breech gives the sensation of a large, nodular mass, whereas the head feels hard and round and is more mobile.

The second maneuver is accomplished as the palms are placed on either side of the maternal abdomen, and gentle but deep pressure is exerted. On one side, a hard, resistant structure is felt—the back. On the other, numerous small, irregular, mobile parts are felt—the fetal extremities. By noting whether the back is directed anteriorly, transversely, or posteriorly, fetal orientation can be determined.

The third maneuver aids confirmation of fetal presentation. The thumb and fingers of one hand grasp the lower portion of the maternal abdomen just above the symphysis pubis. If the presenting part is not engaged, a movable mass will be felt, usually the head. The differentiation between head and

breech is made as in the first maneuver.

The fourth maneuver helps determine the degree of descent. The examiner faces the mother's feet, and the fingertips of both hands are positioned on either side of the presenting part. They exert inward pressure and then slide caudad along the axis of the pelvic inlet. In many instances, when the head has descended into the pelvis, the anterior shoulder or the space created by the neck may be differentiated readily from the hard head.

Abdominal palpation can be performed throughout the latter months of pregnancy and during and between the contractions of labor. At least in the past, according to Lydon-Rochelle and colleagues (1993), experienced clinicians have accurately identified fetal malpresentation using Leopold maneuvers with a high sensitivity—88 percent, specificity—94 percent, positive-predictive value—74 percent, and negative-predictive value—97 percent. With experience, it is possible to estimate the size of the fetus with these maneuvers (Field, 1995). However, and especially with an obese woman, estimates by palpation and actual birth weights often correlate poorly (Fox, 2009; Goetzinger, 2014; Noumi, 2005).

Vaginal Examination

Before labor, the diagnosis of fetal presentation and position by vaginal examination is often inconclusive because the presenting part must be palpated through a closed cervix and lower uterine segment. With the onset of labor and after cervical dilation, vertex presentations and their positions are recognized by palpation of the various fetal sutures and fontanels. Face and breech presentations are identified by palpation of facial features or the fetal sacrum and perineum, respectively. During this vaginal examination, it is advisable to pursue a definite routine, comprising four movements. First, the examiner inserts two fingers into the vagina and the presenting part is found. Differentiation of vertex, face, and breech is then accomplished readily. Second, if the vertex is presenting, the fingers are directed posteriorly and then swept forward over the fetal head toward the maternal symphysis (Fig. 22-9). During this movement, the fingers necessarily cross the sagittal suture, and its linear course is delineated. Next, the positions of the two fontanels, found at either end of the sagittal suture, are ascertained. For this, fingers are passed to the most anterior extension of the sagittal suture, and the fontanel encountered there is examined and identified. Then, the fingers pass along the suture to the other end of the head until the other fontanel is felt and differentiated (Fig. 22-10). Last, the station, or extent to which the presenting part has descended into the pelvis, can also be established at this time (Management of First-Stage Labor). Using these maneuvers, the various sutures and fontanels are determined (Fig. 29-1).

FIGURE 22-9

Locating the sagittal suture by vaginal examination.

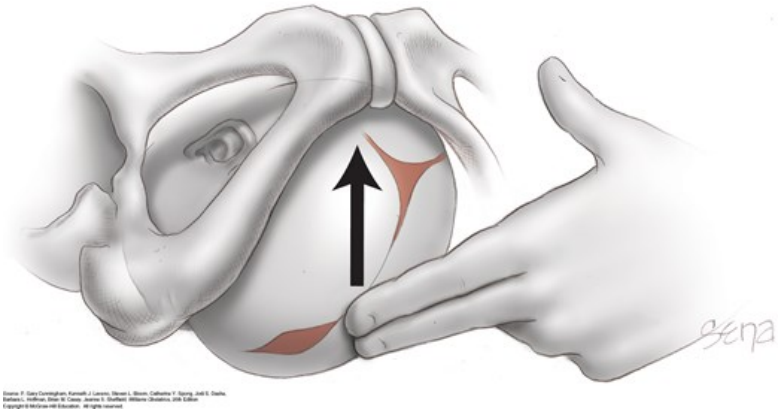
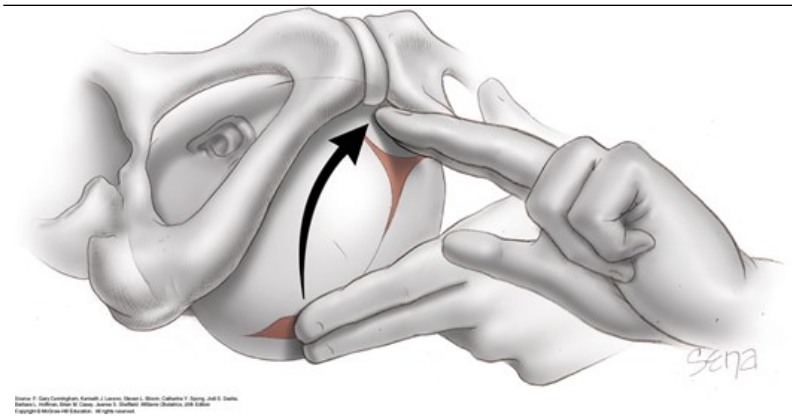


FIGURE 22-10

Differentiating the fontanels by vaginal examination.



Sonography and Radiography

Sonographic techniques can aid fetal position identification, especially in obese women or in women with muscular abdominal walls. Compared with digital examinations, sonography for fetal head position determination during second-stage labor is more accurate (Ramphul, 2014; Wiafe, 2016).

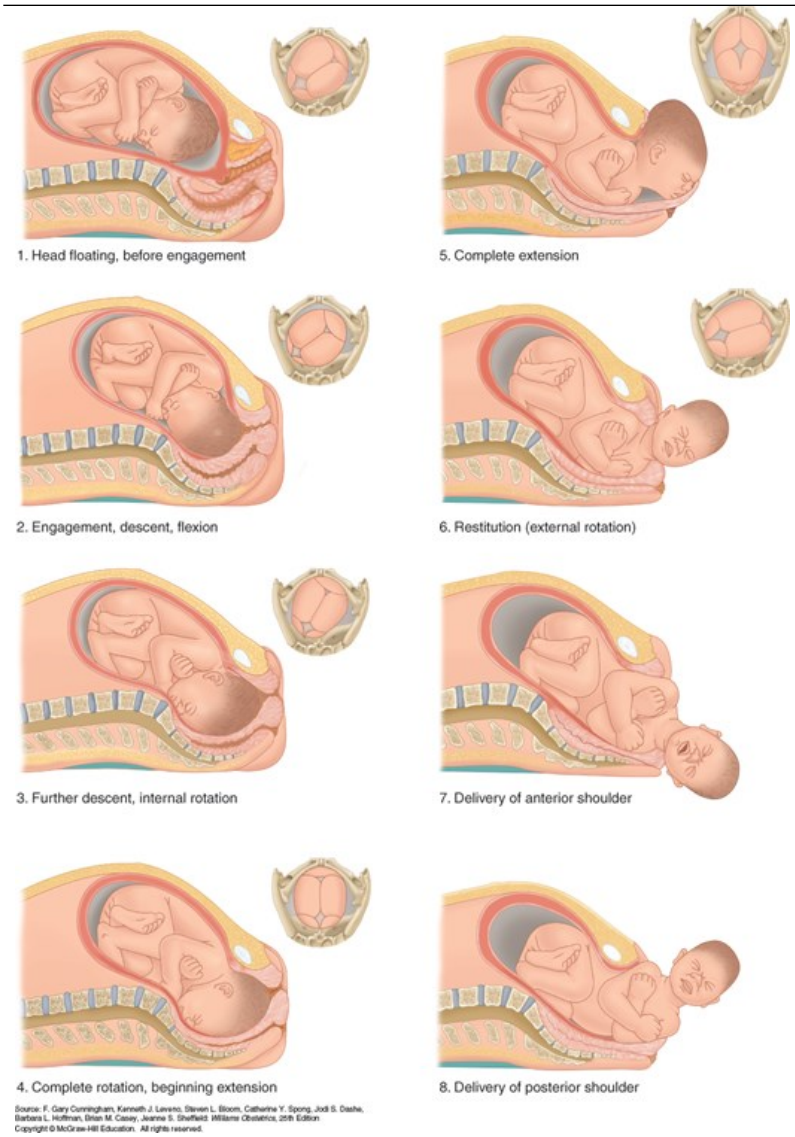
Occiput Anterior Presentation

In most cases, the vertex enters the pelvis with the sagittal suture lying in the transverse pelvic diameter. The fetus enters the pelvis in the *left occiput transverse (LOT)* position more commonly than *right occiput transverse (ROT)* position (Caldwell, 1934). In *occiput anterior positions—LOA* or *ROA* —either the head enters the pelvis with the occiput rotated 45 degrees anteriorly from the transverse position, or this rotation occurs subsequently. The mechanism of labor in all these presentations is usually similar.

The positional changes of the presenting part required to navigate the pelvic canal constitute the *mechanisms of labor.* The *cardinal movements of labor* are engagement, descent, flexion, internal rotation, extension, external rotation, and expulsion (Fig. 22-11). During labor, these movements not only are sequential but also show great temporal overlap. For example, as part of engagement, there is both flexion and descent of the head. It is impossible for the movements to be completed unless the presenting part descends simultaneously. Concomitantly, uterine contractions effect important modifications in fetal attitude, or habitus, especially after the head has descended into the pelvis. These changes consist principally of fetal straightening, with loss of dorsal convexity and closer application of the extremities to the body. As a result, the fetal ovoid is transformed into a cylinder, with the smallest possible cross section typically passing through the birth canal.

FIGURE 22-11

Cardinal movements of labor and delivery from a left occiput anterior position.



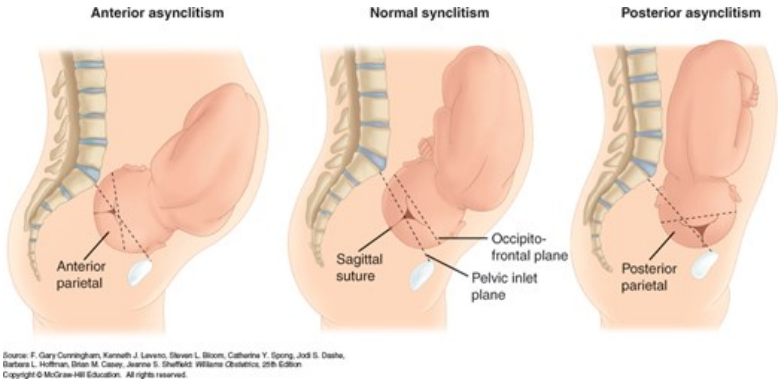
Engagement

The mechanism by which the biparietal diameter—the greatest transverse diameter in an occiput presentation—passes through the pelvic inlet is designated *engagement.* The fetal head may engage during the last few weeks of pregnancy or not until after labor commencement. In many multiparas and some nulliparas, the fetal head is freely movable above the pelvic inlet at labor onset. In this circumstance, the head is sometimes referred to as “floating.” A normal-sized head usually does not engage with its sagittal suture directed anteroposteriorly. Instead, as discussed, the fetal head usually enters the pelvic inlet either transversely or obliquely. Segel and coworkers (2012) analyzed labor in 5341 nulliparous women and found that fetal head engagement before labor onset did not affect vaginal delivery rates in either spontaneous or induced labor.

The fetal head tends to accommodate to the transverse axis of the pelvic inlet, whereas the sagittal suture, while remaining parallel to that axis, may not lie exactly midway between the symphysis and the sacral promontory. The sagittal suture frequently is deflected either posteriorly toward the promontory or anteriorly toward the symphysis (Fig. 22-12). Such lateral deflection to a more anterior or posterior position in the pelvis is called *asynclitism.* If the sagittal suture approaches the sacral promontory, more of the anterior parietal bone presents itself to the examining fingers, and the condition is called *anterior asynclitism.* If, however, the sagittal suture lies close to the symphysis, more of the posterior parietal bone will present, and the condition is called *posterior asynclitism.* With extreme posterior asynclitism, the posterior ear may be easily palpated.

FIGURE 22-12

Synclitism and asynclitism.



Source: F. Gary Cunningham, Kenneth J. Leveno, Steven L. Bloom, Catherine Y. Spong, Jodi S. Dashe, Barbara L. Hoffman, Brian M. Casey, Jeanne S. Sheffield: *Williams Obstetrics*, 25th Edition

Moderate degrees of asynclitism are the rule in normal labor. However, if severe, the condition is a common reason for cephalopelvic disproportion even with an otherwise normal-sized pelvis. Successive fetal head shifting from posterior to anterior asynclitism aids descent.

Descent

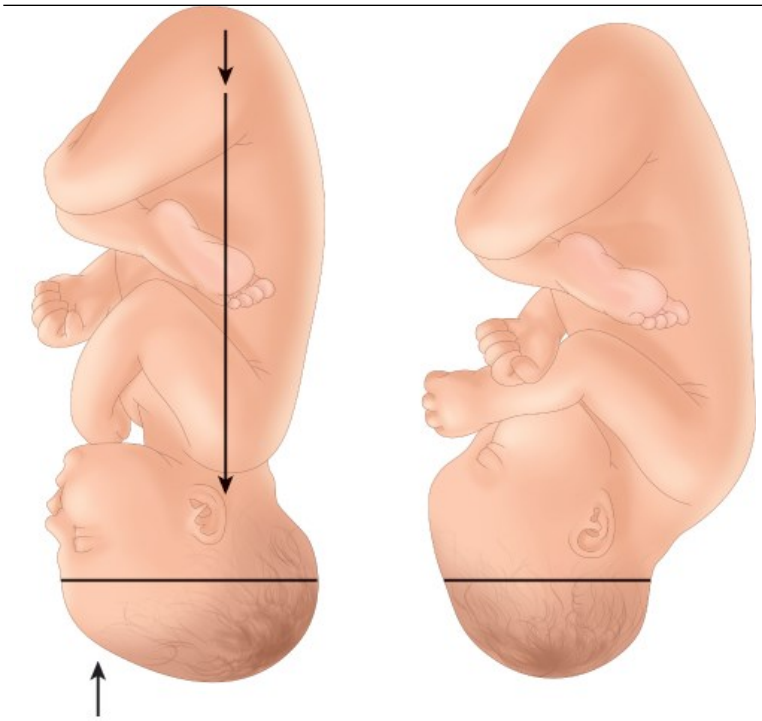
This movement is the first requisite for birth of the newborn. In nulliparas, engagement may take place before the onset of labor, and further descent may not follow until the onset of the second stage. In multiparas, descent usually begins with engagement. Descent is brought about by one or more of four forces: (1) pressure of the amnionic fluid, (2) direct pressure of the fundus upon the breech with contractions, (3) bearing-down efforts of maternal abdominal muscles, and (4) extension and straightening of the fetal body.

Flexion

As soon as the descending head meets resistance, whether from the cervix, pelvic walls, or pelvic floor, it normally flexes. With this movement, the chin is brought into more intimate contact with the fetal thorax, and the appreciably shorter suboccipitobregmatic diameter is substituted for the longer occipitofrontal diameter (Fig. 22-13).

FIGURE 22-13

Lever action produces flexion of the head. Conversion from occipitofrontal (*left*) to suboccipitobregmatic (*right*) diameter typically reduces the anteroposterior diameter from nearly 12 to 9.5 cm.



Source: F. Gary Cunningham, Kenneth J. Leveno, Steven L. Bloom, Catherine Y. Spong, Jodi S. Dashe, Barbara L. Hoffman, Brian M. Casey, Jeanne S. Sheffield: *Williams Obstetrics*, 25th Edition

Internal Rotation

This movement turns the occiput gradually away from the transverse axis. Usually the occiput rotates anteriorly toward the symphysis pubis, but less commonly, it may rotate posteriorly toward the hollow of the sacrum (Figs. 22-14 and 22-15). Internal rotation is essential for completion of labor, except when the fetus is unusually small.

FIGURE 22-14

Mechanism of labor for the left occiput transverse position, lateral view. **A.** Engagement with posterior asynclitism at the pelvic brim. During descent, the sagittal suture is then deflected toward the sacrum. **B.** This leads to anterior asynclitism. **C.** Internal rotation and descent. **D.** Further internal rotation and descent with extension of the neck.

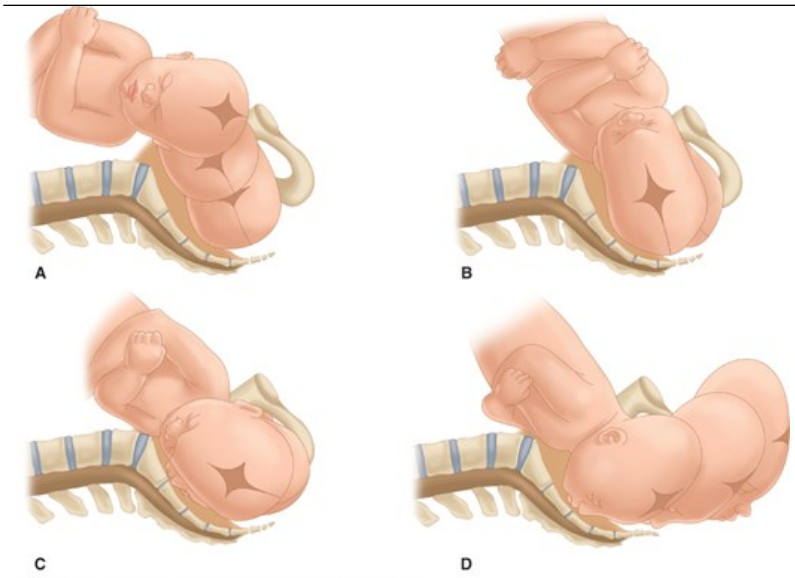
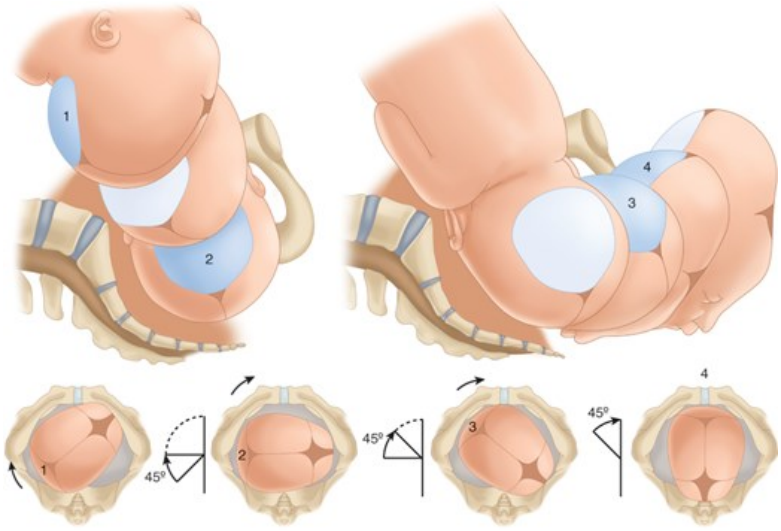


FIGURE 22-15

Mechanism of labor for right occiput posterior position showing anterior rotation.



Calkins (1939) studied more than 5000 women in labor to ascertain the time of internal rotation. He concluded that in approximately two thirds, internal rotation is completed by the time the head reaches the pelvic floor; in about another fourth, internal rotation is completed shortly after the head reaches the pelvic floor; and in the remaining 5 percent, rotation does not take place. When the head fails to turn until reaching the pelvic floor, it typically rotates during the next one or two contractions in multiparas. In nulliparas, rotation usually occurs during the next three to five contractions.

Extension

After internal rotation, the sharply flexed head reaches the vulva and undergoes extension. If the sharply flexed head, on reaching the pelvic floor, did not extend but was driven farther downward, it would impinge on the posterior portion of the perineum and would eventually be forced through the perineal tissues. When the head presses on the pelvic floor, however, two forces come into play. The first force, exerted by the uterus, acts more posteriorly, and the second, supplied by the resistant pelvic floor and the symphysis, acts more anteriorly. The resultant vector is in the direction of the vulvar opening, thereby causing head extension. This brings the base of the occiput into direct contact with the inferior margin of the symphysis pubis

(see Fig. 22-14).

With progressive distention of the perineum and vaginal opening, an increasingly large portion of the occiput gradually appears. The head is born as the occiput, bregma, forehead, nose, mouth, and finally the chin pass successively over the anterior margin of the perineum. Immediately after its delivery, the head drops downward so that the chin lies over the maternal anus.

External Rotation

The delivered head next undergoes *restitution* (see Fig. 22-11). If the occiput was originally directed toward the left, it rotates toward the left ischial tuberosity. If it was originally directed toward the right, the occiput rotates to the right. Restitution of the head to the oblique position is followed by external rotation completion to again reach a transverse position. This movement corresponds to rotation of the fetal body and serves to bring its bisacromial diameter into relation with the anteroposterior diameter of the pelvic outlet. Thus, one shoulder is anterior behind the symphysis and the other is posterior. This movement apparently is brought about by the same pelvic factors that produced internal rotation of the head.

Expulsion

Almost immediately after external rotation, the anterior shoulder appears under the symphysis pubis, and the perineum soon becomes distended by the posterior shoulder. After delivery of the shoulders, the rest of the body quickly passes. When the anterior shoulder is tightly wedged beneath the symphysis, then *shoulder dystocia* is diagnosed, which is described in Chapter 27 (Shoulder Dystocia).

Occiput Posterior Presentation

In approximately 20 percent of labors, the fetus enters the pelvis in an *occiput posterior (OP)* position (Caldwell, 1934). The right occiput posterior (ROP) is slightly more common than the left (LOP). It appears likely from radiographic evidence that posterior positions are more often associated with a narrow forepelvis. They also are more commonly seen in association with anterior placentation (Gardberg, 1994a).

In most occiput posterior presentations, the mechanism of labor is identical to that observed in the transverse and anterior varieties, except that the occiput has to internally rotate to the symphysis pubis through 135 degrees, instead of 90 and 45 degrees, respectively (see Fig. 22-15).

Effective contractions, adequate head flexion, and average fetal size together permit most posteriorly positioned occiputs to rotate promptly as soon as they reach the pelvic floor, and labor is not lengthened appreciably. In perhaps 5 to 10 percent of cases, however, rotation may be incomplete or may not take place at all, especially if the fetus is large (Gardberg, 1994b). Poor contractions, faulty head flexion, or epidural analgesia, which diminishes abdominal muscular pushing and relaxes pelvic floor muscles, may predispose to incomplete rotation. If rotation is incomplete, *transverse arrest* may result. If no rotation toward the symphysis takes place, the occiput may remain in the direct occiput posterior position, a condition known as *persistent occiput posterior.* Both can lead to dystocia and cesarean delivery. Techniques to manually rotate from OP to OA positions are illustrated in Chapter 29 (Occiput Posterior Positions).

Fetal Head Shape Changes

In vertex presentations, labor forces alter fetal head shape. In prolonged labors before complete cervical dilation, the portion of the fetal scalp immediately over the cervical os becomes edematous. This swelling is known as the *caput succedaneum* (Fig. 22-16). It usually attains a thickness of only a few millimeters, but in prolonged labors it may be sufficiently extensive to prevent differentiation of the various sutures and fontanels. More commonly, the caput is formed when the head is in the lower portion of the birth canal and frequently only after the resistance of a rigid vaginal outlet is encountered. Because it develops over the most dependent area of the head, one may deduce the original fetal head position by noting the location of the caput succedaneum.

FIGURE 22-16

Considerable molding of the head and caput succedaneum formation in a recently delivered newborn.

Molding refers to changes in the bony fetal head shape as a result of external compressive forces (see Fig. 22-16). Possibly related to Braxton Hicks contractions, some molding develops before labor. Most studies indicate that there is seldom overlapping of the parietal bones. A "locking" mechanism at the coronal and lambdoidal sutures actually prevents such overlapping (Carlan, 1991). Molding results in a shortened suboccipitobregmatic diameter and a lengthened mentovertical diameter. These changes are of greatest importance in women with contracted pelves or asynclitic presentations. In these circumstances, the degree to which the head is capable of molding may make the difference between spontaneous vaginal delivery and an operative delivery. Some older literature cited severe head molding as a cause for possible cerebral trauma. Because of the multitude of associated factors, for example, prolonged labor with fetal sepsis and acidosis, it is impossible to link molding to any alleged fetal or neonatal neurological sequelae. Most cases of molding resolve within the week following delivery, although persistent cases have been described (Graham, 2006). Differentiation of molding, caput succedaneum, and *cephalohematoma* is discussed in Chapter 33 (Intracranial Hemorrhage).

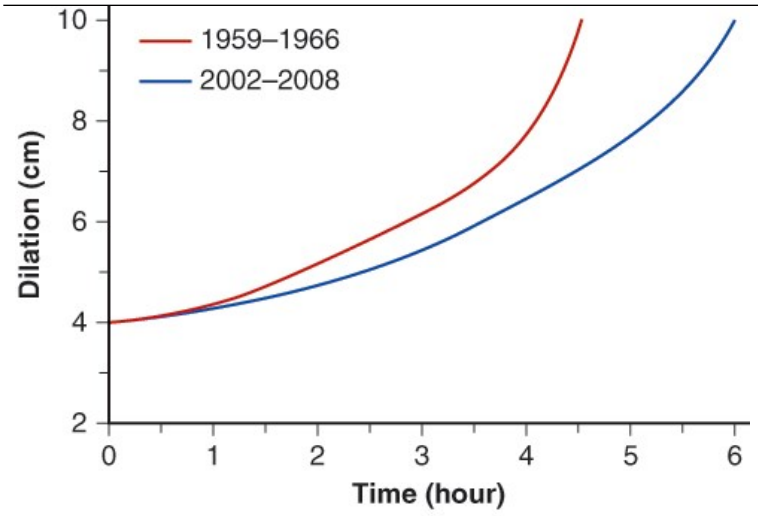
NORMAL LABOR CHARACTERISTICS

The greatest impediment to understanding normal labor is recognizing its start. The strict definition of labor is: *uterine contractions that bring about demonstrable effacement and dilation of the cervix.* This does not easily aid the clinician in determining when labor has actually begun, because this diagnosis is confirmed only retrospectively. Several methods may be used to mark its start. One defines onset as the clock time when painful contractions become regular. Unfortunately, uterine activity that causes discomfort, but that does not represent true labor, may develop at any time during pregnancy. False labor often stops spontaneously, or it may proceed rapidly into effective contractions.

A second method defines the onset of labor as beginning at the time of admission to the labor unit. In the United States, admission for labor is frequently based on the extent of cervical dilation accompanied by painful contractions. If a woman has intact membranes, then a cervical dilation of 3 to 4 cm or greater is presumed to be a reasonably reliable threshold for the diagnosis of labor. In this case, labor onset commences with the time of admission. This presumptive method obviates many of the uncertainties in diagnosing labor during earlier stages of cervical dilation. Laughon and associates (2012) compared the duration of spontaneous labor at term in nulliparas delivered in the United States between 1959 and 1966 to that of those delivered from 2002 to 2008. As shown in Figure 22-17, during those 50 years, the length of labor increased by approximately 2 hours.

FIGURE 22-17

Average labor curves for women with singleton term pregnancies presenting in spontaneous labor with vaginal delivery for nulliparas from 1959–1966 compared with those from 2002–2008. (Redrawn from Laughon SK, Branch W, Beaver J, et al: Changes in labor patterns over 50 years. Am J Obstet Gynecol 206:419.e1.9, 2012.)

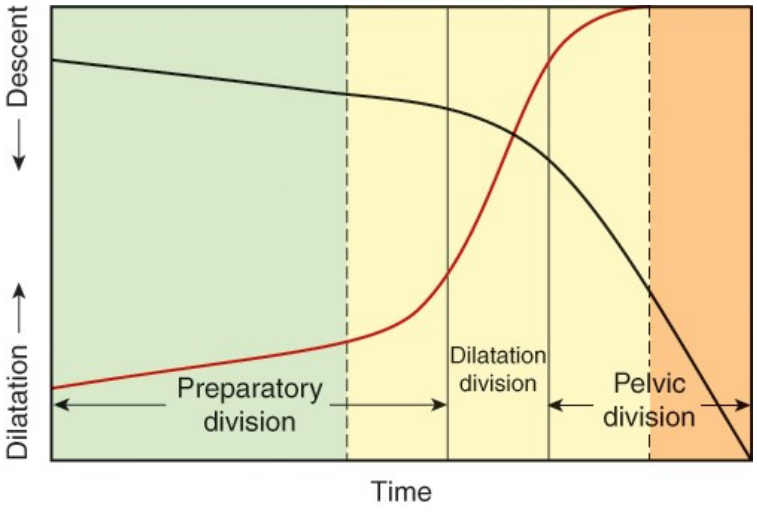


First Stage of Labor

For labor, Friedman (1954) described a characteristic sigmoid pattern by graphing cervical dilation against time. This graphical approach, which was based on statistical observations, changed labor management. Friedman developed the concept of three functional labor divisions to describe the physiological objectives of each division (Fig. 22-18). First, during the *preparatory division,* although the cervix dilates little, its connective tissue components change considerably (Chap. 21, Ancillary Forces). Sedation and conduction analgesia are capable of arresting this labor division. The *dilational division,* during which dilation proceeds at its most rapid rate, is unaffected by sedation. Last, the *pelvic division* commences with the deceleration phase of cervical dilation. The classic labor mechanisms that involve the cardinal fetal movements of the cephalic presentation take place principally during this pelvic division. In actual practice, however, the onset of the pelvic division is seldom clearly identifiable.

FIGURE 22-18

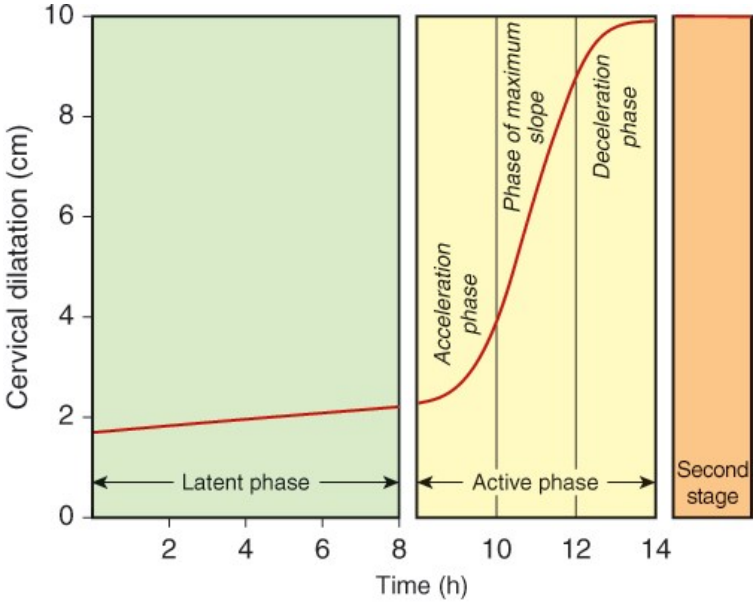
Labor course divided functionally on the basis of dilatation and descent curves into: (1) a preparatory division, including latent and acceleration phases; (2) a dilatational division, occupying the phase of maximum slope; and (3) a pelvic division, encompassing both deceleration phase and second stage concurrent with the phase of maximum slope of descent. (Redrawn from Friedman EA: Labor: Clinical Evaluation and Management, 2nd ed. New York, Appleton-Century-Crofts, 1978.)



As shown in Figure 22-18, the pattern of cervical dilation during the preparatory and dilational divisions of normal labor is a sigmoid curve. Two phases of cervical dilation are defined. The *latent phase* corresponds to the preparatory division, and the *active phase* to the dilational division. Friedman further subdivided the active phase into the *acceleration phase,* the *phase of maximum slope,* and the *deceleration phase* (Fig. 22-19).

FIGURE 22-19

Composite of the average dilatation curve for nulliparous labor. The first stage is divided into a relatively flat latent phase and a rapidly progressive active phase. In the active phase, there are three identifiable component parts that include an acceleration phase, a phase of maximum slope, and a deceleration phase. (Redrawn from Friedman EA: Labor: Clinical Evaluation and Management, 2nd ed. New York, Appleton-Century-Crofts, 1978.)



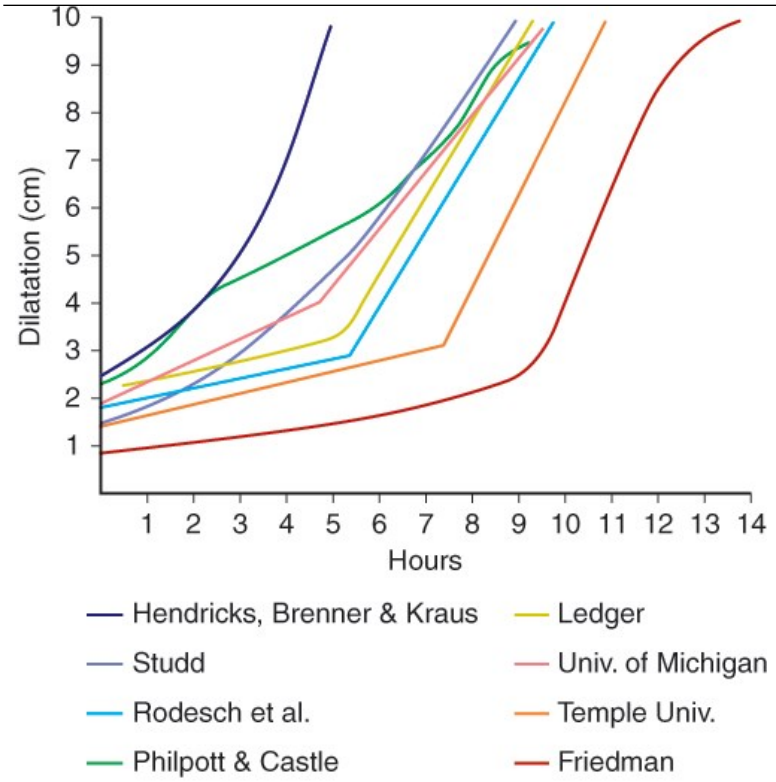
Latent Phase

The onset of latent labor, as defined by Friedman (1972), is the point at which the mother perceives regular contractions. The latent phase for most women ends once dilation of 3 to 5 cm is achieved. This threshold may be clinically useful, for it defines dilation limits beyond which active labor can be expected. More recently, a Consensus Committee of the American College of Obstetricians and Gynecologists and Society for Maternal-Fetal Medicine (2016c) has redefined active labor to begin at 6 cm. A fuller discussion of these labor changes is found in Chapter 23 (Background for the 6-cm Rule).

This concept of a latent phase has great significance in understanding normal human labor, because labor is considerably longer when a latent phase is included. To better illustrate this, Figure 22-20 shows eight labor curves from nulliparas in whom labor was diagnosed beginning with their admission, rather than with the onset of regular contractions. When labor is defined similarly, individual labor curves are remarkably comparable.

FIGURE 22-20

Progress of labor in primigravid women from the time of admission. When the starting point on the abscissa begins with admission to the hospital, a latent phase is not observed.



Source: F. Gary Cunningham, Kenneth J. Leveno, Steven L. Bloom, Catherine Y. Spong, Jodi S. Dashe, Barbara L. Hoffman, Brian M. Casey, Jeanne S. Sheffield: *Williams Obstetrics*, 25th Edition

A *prolonged latent phase* was defined by Friedman and Sachtleben (1963) as one exceeding 20 hours in the nullipara and 14 hours in the multipara. These times corresponded to the 95th percentiles. Factors that affected latent phase duration include excessive sedation or epidural analgesia; unfavorable cervical condition, that is, thick, uneffaced, or undilated; and false labor. Of women who had been administered heavy sedation, 85 percent eventually entered active labor. In another 10 percent, uterine contractions ceased, suggesting that they had false labor. The remaining 5 percent experienced persistence of an abnormal latent phase and required oxytocin stimulation. Amniotomy was discouraged because of the 10-percent incidence of false labor. Sokol and associates (1977) reported a 3- to 4- percent incidence of prolonged latent phase, regardless of parity. Friedman (1972) reported that latent phase prolongation did not adversely influence fetal or maternal morbidity or mortality rates. However, Chelmow and coworkers (1993) disputed the long-held belief that prolongation of the latent phase is benign.

Active Phase

The progress of labor in nulliparas has particular significance because these curves all reveal a rapid change in the slope of cervical dilation rates between 3 and 5 cm (see Fig. 22-20). *Thus, cervical dilation of 3 to 6 cm or more, in the presence of uterine contractions, can be taken to reliably represent the threshold for active labor.* Similarly, these curves provide useful guideposts for labor management.

Turning again to Friedman (1955), the mean duration of active-phase labor in nulliparas was 4.9 hours. But, the standard deviation of 3.4 hours is large, hence, the active phase was reported to have a statistical maximum of 11.7 hours. Indeed, rates of cervical dilation ranged from a minimum of 1.2 up to 6.8 cm/hr. Friedman (1972) also found that multiparas progress somewhat faster in active-phase labor, with a *minimum* normal rate of 1.5 cm/hr. His analysis of active-phase labor concomitantly describes rates of fetal descent and cervical dilation (see Fig. 22-18). Descent begins in the later stage of active dilation, commencing at 7 to 8 cm in nulliparas and becoming most rapid after 8 cm.

Hendricks and coworkers (1970) challenged Friedman's conclusions about the course of normal human labor. Their principal differences included: (1) absence of a latent phase, (2) no deceleration phase, (3) brevity of labor, and (4) dilation at similar rates for nulliparas and multiparas after 4 cm. They disputed the concept of a latent phase because they observed that the cervix dilated and effaced slowly during the 4 weeks preceding labor. They contended that the *latent phase* actually progressed over several weeks. They also reported that labor was relatively rapid. Specifically, the average time from admission to complete dilation was 4.8 hours for nulliparas and 3.2 hours for multiparas.

Others have reassessed the Friedman labor curves. Zhang and associates (2010) studied electronic labor records from 62,415 parturients with spontaneous labor at term and vaginal birth. For nulliparas, the median time to progress from 4 to 5 cm was 1.3 hours, from 5 to 6 cm 0.8 hours, and thereafter, additional centimeters were gained approximately each 0.5 hours. They found that normal labor may take more than 6 hours to progress from 4 to 5 cm and more than 3 hours to progress from 5 to 6 cm dilation. Rates for multiparas were similar from 4 to 6 cm. Then, labor accelerated much faster in multiparas. Data from this study form the foundation for new guidelines regarding cesarean delivery indications for labor arrest put forth in the Obstetric Care Consensus document by the American College of Obstetrics and Gynecology and Society for Maternal-Fetal Medicine (2016c) and described in Chapter 23 (Obstetric Care Consensus Committee).

In a study performed at Parkland Hospital, epidural analgesia was found to lengthen the active phase of the Friedman labor curve by 1 hour (Alexander, 2002). This increase was the result of a slight but significant decline in the rate of cervical dilation—1.4 cm/hr in women given epidural analgesia compared with 1.6 cm/hr in those without such analgesia. Several other reports also note that maternal obesity lengthens the first stages of labor by 30 to 60 minutes (Chin, 2012; Kominiarek, 2011). Finally, Adams and coworkers (2012) found that maternal fear prolonged labor by approximately 45 minutes.

Active-phase abnormalities have been reported to occur in 25 percent of nulliparous and 15 percent of multiparous labors (Sokol, 1977). Friedman (1972) subdivided active-phase problems into *protraction* and *arrest disorders*. Abnormal labor patterns, diagnostic criteria, and treatment methods are summarized in Chapter 23 (Abnormalities of the Expulsive Forces).

Second Stage of Labor

This stage begins with complete cervical dilation and ends with fetal delivery. The median duration is approximately 50 minutes for nulliparas and about 20 minutes for multiparas, but it is highly variable (Kilpatrick, 1989). In a woman of higher parity with a previously dilated vagina and perineum, two or three expulsive efforts after full cervical dilation may suffice to complete delivery. Conversely, in a woman with a contracted pelvis, with a large fetus, or with impaired expulsive efforts from conduction analgesia or sedation, the second stage may be longer. Higher maternal body mass index does not interfere with second-stage labor length (Carlhäll, 2013; Robinson, 2011). Abnormalities of this labor stage are described in Chapter 23 (Second-Stage Descent Disorders).

Labor Duration

The normal duration of labor may be clouded by the many clinical variables that affect the conduct of labor in modern obstetrical units. Kilpatrick and Laros (1989) reported that the mean length of first- and second-stage labor was approximately 9 hours in nulliparas without regional analgesia, and that the 95th percentile upper limit was 18.5 hours. Corresponding times for multiparas were a mean of 6 hours and a 95th percentile maximum of 13.5 hours. These authors defined labor onset as the time when a woman recalled regular, painful contractions every 3 to 5 minutes that led to cervical change.

Spontaneous labor was analyzed in nearly 25,000 women delivered at term at Parkland Hospital in the early 1990s. Almost 80 percent of women were admitted with a cervical dilation of 5 cm or less. Parity—nulliparous versus multiparous—and cervical dilation at admission were significant determinants of the length of spontaneous labor. The median time from admission to spontaneous delivery for all parturients was 3.5 hours, and 95 percent of all women delivered within 10.1 hours. These results suggest that normal human labor is relatively short.

Summary of Normal Labor

Labor is characterized by brevity and considerable biological variation. Active labor can be reliably diagnosed when cervical dilation is ≥3 cm in the presence of uterine contractions. Once this cervical dilation threshold is reached, normal progression to delivery can be expected, depending on parity, in the ensuing 4 to 6 hours. Anticipated progress during a 1- to 3-hour second stage is monitored to ensure fetal safety. Finally, most women in spontaneous labor, regardless of parity, if left unaided, will deliver within approximately 10 hours after admission for spontaneous labor. Insufficient uterine activity is a common and correctable cause of abnormal labor progress. *Therefore, when the length of otherwise normal labor exceeds the expected norm, interventions other than cesarean delivery—for example, oxytocin administration—must be first considered.*

MANAGEMENT OF NORMAL LABOR

The ideal management of labor and delivery requires two potentially opposing viewpoints on the part of clinicians. First, birthing should be recognized as a normal physiological process that most women experience without complications. Second, intrapartum complications, often arising quickly and unexpectedly, should be anticipated. Thus, clinicians must simultaneously make every woman and her supporters feel comfortable, yet ensure safety for the mother and newborn if complications suddenly develop. The American Academy of Pediatrics and the American College of Obstetricians and Gynecologists (2017) have collaborated in the development of *Guidelines for Perinatal Care.* These provide detailed information on the appropriate content of intrapartum care, including both personnel and facility requirements (Table 22-2).

TABLE 22-2

Recommended Nurse/Patient Ratios for Labor and Delivery

Ratio	Clinical Setting
2:1	Birth
1:2	Patients in labor without complications
1:1	Patients in second-stage labor
1:1	Patients with medical/obstetrical complications
1:1	Oxytocin induction/augmentation
1:1	During epidural analgesia initiation
1:1	Circulation for cesarean delivery

Labor and delivery outside the hospital is elected by some parturients. This option and its risks and benefits are discussed in Chapter 27 (Special Populations).

Emergency Medical Treatment and Labor Act—EMTALA

Congress enacted EMTALA in 1986 to ensure public access to emergency services regardless of the ability to pay. All Medicare-participating hospitals with emergency services must provide an appropriate screening examination for any pregnant woman experiencing contractions and presenting to the emergency department for evaluation.

The definition of an emergency condition makes specific reference to a pregnant woman who is having contractions. Labor is defined as “the process of childbirth beginning with the latent phase of labor continuing through delivery of the placenta. A woman experiencing contractions is in true labor unless a physician certifies that after a reasonable time of observation the woman is in false labor.” A woman in true labor is considered “unstable” for interhospital transfer purposes until the newborn and placenta are delivered. A stable woman may, however, be transferred at the direction of the patient or by a physician who certifies that the benefits of treatment at another facility outweigh the transfer risks. Physicians and hospitals violating these federal requirements are subject to civil penalties and termination from participation in the Medicare program.

Identification of Labor

Pregnant women are urged to report early in labor rather than to procrastinate until delivery is imminent for fear that they might be experiencing false labor. Early admittance is especially important if during antepartum care the woman, her fetus, or both are found to have risk factors for intrapartum complications.

Although the differentiation between false and true labor is difficult at times, the diagnosis usually can be clarified by contraction frequency and intensity and by cervical dilation. Pates and associates (2007) studied one commonly used recommendation given to pregnant women. Namely, in the

absence of ruptured membranes or bleeding, uterine contractions 5 minutes apart for 1 hour—that is, ≥12 contractions in 1 hour—may signify labor onset. Among 768 women in this study at Parkland Hospital, active labor defined as cervical dilation ≥4 cm was diagnosed within 24 hours in three fourths of women with ≥12 contractions per hour. Bailit and coworkers (2005) compared labor outcomes of 6121 women who presented in active labor defined as uterine contractions plus cervical dilation ≥4 cm with those of 2697 women who presented in the latent phase. Women admitted during latent-phase labor had more active-phase arrest, more frequent need for oxytocin labor stimulation, and higher rates of chorioamnionitis. It was concluded that physician interventions in women presenting in the latent phase may have been the cause of subsequent labor abnormalities.

In those instances when a diagnosis of labor cannot be established with certainty, observation for a longer period is often wise. Women who present to Parkland Hospital for labor symptoms at $24^{0/7}$ weeks' gestation or greater are routinely evaluated in a labor triage unit contiguous to our labor and delivery unit. All women in the triage area are evaluated by nurse practitioners and certified nurse midwives using written protocols. Women with uncomplicated pregnancies with intact membranes and cervical dilation <4 cm receive continuous external fetal monitoring for up to 2 hours. Women diagnosed with labor by either cervical change or persistent uterine contractions are admitted. After review by a physician, women without cervical change or with abatement of contractions return home with a diagnosis of false labor. In a recent study, a total of 3949 women with uncomplicated pregnancies between $37^{0/7}$ and $41^{6/7}$ weeks' gestation were diagnosed with false labor. The mean interval from hospital discharge to when they again presented was 4.9 days (Nelson, 2017). Within this protocol, hospital discharge with false labor at term was not associated with higher rates of adverse neonatal outcomes or cesarean delivery. The American College of Obstetricians and Gynecologists (2016a) has endorsed hospital-based obstetrical triage units.

Initial Evaluation

Maternal blood pressure, temperature, pulse, and respiratory rate are recorded. Fetal heart rate is evaluated using a portable Doppler device, sonography, or fetoscope. The pregnancy record is promptly reviewed to identify complications. Problems identified or anticipated during prenatal care should be displayed prominently in the pregnancy record. Most often, *unless there has been bleeding in excess of bloody show,* a cervical examination is performed. The gloved index and second fingers are introduced into the vagina while avoiding the anal region.

Ruptured Membranes

During prenatal care, the woman is instructed to be aware of fluid leakage from the vagina and to report such an event promptly. Rupture of the membranes is significant for three reasons. First, if the presenting part is not fixed in the pelvis, the umbilical cord can prolapse and be compressed. Second, labor is likely to begin soon if the pregnancy is at or near term. Third, if delivery is delayed after membrane rupture, intrauterine and neonatal infection is more likely as the time interval increases (Herbst, 2007).

During sterile speculum examination, ruptured membranes are diagnosed if amnionic fluid pools in the posterior fornix or clear fluid flows from the cervical canal. Although several diagnostic tests for the detection of ruptured membranes have been recommended, none is completely reliable. If the diagnosis remains uncertain, another method involves pH determination of vaginal fluid. The pH of vaginal secretions normally ranges from 4.5 to 5.5, whereas that of amnionic fluid is usually >7.0. The use of the indicator *nitrazine* to identify ruptured membranes is a simple and fairly reliable method. Test papers are impregnated with the dye, and the color of the reaction between these paper strips and vaginal fluids is interpreted by comparison with a standard color chart. A pH above 6.5 is consistent with ruptured membranes. False-positive test results may occur with coexistent blood, semen, or bacterial vaginosis, whereas false-negative tests may result with scant fluid.

Other tests to identify amnionic fluid include arborization or ferning of vaginal fluid, which suggests amnionic rather than cervical fluid. Amnionic fluid crystallizes to form a fernlike pattern due to its relative concentrations of sodium chloride, proteins, and carbohydrates. Detection of alpha-fetoprotein in the vaginal vault has been used to identify amnionic fluid (Yamada, 1998). Although rarely required, identification may also follow injection of indigo carmine into the amnionic sac via abdominal amniocentesis. Last, specific amnionic fluid proteins can be sought using point-of-care assays. These include AmniSure, which binds placental alpha microglobulin-1, and ROM Plus, which detects insulin growth factor binding protein-1 plus alpha-fetoprotein (Doret, 2013; Igbinosa, 2017).

Cervical Assessment

The degree of *cervical effacement* reflects the length of the cervical canal compared with that of an uneffaced cervix. When the length of the cervix is reduced by one half, it is 50-percent effaced. When the cervix becomes as thin as the adjacent lower uterine segment, it is completely, or 100-percent,

effaced.

Cervical dilation is determined by estimating the average diameter of the cervical opening by sweeping the examining finger from the margin of the cervical opening on one side to that on the opposite side. The diameter traversed is estimated in centimeters. The cervix is said to be fully dilated when the diameter measures 10 cm, because the presenting part of a term-size newborn usually can pass through a cervix this widely dilated.

The *position* of the cervix is determined by the relationship of the cervical os to the fetal head and is categorized as posterior, midposition, or anterior. Along with position, the *consistency* of the cervix is determined to be soft, firm, or intermediate between these two.

The *fetal station*, that is, the level of the presenting fetal part in the birth canal, is described in relationship to the ischial spines. These spines lie halfway between the pelvic inlet and the pelvic outlet. When the lowermost portion of the presenting fetal part is at the level of the spines, it is designated as being at zero (0) station.

In the past, the long axis of the birth canal above and below the ischial spines was arbitrarily divided into thirds by some and into fifths (approximately 1 cm) by other groups. In 1989, the American College of Obstetricians and Gynecologists adopted the classification of station that divides the pelvis above and below the spines into fifths. Each fifth represents 1 cm above or below the spines. Thus, as the presenting fetal part descends from the inlet *toward* the ischial spines, the designation is –5, –4, –3, –2, –1, then 0 station. Below the spines, as the presenting fetal part descends, it passes +1, +2, +3, +4, and +5 stations to delivery. Station +5 cm corresponds to the fetal head being visible at the introitus.

If the leading part of the fetal head is at 0 station or below, most often the fetal head has engaged—thus, the biparietal plane has passed through the pelvic inlet. *If the head is unusually molded or if caput succedaneum formation is extensive, or both, engagement might not have taken place although the head appears to be at 0 station.*

In a study done at five teaching centers in Denver, residents, nurses, and faculty were surveyed to determine what definitions were being used to describe fetal station (Carollo, 2004). Four different definitions were in use. Disturbingly, these investigators found that few caregivers were aware that others were using different definitions of station! Dupuis and associates (2005) tested the reliability of clinical estimations of station using the position of the leading part in centimeters above or below the spines. A birth simulator was used in which station could be precisely measured and compared with the vaginal examination done by clinicians. They reported that the clinical examiners were incorrect a third of the time.

These five characteristics—cervical dilation, effacement, consistency, position, and fetal station—are assessed when tabulating the Bishop score. This score is commonly used to predict labor induction outcome and is discussed in Chapter 26 (Preinduction Cervical Ripening). Taken together, these factors suggest the subjective “favorability” of the cervix for induction success.

Laboratory Studies

When a woman is admitted in labor, most often the hematocrit or hemoglobin concentration is checked. The hematocrit can be measured easily and quickly. At Parkland Hospital, blood is collected in a standard collection tube with anticoagulant. From this, a heparinized capillary tube is filled to spin in a microhematocrit centrifuge in the labor and delivery unit. This provides a hematocrit value within 3 minutes. The initial collection tube is also sent to the hematology laboratory for evaluation if the point-of-care hematocrit is <30 volume percent. Another labeled tube of blood is allowed to clot and sent to the blood bank for blood type and antibody screen, if needed. A final sample is collected for syphilis and human immunodeficiency virus (HIV) serology. In some labor units, a clean-catch voided specimen is examined in all women for protein and glucose. At Parkland Hospital, however, we obtain a urine specimen for protein determination in hypertensive women only (Table 40-1).

Women with no prenatal care are considered to be at risk for syphilis, hepatitis B, and HIV, and laboratory screening studies for these, as well as a blood type and antibody screen, are performed (American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2017). Some states, for example, Texas, require routine testing for syphilis, hepatitis B, and HIV in all women admitted to labor and delivery units, even if these were done during prenatal care.

Management of First-Stage Labor

As soon as possible after admittance, the remainder of a general examination is completed. Whether a pregnancy is normal can best be determined when all examinations, including record and laboratory review, are completed. A rational plan for monitoring labor can then be established based on the needs of the fetus and the mother. Because labor lengths vary markedly among individuals, precise statements regarding anticipated labor

duration are unwise.

In general, pain relief should depend on the needs and desires of the woman. The American College of Obstetricians and Gynecologists (2017) has specified optimal goals for anesthesia care in obstetrics. This is discussed in detail in Chapter 25. In some units, women can choose to spend part of first-stage labor in a large water tub. Risks and benefits are described in Chapter 27 (Special Populations).

Intrapartum Fetal Monitoring

This is discussed in detail in Chapter 24. Briefly, the American Academy of Pediatrics and American College of Obstetricians and Gynecologists (2017) recommend that during first-stage labor, in the absence of any abnormalities, the fetal heart rate should be checked immediately after a contraction at least every 30 minutes and then every 15 minutes during the second stage. If continuous electronic monitoring is used, the tracing is evaluated at least every 30 minutes during the first stage and at least every 15 minutes during second-stage labor. For women with pregnancies at risk, fetal heart auscultation is performed at least every 15 minutes during first-stage labor and every 5 minutes during the second stage. Continuous electronic monitoring may be used with evaluation of the tracing every 15 minutes during the first stage of labor, and every 5 minutes during the second stage.

Maternal Monitoring

Temperature, pulse, and blood pressure are evaluated at least every 4 hours. If membranes have been ruptured for many hours before labor onset or if there is a borderline temperature elevation, the temperature is checked hourly.

Although uterine contractions are usually assessed with electronic monitoring, they can be quantitatively and qualitatively evaluated manually (Chap. 24, Intrapartum Surveillance of Uterine Activity). With the palm of the hand resting lightly on the uterus, the time of contraction onset is determined. Its intensity is gauged from the degree of firmness the uterus achieves. At the acme of effective contractions, the finger or thumb cannot readily indent the uterus during a “firm” contraction. The time at which the contraction disappears is noted next. This sequence is repeated to evaluate the frequency, duration, and intensity of contractions.

During the first stage of labor, the need for subsequent vaginal examinations to monitor cervical change and presenting part position will vary considerably. When the membranes rupture, an examination to exclude cord prolapse is performed expeditiously if the fetal head was not definitely engaged at the previous examination. The fetal heart rate is also checked immediately and during the next uterine contraction to help detect occult umbilical cord compression. At Parkland Hospital, periodic pelvic examinations are typically performed at 2- to 3-hour intervals to evaluate labor progress. Evidence implicating the number of vaginal examinations in infection-related morbidity is conflicting (Cahill, 2012; Soper, 1989).

Oral Intake

Food and liquids with particulate matter should be withheld during active labor and delivery. Gastric emptying time is remarkably prolonged once labor is established and analgesics are administered. As a consequence, ingested food and most medications remain in the stomach and are not absorbed. Instead, they may be vomited and aspirated (Chap. 25, Inhalational Anesthetics). According to the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists (2017), oral intake of moderate amounts of clear liquids is reasonable for women with uncomplicated labor. Modest amounts of clear liquids such as water, clear tea, black coffee, carbonated beverages, Popsicles, and pulp-free fruit juices are allowed in uncomplicated laboring women. In those with appreciable risks for aspiration or those with significant risks for cesarean delivery, further restriction may be instituted. For example, for those with planned cesarean delivery, liquids are halted 2 hours before and solids are stopped 6 to 8 hours prior to surgery (American College of Obstetricians and Gynecologists, 2016b).

Intravenous Fluids

Although an intravenous (IV) infusion system is often routinely established early in labor, real need for this in the normal pregnant woman is limited, at least until analgesia is administered. However, venous access is advantageous during the immediate puerperium to administer oxytocin prophylactically and at times therapeutically when uterine atony persists. Moreover, with longer labors, the administration of glucose, sodium, and water to the otherwise fasting woman at the rate of 60 to 120 mL/hr prevents dehydration and acidosis. Shrivastava and associates (2009) noted shorter labors in nulliparas delivering vaginally who were provided an intravenous normal saline with dextrose solution compared with those given saline solution only. In another study, 195 women in labor received lactated Ringer or isotonic sodium chloride solution at a rate of either 125 or 250 mL/hr. The mean volume of total IV fluid was 2008 mL in the 125 mL/hr group and 2487 mL in the 250 mL/hr group (Garite, 2000). Labor lasted more

than 12 hours in significantly more of the women given a 125 mL/hr infusion compared with those given 250 mL/hr—26 versus 13 percent, respectively. In yet another study, 311 nulliparas with uncomplicated pregnancies in spontaneous labor at term received one of three IV infusions (Edwards, 2014). Group 1 was given 125 mL/hr of lactated Ringer solution with 5 percent dextrose (D5LR), Group 2 received 250 mL/hour of the same solution (D5LR), and Group 3 was administered 25 mL/hr of D5LR. Groups 1 and 2 were allowed ice chips, Popsicles, and hard candy, and Group 3 also received Gatorade. Oral intake was limited in Groups 1 and 2 but was ad libitum in Group 3. The authors concluded that any of the regimens studied was safe but none was superior for labor performance.

Maternal Position

In bed, the laboring woman may assume the position she finds most comfortable, and often this will be lateral recumbency. Lying supine is typically avoided to avert aortocaval compression and its potential to lower uterine perfusion (Chap. 4, Hemodynamic Function in Late Pregnancy). However, the normal laboring woman need not be confined to bed early in labor. A comfortable chair may be beneficial psychologically and perhaps physiologically. Others encourage ambulation.

Proponents of walking report that it shortens labor, lowers rates of oxytocin augmentation, diminishes the need for analgesia, and decreases the frequency of operative vaginal delivery (Flynn, 1978; Read, 1981). In their Cochrane review, Lawrence and associates (2013) found that labor in ambulant or upright positions shortened first-stage labor by about 1 hour and lowered cesarean delivery and epidural analgesia rates. Lupe and Gross (1986) concluded, however, that no conclusive evidence supports assertions that upright maternal posture or ambulation improves labor. They reported that women preferred to lie on their side or sit in bed. Few chose to walk, fewer to squat, and none wanted the knee-chest position. Parturients tended to assume fetal positions in later labor. Most women enthusiastic about ambulation returned to bed when active labor began (Carlson, 1986; Williams, 1980).

Bloom and colleagues (1998) conducted a randomized trial to study the effects of walking during first-stage labor. In 1067 women with uncomplicated term pregnancies delivered at Parkland Hospital, these investigators reported that ambulation did not affect labor duration. Ambulation did not reduce the need for analgesia, nor was it harmful to the newborn. Because of these observations, we give women without complications the option to select either recumbency or supervised ambulation during labor.

Rupture of Membranes

If the membranes are intact, temptation is great, even during normal labor, to perform amniotomy. The presumed benefits are more rapid labor, earlier detection of meconium-stained amnionic fluid, and the opportunity to apply an electrode to the fetus or insert a pressure catheter into the uterine cavity for monitoring. The advantages and disadvantages of amniotomy are discussed in Chapter 26 (Amniotomy for Induction and Augmentation). Importantly, the fetal head must be well applied to the cervix and not be dislodged from the pelvis during the procedure to avoid umbilical cord prolapse.

In cases with prolonged membrane rupture, defined as greater than 18 hours, antimicrobial administration for prevention of group B streptococcal infections is recommended. This is discussed in Chapter 64 (GBS Vaccine). This practice similarly lowers rates of chorioamnionitis and endometritis (Saccone, 2015).

Urinary Bladder Function

Distention of the bladder can hinder descent of the fetal presenting part and lead to subsequent bladder hypotonia and infection. Periodically during labor, the suprapubic region is inspected and palpated to detect distention. If the bladder is readily seen or palpated above the symphysis, the woman should be encouraged to void. At times, those who may be unable to void on a bedpan may be able to ambulate with assistance to a toilet and successfully void. If the bladder is distended and voiding is not possible, catheterization is indicated. Carley and coworkers (2002) found that 51 of 11,332 vaginal deliveries (1 in 200) were complicated by postpartum urinary retention. Most women resumed normal voiding before discharge from the hospital. Musselwhite and associates (2007) reported retention in 4.7 percent of women who had labor epidural analgesia. Risk factors for retention were primiparity, oxytocin-induced or augmented labor, perineal lacerations, operative vaginal delivery, catheterization during labor, and labor duration >10 hours.

Management of Second-Stage Labor

With full cervical dilation, which signifies the onset of the second stage, a woman typically begins to bear down. With descent of the presenting part, she develops the urge to defecate. Uterine contractions and the accompanying expulsive forces may now last 1 minute and recur at an interval no longer than 90 seconds. As discussed earlier, the median duration of the second stage is 50 minutes in nulliparas and 20 minutes in multiparas, although the interval can vary. Monitoring intervals of the fetal heart rate were discussed in Management of First-Stage Labor, and interpretation of second-stage electronic fetal heart rate patterns is discussed in Chapter 24 (Fetal Heart Rate Patterns During Second-Stage Labor).

In most cases, bearing down is reflexive and spontaneous during second-stage labor. Occasionally, a woman may not employ her expulsive forces to good advantage and coaching is desirable. Her legs should be half-flexed so that she can push with them against the mattress. When the next uterine contraction begins, she is instructed to exert downward pressure as though she were straining at stool. A woman is not encouraged to push beyond the completion of each contraction. Instead, she and her fetus are allowed to rest and recover. During this period of actively bearing down, the fetal heart rate auscultated during the contraction is likely to be slow but should recover to normal range before the next expulsive effort. Fetal and obstetrical outcomes appear to be unaffected whether pushing is coached or uncoached during second-stage labor (Bloom, 2006; Tuuli, 2012). Bloom and colleagues (2006) studied effects of actively coaching expulsive efforts in women without epidural analgesia. They reported that although the second stage was slightly shorter in coached women, no other maternal advantages were gained.

Several positions during the second stage have been recommended to augment pushing efforts. Eason and colleagues (2000) reviewed various positions and their effect on the incidence of perineal trauma. They found that the supported upright position had no advantages over the recumbent one. Upright positions include sitting, kneeling, squatting, or resting with the back at a 30-degree elevation. In women with regional analgesia, one recent randomized trial found higher vaginal delivery rates in those in a recumbent position compared with an upright one—41 versus 35 percent (The Epidural and Position Trial Collaborative Group, 2017). In women without epidural analgesia, Gupta (2017) in their review compared upright positions with supine or lithotomy positions and their effect on labor. Upright positions offered a slightly shorter interval to delivery as well as fewer episiotomies and operative vaginal deliveries. However, rates of blood loss >500 mL and perhaps of second-degree lacerations were increased. Berghella and coworkers (2008) hypothesized that parity, less intense aortocaval compression, improved fetal alignment, and larger pelvic outlet diameters might explain these findings. In an earlier study, a 20- to 30-percent increase in the area of the pelvic outlet was noted with squatting compared with the supine position (Russell, 1969). Finally, Babayer and associates (1998) cautioned that prolonged sitting or squatting during the second stage may cause neuropathy of the common fibular (formerly common peroneal) nerve.

As the head descends through the pelvis, the perineum begins to bulge and the overlying skin becomes stretched. Now the scalp of the fetus may be visible through the vulvar opening. At this time, the woman and her fetus are prepared for delivery, which is described in Chapter 27 (Preparation for Delivery).

LABOR MANAGEMENT PROTOCOLS

An orderly and systematic approach to labor management results in reproducible beneficial maternal and perinatal outcomes (Althabe, 2008). Several labor management protocols are subsequently presented. These include those from the National Maternity Hospital in Dublin, from the World Health Organization, and from Parkland Hospital.

In Dublin more than 30 years ago, O'Driscoll and associates (1984) pioneered the concept that a disciplined, standardized labor management protocol reduced the number of cesarean deliveries for dystocia. Their overall cesarean delivery rate was 5 percent in the 1970s and 1980s with such management. The approach is now referred to as *active management of labor.* Two of its components—amniotomy and oxytocin—have been widely used, especially in English-speaking countries outside the United States. With this protocol, labor is diagnosed when painful contractions are accompanied by complete cervical effacement, bloody "show," or ruptured membranes. Women with such findings are committed to delivery within 12 hours. Pelvic examination is performed each hour for the next 3 hours, and thereafter at 2-hour intervals. When dilation has not increased by at least 1 cm/hr, amniotomy is performed. Progress is again assessed at 2 hours, and high-dose oxytocin infusion, described in Chapter 26 (Oxytocin), is started unless dilation of at least 1 cm/hr is attained. Women are constantly attended by midwives. If membranes rupture before admission, oxytocin is begun for no progress at the 1-hour mark.

López-Zeno and colleagues (1992) prospectively compared such active management with their "traditional" approach to labor management at Northwestern Memorial Hospital in Chicago. They randomly assigned 705 nulliparas with uncomplicated pregnancies in spontaneous labor at term. The cesarean delivery rate was significantly lower with active versus traditional management—10.5 versus 14.1 percent, respectively. Subsequent studies did not show this. Wei and associates (2013) in a Cochrane database review found a modest reduction in cesarean delivery rates when active

management of labor was compared with standard care. Frigoletto and coworkers (1995) reported another randomized trial with 1934 nulliparous women at Brigham and Women's Hospital in Boston. Although they found that such management somewhat shortened labor, it did not affect the cesarean delivery rate. These observations have since been reported by others (Brown, 2013).

A *partograph* was designed by the World Health Organization (WHO) for use in developing countries (Dujardin, 1992). According to Orji (2008), the partograph is similar for nulliparas and multiparas. Labor is divided into a latent phase, which should last no longer than 8 hours, and an active phase. The active phase starts at 3 cm dilation, and progress should be no slower than 1 cm/hr. A 4-hour wait is recommended before intervention when the active phase is slow. Labor is graphed, and analysis includes use of alert and action lines. Lavender and colleagues (2006) randomized 3000 nulliparous women to labor interventions at 2 hours versus 4 hours as recommended by WHO. Their cesarean delivery rate was unaffected, and they concluded that interventions such as amniotomy and oxytocin were needlessly increased using the 2-hour time interval. From their Cochrane Database review, Lavender and associates (2013) do not recommend use of the partograph for standard labor management.

At Parkland Hospital, women are admitted if active labor is diagnosed or if ruptured membranes are confirmed. Labor is defined as cervical dilation of 3 to 4 cm or more in the presence of uterine contractions. Management guidelines direct that a pelvic examination be performed approximately every 2 hours. Ineffective labor is suspected when the cervix does not dilate within approximately 2 hours of admission. Amniotomy is then performed, and labor progress determined at the next 2-hour evaluation. In women whose labors do not progress, an intrauterine pressure catheter is placed to assess uterine function. Hypotonic contractions and no cervical dilation after an additional 2 to 3 hours result in stimulation of labor using the high-dose oxytocin regimen described in Chapter 26 (Oxytocin). The goal is uterine activity of 200 to 250 Montevideo units for 2 to 4 hours before dystocia can be diagnosed. If hypotonic contractions are strongly suspected, internal monitors may be placed with amniotomy and again cervical change and contraction pattern are assessed in 2 hours. Confirmation of deficient Montevideo units at that time may prompt oxytocin augmentation for maternal or fetal indications.

Dilation rates of 1 to 2 cm/hr are accepted as evidence of progress after satisfactory uterine activity has been established with oxytocin. This can require up to 8 hours or more before cesarean delivery is performed for dystocia. The cumulative time required to effect this stepwise management approach permits many women to establish effective labor. This management protocol has been evaluated in more than 20,000 women with uncomplicated pregnancies. Importantly, these labor interventions and the relatively infrequent use of cesarean delivery did not jeopardize the fetus–newborn.

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