Chapter

6 Complications of Labor and Delivery

PRETERM LABOR

Labor that occurs before week 37 is called **preterm labor** (PTL). Many patients present with preterm contractions, but only those who have cervical change as measured on cervical examination are diagnosed as having PTL. It differs from **cervical insufficiency**, which is a silent, painless dilation, and effacement of the cervix. Both can result in preterm delivery, which is the leading cause of fetal morbidity and mortality in the United States. The incidence of preterm delivery in the United States reached a peak in 2005 to more than 12% of all births, which is higher than that in 2000 where the rate was 11.6%. Although since 2006 the preterm birth rate has declined, it is still higher than that in 2000. Approximately a half of a million babies are born preterm each year, though only approximately 80,000 of these are before 32 weeks' gestation.

PRETERM DELIVERY

Infants born before 37 weeks' gestation are termed **preterm**. Infants born weighing less than 2,500 g are termed **low-birth-weight** (LBW) infants. Infants who have not grown appropriately for their gestational age have **intrauterine growth restriction** (IUGR) or are **small for gestational age** (SGA). Thus, an IUGR infant can be born after week 37 but still be LBW. Morbidity and mortality of preterm infants are dramatically affected by gestational age and birth weight. Prematurity puts infants at increased risk of respiratory distress syndrome (RDS) or hyaline membrane disease, intraventricular hemorrhage, sepsis, and necrotizing enterocolitis. Infants born on the cusp of viability at 24 weeks' gestation have a greater than 50% mortality rate, whereas infants born after week 34 have a mortality rate that is only slightly higher than that of full-term neonates.

ETIOLOGY AND RISK FACTORS

The defining physiologic mechanism that causes the onset of labor is unknown. However, various risk factors have been associated with PTL. These include preterm rupture of membranes; chorioamnionitis; multiple gestations; uterine anomalies such as a bicornuate uterus; previous preterm delivery; maternal prepregnancy weight less than 50 kg; placental abruption; maternal disease including preeclampsia, infections, intra-abdominal disease or surgery; and low socioeconomic status.

TOCOLYSIS

Tocolysis is the attempt to prevent contractions and the progression of labor. Many tocolytics are used in the United States, but only ritodrine—a beta-mimetic agent—is FDA approved for this purpose. It is difficult to conduct placebo-controlled studies of new tocolytics because most patients and clinicians are unwilling to allow contractions to proceed without some tocolytic therapy. Thus, many of the current trials compare currently used tocolytics to other tocolytics. Because the evidence for which of the tocolytic agents may be the most effective is unclear, institutions and practitioners vary widely in practice.

Studies have demonstrated that tocolytics prolong gestation for only 48 hours. The principal benefit from gaining 48 hours in a pregnancy is to allow treatment with steroids to enhance fetal lung maturity and reduce the risk of complications associated with preterm delivery. **Betamethasone**, a glucocorticoid, has been shown to reduce the incidence of RDS and other complications from preterm delivery. Prior to 34 weeks of gestation, the advantages of treating with steroids need to be weighed against the risks of prolonging the pregnancy. There are many situations in which PTL should be allowed to progress. Chorioamnionitis, nonreassuring fetal testing, and significant placental abruption are absolute indications to allow labor to progress and often to hasten delivery. With many other issues such as maternal disease—particularly preeclampsia or poor placental perfusion—an assessment of the severity of the situation, the precipitous nature of the complication, and the risks from prematurity all contribute to the decision of whether or not to tocolyze.

TOCOLYTICS

The goal of a tocolytic is to decrease or halt the cervical change resulting from contractions. In the case of preterm contractions without cervical change, hydration can often decrease the number and strength of the contractions. This operates along the principle that a dehydrated patient has increased levels of vasopressin or **antidiuretic hormone** (ADH), the octapeptide synthesized in the hypothalamus along with oxytocin. Because ADH differs from oxytocin by only one amino acid, it may bind with oxytocin receptors and lead to contractions. Thus, hydration, which decreases the level of ADH, may also decrease the number of contractions. For patients who do not respond to hydration or whose cervices are actively changing, a variety of tocolytics may be used.

Beta-mimetics

Uterine myometrium is composed of smooth muscle fibers. The contraction of these fibers is regulated by myosin light chain kinase (MLK), which is activated by calcium ions through their interaction with calmodulin (Fig. 6-1). By increasing the level of cAMP, calcium is sequestered in the sarcoplasmic reticulum, causing a decrease in the level of free calcium ions and a decrease in uterine contractions. Conversion of ATP to cAMP is increased by β-agonists that bind and activate β_2 receptors on myometrial cells.

The two **beta-mimetics** historically used for PTL are **ritodrine** and **terbutaline**. Although both are certainly effective in halting preterm contractions, randomized controlled studies in which patients were truly in PTL showed that β-agonists increased gestation an average of only 24 to 48 hours further over hydration and bed rest alone. Side effects of these drugs include tachycardia, headaches, and anxiety. More seriously, pulmonary edema may occur and, in rare cases, maternal death. Ritodrine is given as continuous IV therapy, whereas terbutaline is usually given as 0.25 mg SC, loaded Q 20 min × 3 dosages, and then Q 3 to 4 h maintenance. Because terbutaline may cause maternal death and cardiac events, including tachycardia, transient hyperglycemia, hypokalemia, cardiac arrhythmias, pulmonary edema, and myocardial ischemia, the FDA has now added a black box warning to the use of terbutaline IV beyond 24 to 48 hours. Additionally, oral terbutaline is not recommended because studies have not shown it to be an effective tocolytic beyond the 48-hour window. Subcutaneous terbutaline is still used to acutely stop contractions in obstetric triage when ruling out PTL and with uterine hypertonus leading to an abnormal fetal heart tracing.

Magnesium Sulfate

Magnesium decreases uterine tone and contractions by acting as a calcium antagonist and a membrane stabilizer. Although magnesium can stop contractions, in small placebo-controlled trials, it has not been shown to change gestational age of delivery. In larger trials, the efficacy of magnesium did not vary significantly from that of beta-mimetics. Side effects such as flushing, headaches, fatigue, and diplopia are seen, but they

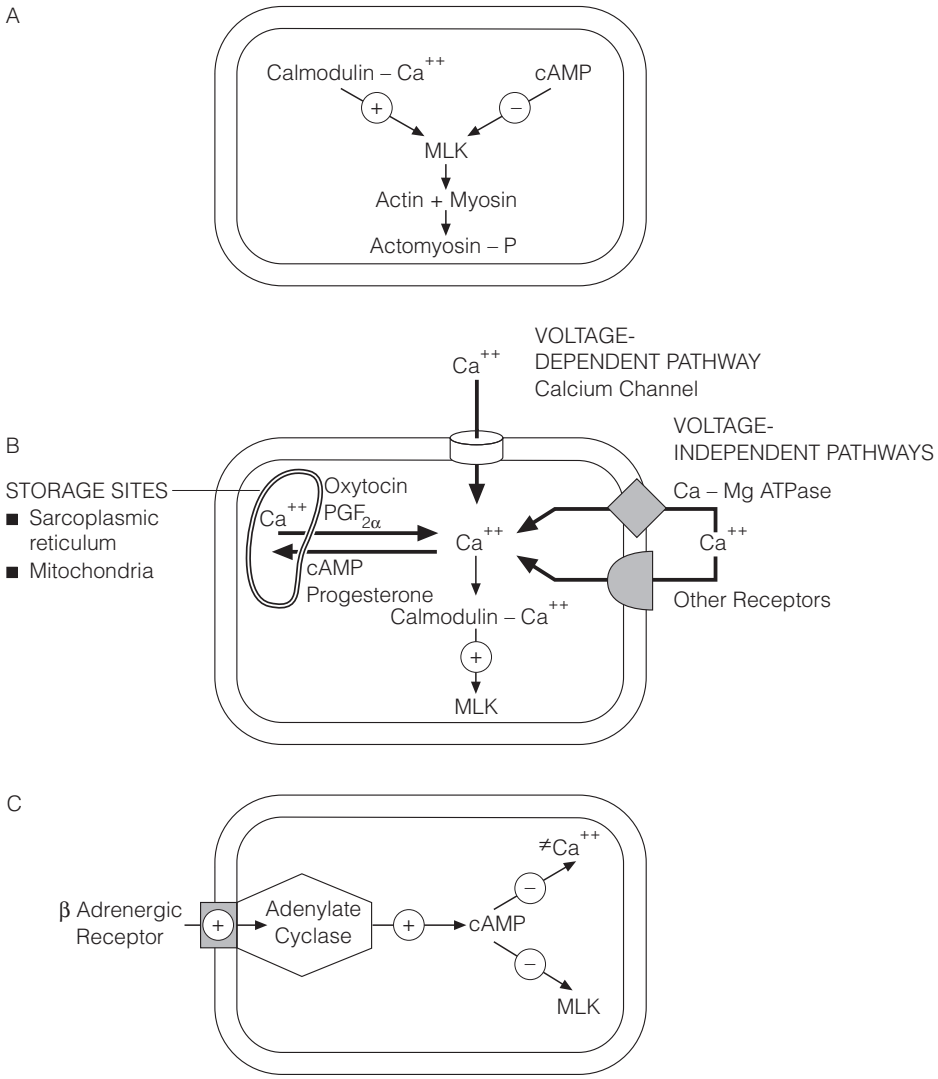


Figure 6-1 • Control of myometrial contractility: myosin light-chain kinase (MLK) is the key enzyme.

are generally considered to be less severe than those seen with ritodrine and terbutaline. At toxic levels of magnesium (> 10 mg/dL), respiratory depression, hypoxia, and cardiac arrest have been seen. Deep tendon reflexes (DTRs) are depressed at magnesium levels less than 10 mg/dl. Therefore, a reliable and quick assessment for magnesium toxicity can be achieved with serial DTR exams. Pulmonary edema has also been seen in women treated with magnesium sulfate, although it may be secondary to the concomitant IV fluid given to patients in PTL. Generally, magnesium sulfate should be loaded as a 6-g bolus over 15 to 30 minutes, and then maintained at a 2- to 3-g/hour continuous infusion. A slower infusion should be used in the case of renal insufficiency because magnesium is cleared via the kidneys.

Calcium Channel Blockers

Calcium channel blockers decrease the influx of calcium into smooth muscle cells, thereby diminishing uterine contractions. In vitro they have been shown to decrease myometrial contractions. In clinical trials, **nifedipine** has been the principal drug studied, and it seems to have comparable efficacy to that of ritodrine and magnesium. Side effects include headaches, flushing, and dizziness. Nifedipine is given orally and, as with other tocolytics, should be loaded. Typically a 10 mg dose Q 15 min for the first hour or until contractions have ceased is given. This is followed by a maintenance dosage of 10 to 30 mg Q 4 to 6 h as tolerated according to the patient's BP. In small studies, long-acting preparations of nifedipine have been shown to have efficacy similar to that of quick-release doses, and therefore can be used for long-term therapy to increase compliance and decrease side effects.

Prostaglandin Inhibitors

Prostaglandins increase the intracellular levels of calcium and enhance myometrial gap junction function, thereby increasing myometrial contractions. Thus, they are commonly used to induce labor and to heighten contractions in postpartum patients with uterine atony. Conversely, antiprostaglandin agents are used to inhibit contractions and possibly halt labor. **Indomethacin**—a nonsteroidal anti-inflammatory drug (NSAID) that blocks the enzyme cyclooxygenase and decreases the level of prostaglandins—is used as a tocolytic. In clinical trials, it has been shown to effectively decrease contractions and forestall labor with minimal maternal side effects. However, it has been associated with a variety of fetal complications, including premature constriction of the ductus arteriosus, pulmonary hypertension, and oligohydramnios secondary to fetal renal failure. Furthermore, one study showed an increased risk of necrotizing enterocolitis and intraventricular hemorrhage in extremely premature fetuses that had been exposed to indomethacin within 48 hours of delivery. Currently, indomethacin is most commonly used before 32 weeks' gestation and generally only for 48 to 72 hours. If indomethacin is used, the amniotic fluid index should be checked prior to initiating the drug, and again after 48 hours, to monitor for development of oligohydramnios. Indomethacin should be stopped promptly if amniotic fluid is decreased.

Oxytocin Antagonists

Oxytocin antagonists (e.g., atosiban) have been studied as tocolytics. In theory, these seem to be an obvious choice for an effective tocolytic and should have minimal side effects. While they have shown to decrease uterine myometrial contractions, clinical studies have been small, and have not demonstrated an improvement in outcomes. Current use has been limited to experimental trials that have shown no clinical difference from the other commonly used tocolytics.

PRETERM AND PREMATURE RUPTURE OF MEMBRANES

Rupture of membranes (ROM) occurring before week 37 is considered **preterm rupture of the membranes**, whereas ROM occurring before the onset of labor is termed **premature rupture of the membranes** (PROM). If the two occur together it is termed **preterm premature rupture of the membranes** (PPROM). Anytime ROM lasts longer than 18 hours before delivery, it is described as **prolonged rupture of membranes**.

PRETERM ROM

Spontaneous rupture of the fetal membranes before week 37 is a common cause of PTL, preterm delivery, and chorioamnionitis. Without intervention, approximately 50% of patients who have ROM will go into labor within 24 hours and up to 75% will do so within 48 hours. These rates are inversely correlated to gestational age at ROM; thus, patients with ROM prior to 26 weeks are more likely to gain an additional week as compared to those at greater than 30 weeks. While maintaining the pregnancy to gain further fetal maturity would seem beneficial, prolonged PPROM has been associated with increased risk of chorioamnionitis, abruption, and cord prolapse.

Diagnosis

Commonly, a patient complains of a gush of fluid from the vagina. However, any increased vaginal discharge or complaints of stress incontinence should be evaluated to rule out ROM. The diagnosis is made by obtaining a history of leaking vaginal fluid, pooling on speculum examination, and positive nitrazine and fern tests. If these tests are equivocal, an ultrasound can be performed to examine the level of amniotic fluid. Some providers and hospitals will use the Amnisure test (discussed in Chapter 4). If the diagnosis is still unconfirmed, an amniocentesis dye test can be performed by injecting a dye via amniocentesis and observing whether or not the dye leaks into the vagina. This is also known as the **tampon test** because the dye is usually identified by its absorption into a tampon. If there is concern for chorioamnionitis, maternal temperature, WBC count, uterine tenderness, and the fetal heart tracing should all be checked for signs of infection.

Treatment

The management of PROM varies depending on the gestational age of the fetus. The rationale for the management of PPROM is that at some gestational age, usually somewhere between 32 and 36 weeks, the risk from prematurity is equal to the risk of infection. Up to this point, the risk of prematurity drives management, whereas after this point, the risk of infection motivates delivery. There is debate regarding the exact gestational age at which the risk of infection is greater. Some practitioners prefer to wait until week 36, whereas others prefer to test for fetal lung maturity starting at week 32 and deliver when mature, while still others would deliver at 32 to 34 weeks' gestation without fetal lung maturity testing. The most common practice across the country is delivery at 34 weeks' gestation. However, depending on the population being cared for, the optimal week of gestation to deliver probably varies.

There is strong evidence that the use of antibiotics in PPROM leads to a longer latency period prior to the onset of

labor. Thus, ampicillin with or without erythromycin is recommended in the setting of PPROM. There is debate surrounding the use of tocolysis and corticosteroids in the setting of PPROM. Tocolysis seems to add little, if any, benefit in PPROM and may even be harmful in the setting of chorioamnionitis. However, at many institutions tocolysis is used for 48 hours, particularly at earlier gestational ages, in order to gain time to administer a course of corticosteroids. Currently, the recommendation is to use corticosteroids in the setting of PPROM because of the fetal benefits, despite any concern regarding immunosuppression.

PREMATURE RUPTURE OF THE MEMBRANES

The most common concern of PROM is that of chorioamnionitis, the risk of which increases with the length of ROM. Antibiotics are recommended for women with prolonged ROM and women with unknown group B streptococcus (GBS) status. Commonly, labor is induced/augmented if ROM occurs anytime after 34 to 36 weeks. Some patients may elect to bear the risk of increased infection to await the onset of spontaneous labor. However, the risks of infection with prolonged PROM should be discussed with patients before any decision is made. One large, randomized, controlled trial demonstrated that there is no difference in length of labor or mode of delivery with immediate induction/augmentation of PROM, but the rate of chorioamnionitis is higher among those with expectant management.

OBSTRUCTION, MALPRESENTATION, AND MALPOSITION

Although the most common form of delivery is the spontaneous vertex vaginal delivery, other presentations and deliveries also occur. Many of the malpresentations lead to cesarean delivery.

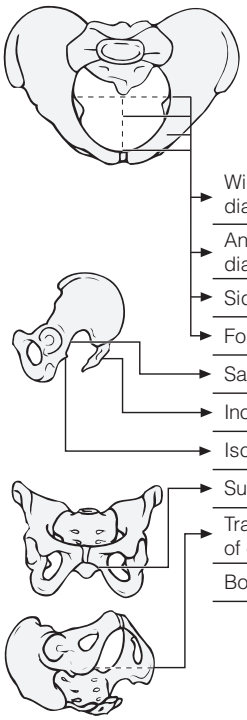
CEPHALOPELVIC DISPROPORTION

One of the most common indications for cesarean section is failure to progress (FTP) in labor, most often caused by **cephalopelvic disproportion** (CPD). The three "Ps"—pelvis, passenger, and power—are primarily responsible for a vaginal delivery. If the pelvis is too small, the fetal presenting part is too large, or the contractions are inadequate, there will be FTP. The strength of uterine contractions can be measured with an intrauterine pressure catheter (IUPC) and augmented with oxytocin, but little can be done about the other two factors that contribute to CPD.

Diagnosis

The maternal pelvis is described as one of four dominant types: **gynecoid**, **android**, **anthropoid**, and **platypelloid** (Fig. 6-2). Many pelvises have characteristics from more than one of these types. Common measurements of the pelvis include those of the pelvic inlet, the midpelvis, and the pelvic outlet. The **obstetric conjugate** is the distance between the sacral promontory and the midpoint of the symphysis pubis, and the shortest anteroposterior diameter of the pelvic inlet. The anteroposterior diameter of the pelvic outlet is the distance from the tip of the sacrum to the inferior margin of the pubic symphysis and usually ranges from 9.5 to 11.5 cm. These measurements are performed with both clinical and X-ray pelvimetry, but it is rare to assume CPD based on measurements alone.

The fetal skull is composed of the face, the base, and the vault. The face and base are composed of fused bones that do not change during labor; however, the bones of the vault are not fused and can undergo molding to conform to the maternal pelvis. The vault is composed of five bones: two frontal, two parietal, and one occipital. The spaces between the bones are known as sutures; the two places where the sutures intersect



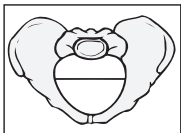
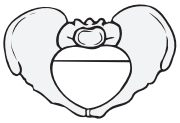
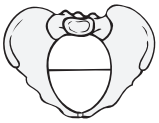
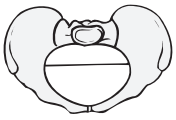
	 **Gynecoid**	 **Android**	 **Anthropoid**	 **Platypelloid**
Widest transverse diameter of inlet	12 cm	12 cm	<12 cm	12 cm
Anteroposterior diameter of inlet	11 cm	11 cm	>12 cm	10 cm
Side walls	Straight	Convergent	Narrow	Wide
Forepelvis	Wide	Narrow	Divergent	Straight
Sacrosciatic notch	Medium	Narrow	Backward	Forward
Inclination of sacrum	Medium	Forward (lower 1/3)	Wide	Narrow
Ischial spines	Not prominent	Not prominent	Not prominent	Not prominent
Suprapubic arch	Wide	Narrow	Medium	Wide
Transverse diameter of outlet	10 cm	<10 cm	10 cm	10 cm
Bone structure	Medium	Heavy	Medium	Medium

Figure 6-2 • Characteristics of four types of pelvises.

are the **anterior** and **posterior fontanelles**. How the fetal head presents to the maternal pelvis is important in accomplishing a vaginal delivery. There is great variation in the diameter of the skull at various levels and with various inclinations. When the fetal skull is properly flexed, the suboccipitobregmatic diameter presenting to the pelvis averages 9.5 cm in a term infant. When the sagittal suture is not located midline in the pelvis (asynclitism), the diameter of the skull being accommodated is effectively increased.

Treatment

Even if CPD is suspected, it is still often worthwhile to attempt a trial of labor. In the case of fetal macrosomia, elective induction of labor may be chosen before the opportunity for vaginal delivery passes. This practice leads to a similar rate of cesarean delivery, but as a result of failed induction rather than CPD.

BREECH PRESENTATION

Breech presentation, or buttocks first, occurs in 3% to 4% of all singleton deliveries. Factors associated with breech presentation include previous breech delivery, uterine anomalies, polyhydramnios, oligohydramnios, multiple gestation, PPROM, hydrocephaly, and anencephaly. Persistent breech presentation is also associated with placenta previa and fetal anomalies. Complications of a vaginal breech delivery include prolapsed cord and entrapment of the head.

Types of Breech

There are three categories of the breech presentation (Fig. 6-3): **frank**, **complete**, and **incomplete** or **footling**. The frank breech has flexed hips and extended knees, and thus the feet are near the fetal head. The complete breech has flexed hips, but one or both knees are flexed as well, with at least one foot near the breech. The incomplete or footling breech has one or both of the hips not flexed so that the foot or knee lies below the breech in the birth canal.

Diagnosis

The breech presentation may be diagnosed in several ways. With abdominal examination using the Leopold maneuvers, the fetal head can be palpated near the fundus while the breech is palpated in the pelvis. With vaginal examination, the breech can be palpated using common landmarks such as the gluteal cleft and the anus or, in the case of an incomplete breech, the fetal lower extremity. Diagnosis is often made or confirmed with ultrasound. On ultrasound, it is easy to confirm breech and then to determine the type of breech. With bedside Doppler, the fetal heart beat is often heard in the upper part of the uterus.

Treatment

How a breech presentation is managed depends on the experience of the obstetrician and the patient's wishes. The three management options are external cephalic version of the breech, trial of breech vaginal delivery, and elective cesarean delivery. External version consists of manipulation of the breech infant into a vertex presentation. It is rarely performed before 36 to 37 weeks' gestation because of the potential for spontaneous version before this point and the risk of delivery after version secondary to abruption or ROM. External version is usually attempted without anesthesia, and if successful, the patient can continue the pregnancy with a 5% to 10% risk of the fetus reverting back to breech presentation. If the version is not successful, a second attempt is often made under epidural anesthesia at 39 weeks of gestation. If successful, then either labor can be induced or the patient can continue the pregnancy. If the second attempt fails, often the patient will then have a cesarean delivery.

Trial of breech vaginal delivery can be attempted in the proper setting, but is becoming increasingly rare in the United States because a prospective randomized trial found higher rate of neonatal morbidity and mortality with trial of labor. Complications of breech deliveries include cord prolapse, entrapment of the fetal head, and fetal neurologic injury.

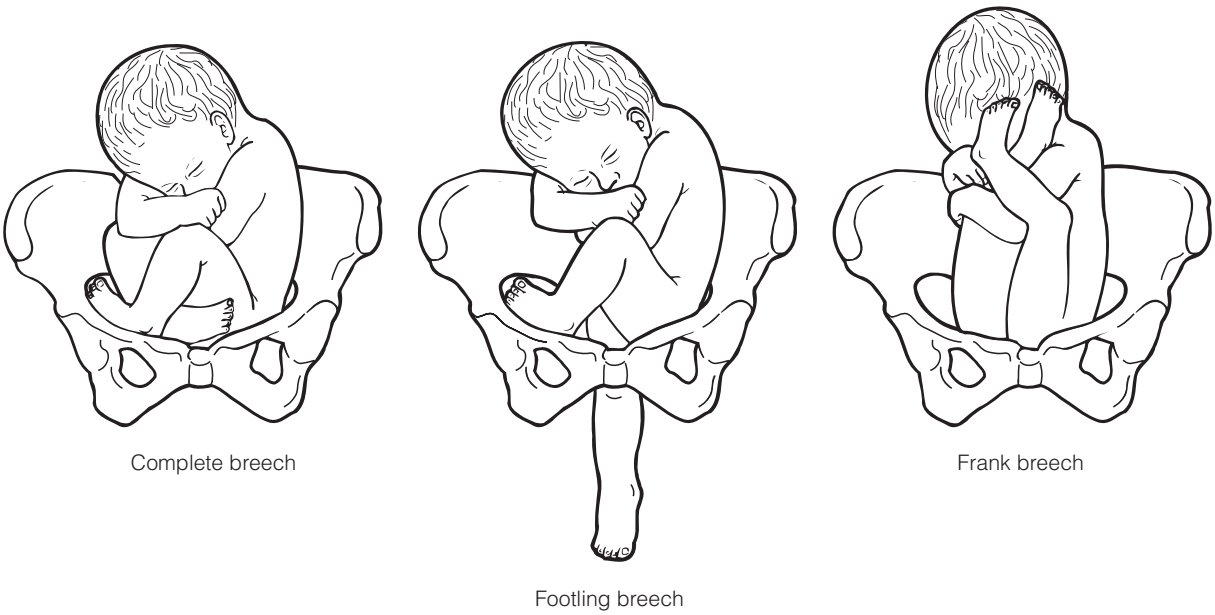


Figure 6-3 • Types of breech presentations.

A favorable pelvis (by clinical examination, pelvic radiograph, MRI, or CT pelvimetry), a flexed head, estimated fetal weight between 2,000 and 3,800 g, and frank or complete breech are common criteria used for trial of labor of breech presentation. Relative contraindications include nulliparity, estimated fetal weight greater than 3,800 g, and incomplete breech presentation. Patients with these contraindications are usually recommended to undergo cesarean delivery. However, if a patient wishes to attempt vaginal delivery, careful monitoring of the fetus and progress of labor is imperative.

OTHER MALPRESENTATION

Malpresentation can occur even in the setting of a cephalic or vertex presentation. The face, brow, or a compound presentation with a fetal upper extremity can complicate the cephalic presentation. Additionally, the shoulder can present in the setting of a transverse lie.

Face

The diagnosis of face presentation (Fig. 6-4) can be made with vaginal examination and palpation of the nose, mouth, eyes, or chin (mentum). If the fetus is mentum anterior, vaginal delivery will often ensue. However, with a mentum posterior or transverse, the fetus must rotate to mentum anterior to deliver vaginally. Augmentation is used only sparingly with a face presentation as the pressure on the face leads to edema. Of note, many anencephalic fetuses have a face presentation.

Brow

Brow presentation (Fig. 6-5) occurs when the portion of the fetal skull just above the orbital ridge presents. With the brow presenting, a larger diameter must pass through the pelvis. Therefore, unless the fetal head is particularly small (e.g., preterm) or the pelvis is particularly large, the brow presentation must convert to vertex or face to deliver.

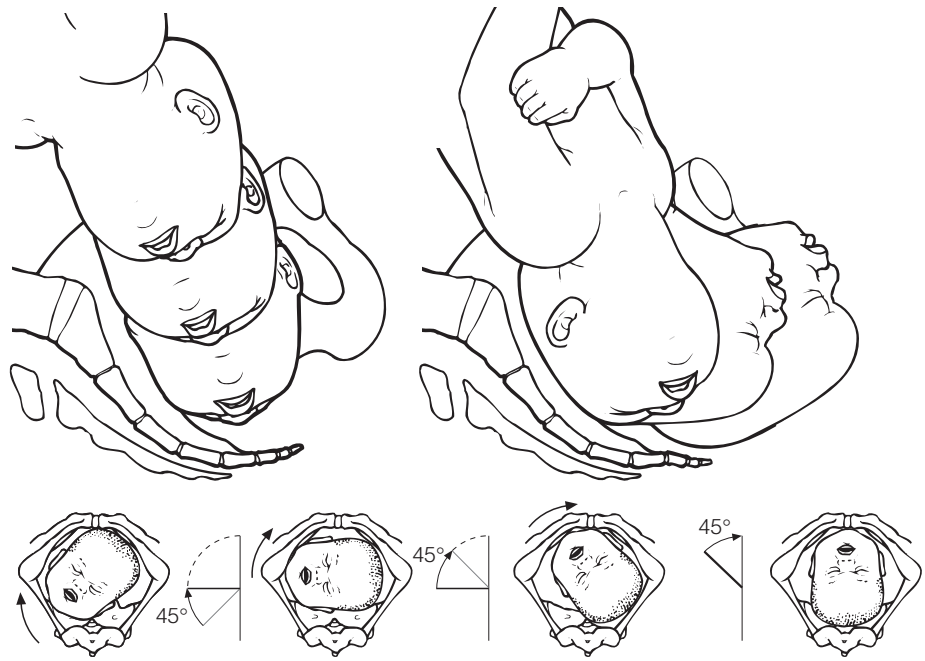


Figure 6-4 • **(A)** Mechanisms of labor for right mentum posterior position with subsequent rotation of mentum anterior and delivery. **(B)** Face presentation with fetal head well engaged in the mentolateral position.

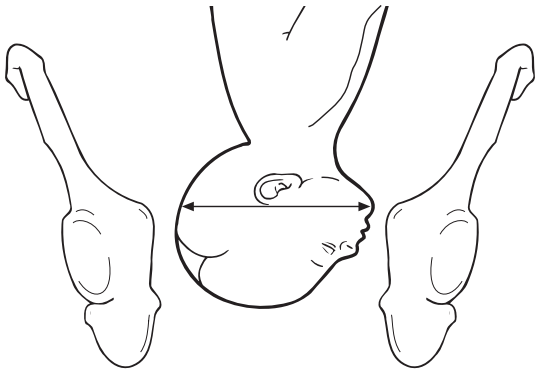


Figure 6-5 • Brow presentation with mentovertex diameter presenting.

Compound Presentation

A fetal extremity presenting alongside the vertex or breech is considered a compound presentation (Fig. 6-6). This occurs in less than 1:1,000 pregnancies. The rate increases with prematurity, multiple gestations, polyhydramnios, and CPD. A common complication of compound presentation is umbilical cord prolapse. The diagnosis is often made with vaginal examination when the fetal extremity is palpated alongside the presenting part. At this point, it should be determined whether the prolapsed fetal part is a hand or foot. Ultrasound may be used to determine the type of extremity presenting.

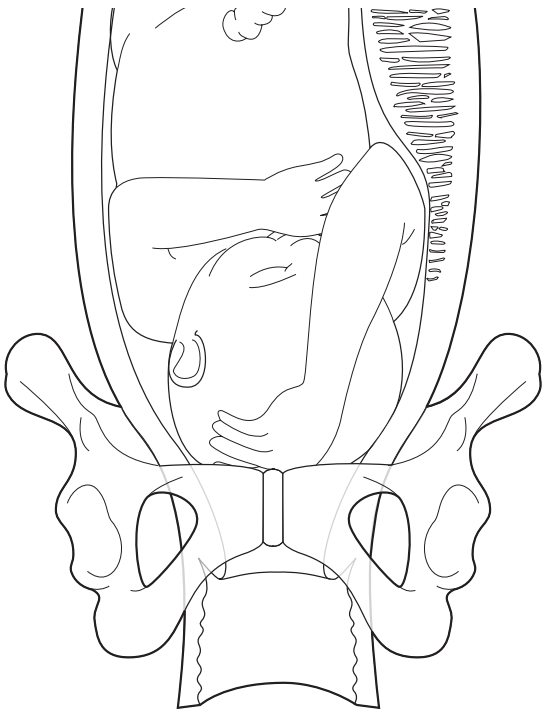


Figure 6-6 • Compound presentation with the left hand lying in front of the vertex. With further labor, the hand and arm may retract from the birth canal and the head may then descend normally.

Often, if an upper extremity is presenting alongside the vertex, the part may be gently reduced. However, prolapse of a lower extremity in vertex presentation is far less likely to deliver vaginally. Compound presentation of a lower extremity with a breech is considered a footling or incomplete breech presentation and calls for cesarean section. In all cases of compound presentation, umbilical cord prolapse should be suspected and careful monitoring with continuous fetal heart tracings and frequent vaginal examinations should ensue.

Shoulder

If the fetus is in a transverse lie, often the shoulder is presenting to the pelvic inlet. Diagnosis of this malpresentation can be made with abdominal or vaginal examination and ultrasound confirmation. Unless there is spontaneous conversion to vertex, shoulder presentations are delivered via cesarean section because of the increased risk of cord prolapse, increased risk for uterine rupture, and the difficulty of vaginal delivery.

MALPOSITION

The fetal position that optimizes the probability of the fetal head passing through the maternal pelvis is occiput anterior (OA). Left OA (LOA) and right OA (ROA) are also normal and commonly complete internal rotation to OA by the late first stage or second stage of labor. However, if the fetus is occiput transverse (OT) or occiput posterior (OP), it is called malposition, particularly in active first stage of labor or second stage. Fetal malposition has an association with a higher rate of cesarean delivery. Interestingly, it is seen more commonly with epidural use. It appears that the epidural does not cause the fetus to become OP or OT, but for those in OP or OT position at the time of epidural placement, they are more likely to stay OP or OT than in pregnancies where an epidural was not obtained.

Persistent Occiput Transverse and Posterior Position

The most common position of the fetus at the onset of labor is either left occiput transverse (LOT) or right occiput transverse (ROT). From the transverse position, the cardinal movement of internal rotation usually converts the fetus to the occiput anterior (OA) position. However, it is not uncommon for the fetus to stay in the occiput transverse (OT) position or rotate to the occiput posterior (OP) position. If this occurs, the progress of labor may be arrested. Diagnosis is made by palpation of the fetal sutures and fontanelles, and following the progress of labor.

A persistent OT position leading to arrest of labor is more common in women with a platypelloid pelvis. If the cervix is not fully dilated, a minority of clinicians will make an attempt at manual rotation to the OA position. However, if the cervix is fully dilated, rotation to the OA position can be attempted manually or with forceps. Additionally, in the setting of full dilation, an attempt at vacuum delivery may be effective as the traction on the fetal scalp may lead to autorotation to the OA position.

During descent, OP positions may rotate to OA, although this does not always occur and can slow progress in labor. The management is similar to that for OA position: patiently watch and wait. However, spontaneous vaginal delivery occurs less often. In the setting of OP or OT position and active phase arrest, manual rotation prior to complete cervical dilation has been described, though it may be associated with injury

to the cervix. If the second stage of labor is prolonged, the options include delivery of the fetus with forceps or vacuum in the OP position, rotation with forceps, or manual rotation. In either the OT or OP position, if the attempt at rotation or operative vaginal delivery fails, cesarean delivery is commonly required. While OP position fetuses deliver vaginally in about 50% of cases, OT position fetuses rarely deliver vaginally in the OT position and must rotate to either OA or OP to deliver vaginally.

OBSTETRIC EMERGENCIES

FETAL BRADYCARDIA

One of the most common events in labor and delivery that leads to anxiety among both the practitioners and the patients is fetal heart rate (FHR) bradycardia. Any time the fetal heart rate is below 100 to 110 bpm for longer than 2 minutes, it is called a **prolonged deceleration**. Longer than 10 minutes is termed **bradycardia**. Older terminology deemed a deceleration lasting longer than 2 minutes a bradycardia, and so this term is commonly used in labor and delivery in the setting of prolonged decelerations. Either way, these FHR decelerations are associated with a number of complications such as placental abruption, cord prolapse, uterine tetanic contraction, uterine rupture, pulmonary embolus (PE), amniotic fluid embolus (AFE), and seizure. They have also been associated with poor fetal outcome.

The etiology of prolonged FHR decelerations can be considered to be preuterine, uteroplacental, or postplacental. Preuterine issues would be any event leading to maternal hypotension or hypoxia. These would include seizure, AFE, PE, MI, respiratory failure, or recent epidural or spinal placement leading to hypotension. Uteroplacental issues include placental abruption, infarction, and hemorrhaging previa, as well as uterine hyperstimulation. Postplacental etiologies include cord prolapse, cord compression, and rupture of a fetal vessel such as vasa previa.

Diagnosis

FHR decelerations are usually not subtle. However, the FHR can easily be confused with the maternal heart rate, which is commonly between 60 to 100 bpm, and therefore, these should be differentiated. This can be done by placing a fetal scalp electrode (FSE) on the fetal scalp and concomitantly an O_2 saturation monitor on the mother. In facilities without access to these tools, palpation of the maternal pulse while listening to the FHR can usually help differentiate between the two.

Diagnosis of the etiology of the bradycardia is often more important than the diagnosis of bradycardia, which is relatively straightforward in the era of continuous fetal monitoring. A simple algorithm to diagnose the etiology of bradycardia is as follows:

1. Look at the mother for signs of respiratory compromise or change in mental status. This should commonly diagnose seizures, PE, and AFE.
2. While putting on a glove for a cervical examination, assess the maternal BP and heart rate. This will diagnose maternal hypotension, commonly seen after epidural placement and a potential cause of FHR decelerations. This will also aid in determining whether the FHR being recorded could be maternal.
3. Immediately before the examination look to see how much vaginal blood is passing. With increased vaginal bleeding, placental abruption and uterine rupture should be considered. If placentation is unknown, placenta previa is also a possibility. Rarely, vaginal bleeding is secondary to rupture of a fetal vessel as in vasa previa.
4. Examine the patient with one hand on the maternal abdomen and one hand vaginally feeling for cervical dilation, fetal station, and prolapsed umbilical cord. The abdominal hand should feel for uterine hyperstimulation and fetal parts outside the uterus. If the fetal station is dramatically lower than expected, then the prolonged FHR deceleration may be due to rapid descent and vagal stimulation. If the fetal station is much higher than expected, uterine rupture should be suspected. If the cervix is fully dilated and the fetus in the pelvis, operative vaginal delivery can be performed if the FHR decelerations do not resolve in a timely fashion.

Treatment

In the setting of prolonged FHR deceleration, the initial management is standardized. The patient is moved to left or right lateral decubitus position to resolve a FHR deceleration secondary to compression of the inferior vena cava (IVC), leading to decreased preload or, more commonly, a compressed umbilical cord by the fetus. Oxygen by face mask is commonly administered to the mother in case hypoxia is an issue. The examination is performed as described above, and the individual etiologies are diagnosed and treated appropriately. In the setting of maternal hypotension, the patient can be given aggressive IV hydration and ephedrine. The management of seizure, AFE, uterine rupture, are discussed later in the current chapter, and PE is discussed in Chapter 11. Tetanic uterine contraction is treated with nitroglycerin, usually administered via a sublingual spray, and/or terbutaline (a β-agonist tocolytic). If umbilical cord prolapse is identified, there have been case reports of replacement into the uterus; but most commonly this requires an emergent cesarean delivery, performed with the examining clinician lifting the fetal head to avoid compression of the prolapsed cord. In the setting of previa, cesarean delivery should be expedited. If abruption is suspected, and the patient is remote from delivery, cesarean section may be necessary.

It is imperative that the timing of these events is followed very closely. Clinicians need to know the capabilities of their labor and delivery units and the rapidity of response of the anesthesiologists. Commonly, a patient is moved from the labor room to the OR after 4 to 5 minutes of FHR deceleration. If the FHR is checked in the OR (at this time, usually 8 minutes) and the bradycardia persists, plans for emergent cesarean delivery should proceed. The rapidity of this delivery may not allow all of the most common sterile techniques typically employed because delivery of the fetus within the next 2 to 4 minutes is the goal.

SHOULDER DYSTOCIA

Once the head of the fetus is delivered, the difficulty in delivering the shoulders, particularly because of impaction of the anterior shoulder behind the pubic symphysis, is termed **shoulder dystocia**. Risk factors for shoulder dystocia include fetal macrosomia (weight over 4,000 g), preconceptional and gestational diabetes, previous shoulder dystocia, maternal obesity, postterm pregnancy, prolonged second stage of labor,

and operative vaginal delivery. The incidence of shoulder dystocia has been reported to be between 0.15% and 1.7% of all vaginal deliveries. Increased morbidity and mortality are associated with shoulder dystocia. Fetal complications include fractures of the humerus and clavicle, brachial plexus nerve injuries (Erb palsy), phrenic nerve palsy, hypoxic brain injury, and death.

Diagnosis

The actual diagnosis of a shoulder dystocia is made when routine obstetric maneuvers fail to deliver the fetus. When antepartum risk factors are present, shoulder dystocia can be predicted, prepared for, and possibly even prevented. Preparation for a shoulder dystocia includes placing the patient in the dorsal lithotomy position, having adequate anesthesia, and having several experienced clinicians present at the birth. At the time of delivery, suspicion is increased with prolonged crowning of the head and then with the "turtle" sign of either incomplete delivery of the head or the chin tucking up against the maternal perineum. When a fetus is suspected to weigh over 4,500 g, elective cesarean section should be offered.

Treatment

As with any obstetric emergency, it is important to have all members of the health care team effectively working together. Once a shoulder dystocia is identified, the labor and delivery alert should be sounded and the pediatric team should be called. Similar to a code, someone needs to be running the shoulder dystocia emergency; in a teaching hospital this is usually the attending or chief resident, and in a private hospital, this is usually the delivering obstetrician. Someone should be assigned to keep track of time, as a shoulder dystocia can lead to entrapment and complete compression of the umbilical cord, thus delivery in less than 5 minutes is imperative. Two individuals should be assigned to hold the patient's legs and one person assigned to give suprapubic pressure.

The specific series of maneuvers for delivering an infant with a shoulder dystocia are as follows:

- **McRoberts maneuver**—sharp flexion of the maternal hips that decreases the inclination of the pelvis increasing the AP diameter can free the anterior shoulder (Fig. 6-7).
- **Suprapubic pressure**—pressure applied just above the maternal pubic symphysis at an oblique angle to dislodge the anterior shoulder from behind the pubic symphysis (Fig. 6-8).
- **Rubin maneuver**—pressure on an either accessible shoulder toward the anterior chest wall of the fetus to decrease the bisacromial diameter and free the impacted shoulder (Fig. 6-9).

Figure 6-7 • Sharp flexion of both maternal hips (McRoberts maneuver) brings the pelvic inlet and outlet into a more vertical alignment, facilitating delivery of the fetal shoulders.

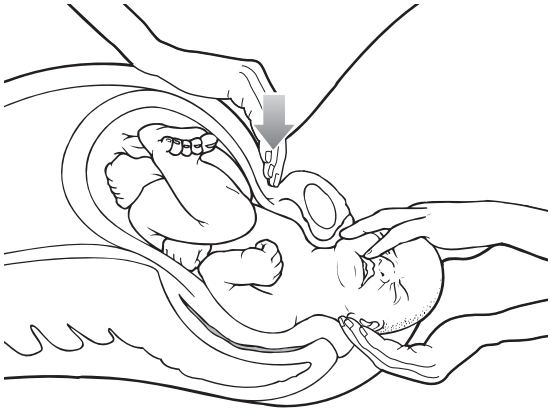


Figure 6-8 • Moderate suprapubic pressure is often the only additional maneuver necessary to free the anterior fetal shoulder.

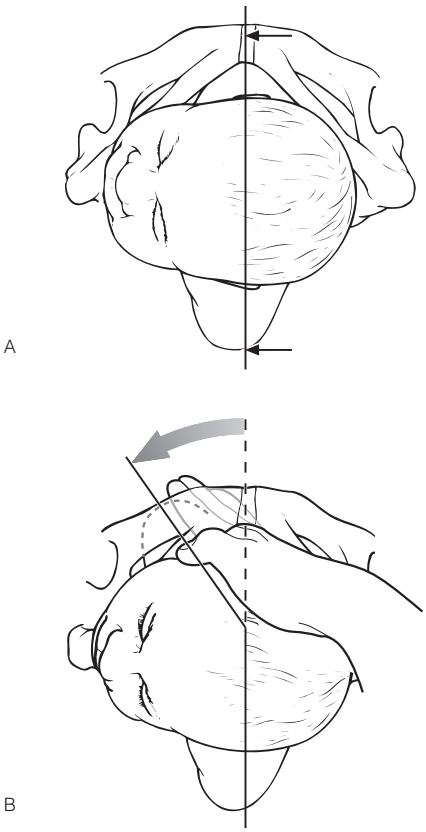


Figure 6-9 • Rubin maneuver. **(A)** The shoulder-to-shoulder diameter is shown as the distance between the two small arrows. **(B)** The most easily accessible fetal shoulder (the anterior is shown here) is pushed toward the anterior chest wall of the fetus. Most often, this results in abduction of both the shoulders, reducing the shoulder-to-shoulder diameter, and freeing the impacted anterior shoulder.

- **Wood's corkscrew maneuver**—pressure behind the posterior shoulder to rotate the infant and dislodge the anterior shoulder.
- **Delivery of the posterior arm/shoulder**—delivery of the posterior arm by sweeping the posterior arm across the chest to allow the bisacromial diameter to rotate to an oblique diameter of the pelvis and the anterior shoulder to be freed.

If these maneuvers are unsuccessful, they may be performed again. If the infant is still undelivered, there are several other maneuvers that can be performed. A generous episiotomy may provide more room to deliver the posterior arm/shoulder, or the cutting or fracturing the fetal clavicle can disimpact the anterior shoulder. If these maneuvers fail, the **Zavanelli** maneuver, which involves placing the infant's head back into the pelvis and performing cesarean delivery, can be attempted. Additionally, symphysiotomy, cutting the maternal pubic symphysis, will often release the infant; however, this is a morbid procedure often complicated by infection, healing difficulties, and chronic pain. Thus, it should be reserved for the true emergency, and in the United States, most clinicians would simply do a cesarean and attempt to facilitate delivery abdominally before performing a symphysiotomy.

UTERINE RUPTURE

Uterine rupture is seen in 1 in 10,000 to 20,000 deliveries in patients with unscarred uteri. Associated complications in these patients include uterine fibroids, uterine malformations, obstructed labor, and the use of uterotonic agents such as oxytocin and prostaglandins. In patients who have had a prior uterine scar from myomectomy or cesarean delivery, the risk of uterine rupture is theoretically 0.5% to 1.0%. The risk is increased in patients who have more than one cesarean scar, have a "classical" or high vertical scar, undergo labor induction, and/or are treated with uterotonic agents.

Uterine rupture is suspected in the setting of FHR decelerations in patients with prior scars on their uterus. Patients may feel a "popping" sensation or experience sudden abdominal pain. On physical examination, the fetus may be palpable in the extrauterine space, there may be vaginal bleeding, and commonly the fetal presenting part is suddenly at a much higher station than previously. If a uterine rupture is strongly suspected, the patient should be taken to the OR for immediate cesarean delivery and exploratory laparotomy.

MATERNAL HYPOTENSION

Pregnant patients commonly have BPs around 90/50 mm Hg. BPs much lower than the 80/40 mm Hg range is unusual and can lead to poor maternal and uterine perfusion. Common etiologies of maternal hypotension include vasovagal events, regional anesthesia, overtreatment with antihypertensive drugs, hemorrhage, anaphylaxis, and AFE. Most of these events can be differentiated quickly by the clinical scenario.

Treatment of maternal hypotension may vary depending on the etiology, but the mainstays are aggressive IV hydration and adrenergic medications to constrict peripheral vessels, and increase both the preload and the afterload. If the event occurs in close proximity to medication administration, Benadryl and epinephrine should be considered for a possible anaphylactic reaction. If the patient has an AFE, the mortality rate is quite high. The definitive diagnosis of AFE is the finding of fetal cells in the pulmonary vasculature at autopsy.

SEIZURE

Seizures on labor and delivery are usually quite startling and can be dangerous. In patients with a history of a seizure disorder as well as those with preeclampsia, careful observation for particular seizure precursors is maintained. However, many patients who seize on labor and delivery have no history and may be normotensive.

Many vasovagal events are misdiagnosed as a seizure because the patient may have several tonic–clonic movements. One of the key ways to differentiate between the two is the presence of a postictal period after the event. To help sort out the etiology, patients should have a full preeclamptic workup, toxicology panel, chemistry panel, and, when it is safe for the patient to leave the unit, obtain a head CT. A neurology consult is also indicated. Acutely, the patients should be managed with the ABCs of resuscitation and with antiseizure medications (Table 6-1). In pregnancy, magnesium sulfate is the antiseizure medication of choice.

TABLE 6-1 Management of a Pregnant Patient with Seizures or in Status Epilepticus

Assess and establish airway and vital signs including oxygenation
Assess FHR or fetal status
Bolus magnesium sulfate, or give 10 g IM
Bolus with lorazepam 0.1 mg/kg, 5.0–10.0 mg at no more than 2.0 mg/min
Load phenytoin 20 mg/kg, usually 1–2 g at no more than 50 mg/min
If not successful, load phenobarbital 20 mg/kg, usually 1–2 g at no more than 100 mg/min
Laboratory tests include CBC, metabolic panel, AED levels, and toxicology screen
If fetal testing is not reassuring, move to emergent delivery

KEY POINTS

- Preterm delivery occurs in greater than 10% of all pregnancies.
- PTL is treated with tocolytics including β-agonists, magnesium, calcium channel blockers, and NSAIDs.
- Current tocolytics are only marginally effective, but may buy time for a course of betamethasone to accelerate fetal lung maturity.
- Preterm rupture of membranes is when ROM occurs before 37 weeks of gestation; premature rupture of membranes (PROM) is ROM that occurs before the onset of labor.
- The latency period prior to the onset of labor is inversely correlated with gestational age in PPROM.
- Once ROM is confirmed, the therapeutic course depends on gestational age, risk of infection, and fetal lung maturity; any patient who shows signs of infection or fetal distress needs delivery.
- If the fetal head is too large to pass through the maternal pelvis, it is deemed CPD.
- Unless ultrasound and CT have been used to document a fetal head larger than the maternal pelvis, in the case of suspected CPD, a trial of labor is often attempted.
- There are three types of breech: frank, complete, and incomplete or footling.
- Breech presentations may be managed by external version to vertex, cesarean delivery, and less frequently a trial of labor. The complications of labor and delivery of breech presentation include cord prolapse and entrapment of the fetal head.
- Vertex malpresentations include face, brow, compound, and persistent OP. These presentations will often deliver vaginally but need closer monitoring and sometimes require different maneuvers.
- Prolonged fetal heart rate decelerations may have a variety of etiologies and can be thought of as preuterine, uteroplacental, and postplacental.
- A quick examination and verification of vital signs will often determine the etiology of a prolonged deceleration.
- If there is no sign of resolution of the FHR deceleration in 4 to 5 minutes, the patient should either be delivered vaginally or moved to the OR for cesarean.
- Shoulder dystocias can result in fetal fractures, nerve damage, and hypoxia.
- Risk factors for shoulder dystocia include fetal macrosomia, diabetes, previous dystocia, maternal obesity, postterm deliveries, and prolonged stage 2 of labor.
- The maneuvers to reduce a shoulder dystocia include McRoberts maneuver, suprapubic pressure, Rubin maneuver, Wood's corkscrew maneuver, delivery of posterior arm, episiotomy, fracture or cutting the clavicle or pubic symphysis, and the Zavanelli maneuver.
- Uterine rupture is uncommon in patients with no prior uterine scar; it is seen in 0.5% to 1.0% of patients who labor with a prior cesarean delivery.
- Maternal hypotension may have a variety of etiologies including regional anesthesia, hemorrhage, vasovagal events, AFE, and anaphylaxis.
- The first-line treatment of patients with seizures in pregnancy is IV or IM magnesium sulfate.