Chapter 29: Operative Vaginal Delivery

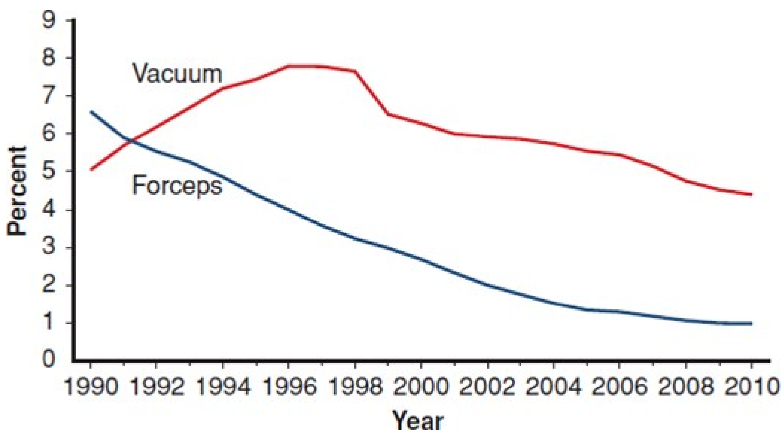
Introduction

Operative deliveries are vaginal deliveries accomplished with the use of a vacuum device or forceps. Once either is applied to the fetal head, outward traction generates forces that augment maternal pushing to deliver the fetus vaginally. The most important function of both devices is traction. In addition, however, forceps may also be used for rotation, particularly from occiput transverse and posterior positions.

The precise frequency of operative vaginal delivery in the United States is unknown. According to the birth certificate data from the National Vital Statistics Report, forceps- or vacuum-assisted vaginal delivery was used for 3.6 percent of births in the United States in 2010. According to Yeomans (2010), the vacuum-to-forceps delivery ratio is 4:1. Figure 29-1 depicts the decline in the rates of this type of delivery since 1990. In general, operative vaginal delivery attempts are successful. In the United States in 2006, only 0.4 percent of forceps trials and 0.8 percent of vacuum extraction attempts failed to result in vaginal delivery (Osterman, 2009).

Figure 29-1

Decline in operative vaginal delivery rates, 1990–2010. (From Martin, 2012.)



Indications

If it is technically feasible and can be safely accomplished, termination of second-stage labor by operative vaginal delivery is indicated in any condition threatening the mother or fetus that is likely to be relieved by delivery. Some fetal indications for operative vaginal delivery include nonreassuring fetal heart rate pattern and premature placental separation. In the past, forceps delivery was believed to be somewhat protective of the fragile preterm infant head. Subsequent studies, however, reported no significant differences in outcomes for neonates who weighed 500 to 1500 g between those delivered spontaneously and those delivered by outlet forceps (Fairweather, 1981; Schwartz, 1983).

Some maternal indications include heart disease, pulmonary injury or compromise, intrapartum infection, and certain neurological conditions. The most common are exhaustion and prolonged second-stage labor. For nulliparas, the latter is defined as > 3 hours with or > 2 hours without regional analgesia (American College of Obstetricians and Gynecologists, 2012). In parous women, it is defined as > 2 hours with and > 1 hour without regional analgesia.

Operative vaginal delivery should generally be performed from either a low or outlet station. Additionally, forceps or vacuum delivery generally should not be used *electively* until the criteria for an outlet delivery have been met. In these circumstances, operative vaginal delivery is a simple and safe operation, although with some risk of maternal lower reproductive tract injury (Yancey, 1991). Moreover, there is no evidence that use of prophylactic operative delivery is beneficial in the otherwise normal delivery.

Classification and Prerequisites

The American College of Obstetricians and Gynecologists (2012) classifies operative vaginal deliveries as summarized in Table 29-1. It emphasizes that the two most important discriminators of risk for both mother and infant are station and rotation. Station is measured in centimeters, –5 to 0 to +5. Zero station reflects a line drawn between the ischial spines. Deliveries are categorized as outlet, low, and midpelvic procedures. High forceps, in which instruments are applied above 0 station, have no place in contemporary obstetrics.

TABLE 29-1

Operative Vaginal Delivery Prerequisites and Classification According to Station and Rotation[a]

Procedure	Criteria
Outlet forceps	• Scalp is visible at the introitus without separating the labia • Fetal skull has reached pelvic floor • Fetal head is at or on perineum • Sagittal suture is in anteroposterior diameter or right or left occiput anterior or posterior position, and • Rotation does not exceed 45 degrees
Low forceps (2 types)	Leading point of fetal skull is at station ≥ +2 cm, and not on the pelvic floor, and: a. Rotation is 45 degrees or less, *or* b. Rotation is greater than 45 degrees
Midforceps	Station is between 0 and +2 cm
High	Not included in classification
Prerequisites	
1. Experienced operator 2. Engaged head 3. Ruptured membranes 4. Vertex presentation[b] 5. Completely dilated cervix 6. Precisely assessed fetal head position 7. Cephalopelvic disproportion not suspected 8. No fetal coagulopathy or bone demineralization disorder	

[a]Classification for the vacuum delivery system is the same as for forceps except that vacuum is used for traction but not rotation.

[b]Forceps, but not vacuum extractor, may be used for delivery of a face presentation with mentum anterior.

Once station and rotation are assessed, there are several prerequisites for operative vaginal delivery (see Table 29-1). In addition and specific to vacuum extraction, fetuses should be at least 34 weeks gestational age, and although infrequently used in the United States, fetal scalp blood sampling should not have been recently performed.

Regional analgesia or general anesthesia is preferable for low forceps or midpelvic procedures, although pudendal blockade may prove adequate for outlet forceps. Before operative vaginal delivery, the bladder should also be emptied to provide additional pelvic space and minimize bladder trauma.

Morbidity

In general, a higher station and/or greater degrees of rotation increase the chance of maternal or fetal injury. In the discussion of operative vaginal delivery, morbidity is most properly compared with morbidity from cesarean delivery, and not with that from spontaneous vaginal delivery. This is because the alternative to indicated operative vaginal delivery is cesarean delivery. As examples, postpartum uterine infection and pelvic cellulitis are more frequent, and often more severe, in women following cesarean delivery compared with that following operative vaginal delivery (Robertson, 1990). Moreover, in a study of more than 1 million births, Spiliopoulos and associates (2011) reported cesarean delivery, but not operative vaginal delivery, as a risk for peripartum hysterectomy.

Maternal Morbidity

Lacerations

The very conditions that lead to indications for operative vaginal delivery also increase the need for episiotomy and the likelihood of lacerations (de Leeuw, 2008). That said, operative vaginal delivery is associated with higher rates of third- and fourth-degree lacerations as well as vaginal wall and cervical lacerations (Hamilton, 2011; Hirayama, 2012; Landy, 2011). These appear to occur more frequently with forceps compared with vacuum extraction, and especially if there is a midline episiotomy (Kudish, 2006; O'Mahony, 2010). Hagadorn-Freathy and coworkers (1991) reported a 13-percent rate of third- and fourth-degree episiotomy extensions and vaginal lacerations for outlet forceps, 22 percent for low forceps with less than 45-degree rotation, 44 percent for low forceps with more than 45-degree rotation, and 37 percent for midforceps deliveries.

In an effort to lower rates of third- and fourth-degree lacerations, and coincident with overall efforts to reduce routine episiotomy use, many advocate only indicated episiotomy with operative vaginal delivery. For example, Ecker and colleagues (1997) reported a significant decrease in the episiotomy rate with both forceps—96 to 30 percent—as well as vacuum—89 to 39 percent—deliveries from 1984 to 1994. During this time, there was a decrease in fourth-degree but no change in third-degree lacerations. If episiotomy is required, several studies have reported a protective effect from mediolateral episiotomy against these more extensive perineal lacerations (de Leeuw, 2008; de Vogel, 2012; Hirsch, 2008). But as discussed in Chapter 27 (Repair of Episiotomy or Perineal Laceration), this is balanced against the additional potential morbidity compared with a midline episiotomy. Early disarticulation of forceps and cessation of maternal pushing during disarticulation can also be protective. Last, these injuries are more common with operative vaginal delivery from an occiput posterior position (Damron, 2004). Thus, manual or forceps rotation from occiput posterior to occiput anterior position and then subsequent operative vaginal delivery may decrease lower-reproductive-tract injury.

Pelvic Floor Disorders

This term encompasses urinary incontinence, anal incontinence, and pelvic organ prolapse. Operative vaginal delivery has been suggested as a possible risk for each of these. Proposed mechanisms include structural compromise and/or pelvic floor denervation secondary to forces exerted during delivery.

Urinary retention and bladder dysfunction are often short-term effects of forceps and vacuum deliveries (Mulder, 2012). Importantly, episiotomy and epidural analgesia, both common associates of operative vaginal delivery, are also identified risks for urinary retention. Symptoms are brief and typically resolve with 24 to 48 hours of passive catheter bladder drainage.

Regarding more sustained urinary dysfunction, parity and specifically vaginal delivery are known risk factors for urinary incontinence (Gyhagen, 2013; Rortveit, 2003). And, a few studies show a greater attributable risk with operative vaginal delivery (Baydock, 2009; Handa, 2011). But, many studies do not support an increased risk compared with vaginal delivery alone (Handa, 2012; Leijonhufvud, 2011; MacArthur, 2006; Thom, 2011).

Evidence linking anal incontinence with operative vaginal delivery is conflicting. Some studies show that anal sphincter disruption caused by higher-order episiotomy, but not delivery mode, is the main etiological factor strongly associated with anal incontinence (Baud, 2011; Bols, 2010; Evers, 2012; Nygaard, 1997). In contrast, others directly link operative vaginal delivery with this complication (MacArthur, 2005; Pretlove, 2008). But, these studies may not be incongruous as operative vaginal delivery, as previously discussed, is associated with increased rates of higher-order episiotomy. Importantly, several studies and reviews have not found cesarean delivery to be protective for anal incontinence (Nelson, 2010).

Last, evidence linking pelvic organ prolapse with operative vaginal delivery also shows mixed results (Gyhagen, 2013; Handa, 2011). Interestingly, Glazener and associates (2013) evaluated women 12 years after delivery by means of a symptom questionnaire and physical examination. Complaints of prolapse *symptoms* were linked to operative vaginal delivery, but true *objective measurement of prolapse* showed a protective effect from this delivery mode compared with vaginal delivery alone.

Perinatal Morbidity

Acute Perinatal Injuries

These are more frequent with operative vaginal deliveries than with cesarean delivery or spontaneous vaginal delivery alone. Although these may be seen with either method, they are more commonly seen with vacuum extraction. Some injuries include cephalohematoma, subgaleal hemorrhage, retinal hemorrhage, neonatal jaundice secondary to these hemorrhages, shoulder dystocia, clavicular fracture, and scalp lacerations. Cephalohematoma and subgaleal hemorrhage are both extracranial lesions described in Chapter 33 (Extracranial Hematomas).

In 1998, the Food and Drug Administration issued a Public Health Advisory regarding the possible association of vacuum-assisted delivery with serious fetal complications, including death. In response, the American College of Obstetricians and Gynecologists (1998) issued a Committee Opinion recommending the continued use of vacuum-assisted delivery devices when appropriate. At that time, they estimated that there was approximately one adverse event per 45,455 vacuum extractions per year.

In contrast, forceps-assisted vaginal delivery has higher rates of facial nerve injury, brachial plexus injury, depressed skull fracture, and corneal abrasion (Demissie, 2004; Dupuis, 2005; American College of Obstetricians and Gynecologists, 2012). And while some studies have associated vacuum extraction with higher rates of intracranial hemorrhage, others show similar rates with either of the two methods (Towner, 1999; Wen, 2001; Werner, 2011).

As a group, if operative vaginal delivery is compared with cesarean delivery, rates of extracranial hematoma, skull fracture, facial nerve or brachial plexus injury, retinal hemorrhage, and facial or scalp laceration are lower with cesarean delivery, and shoulder dystocia is eliminated. Importantly, however, fetal acidemia rates are not increased with operative vaginal delivery (Contag, 2010; Walsh, 2013). Intracranial hemorrhage rates are similar among infants delivered by vacuum extraction, forceps, or cesarean delivery during labor (Towner, 1999). But, these rates are higher than among those delivered spontaneously or by cesarean delivery before labor. These authors suggest that the common risk factor for intracranial hemorrhage is abnormal labor. Werner and associates (2011), in their evaluation of more than 150,000 singleton deliveries, reported that forceps-assisted delivery was associated with fewer total neurological complications compared with vacuum-assisted or cesarean delivery. However, as a subset, subdural hemorrhage was significantly more frequent in both operative vaginal delivery cohorts compared with infants in the cesarean delivery group.

Reports of neonatal morbidity rates compared between midforceps and cesarean delivery are conflicting. In the study by Towner and colleagues (1999), similar risks were reported for intracranial hemorrhage. Bashore and associates (1990) observed comparable Apgar scores, cord blood acid-base values, neonatal intensive care unit admission, and birth trauma between these two. In another study, however, Robertson and coworkers (1990) reported significantly higher rates of these adverse outcomes in the midforceps group. And Hagadorn-Freathy and colleagues (1991) reported an increased risk for facial nerve palsy—9 percent—with midforceps delivery.

Mechanisms of Acute Injury

In general, with operative vaginal delivery, the types of fetal injury can usually be explained by the forces exerted. In cases of cephalohematoma or subgaleal hemorrhage, suction and perhaps rotation during vacuum extraction may lead to a primary vessel laceration (Fig. 33-1, Spinal Cord Injury). Intracranial hemorrhage may result from skull fracture and vessel laceration or from vessel laceration alone due to exerted forces. With facial nerve palsy, one of the forceps blades may compress the nerve against the facial bones (Duval, 2009; Falco, 1990). The higher rates of shoulder dystocia seen with vacuum extraction may result from the angle of traction. With the vacuum, this angle creates vector forces that actually pull the anterior shoulder into the symphysis pubis (Caughey, 2005). To explain brachial plexus injury, Towner and Ciotti (2007) proposed that as the fetal head descends down the birth canal, the shoulders may stay above the pelvic inlet. Thus, similar to shoulder dystocia at the symphysis, this "shoulder dystocia at the pelvic inlet" is overcome by traction forces but with concomitant stretch on the brachial plexus.

Long-Term Infant Morbidity

Evidence regarding long-term neurodevelopmental outcomes in children delivered by operative vaginal delivery is reassuring. Seidman and colleagues (1991) evaluated more than 52,000 Israeli Defense Forces draftees at age 17 years and found that regardless of delivery mode, there were similar rates of physical or cognitive impairments. Wesley and associates (1992) noted similar intelligence scores among 5-year-olds following spontaneous, forceps, or vacuum deliveries. Murphy and coworkers (2004) found no association between forceps delivery and epilepsy in a cohort of 21,441 adults. In their epidemiological review, O'Callaghan and colleagues (2011) found no association between cerebral palsy and operative vaginal delivery. A prospective study by Bahl and associates (2007) included children of 264 women who underwent operative delivery. Their incidence of neurodevelopmental morbidity was similar in those undergoing successful forceps delivery, failed forceps with cesarean delivery, or cesarean delivery without forceps.

Data regarding midforceps deliveries are for the most part reassuring. Broman and coworkers (1975) reported that infants delivered by midforceps had slightly higher intelligence scores at age 4 years compared with those of children delivered spontaneously. Using the same database, however, Friedman and associates (1977, 1984) analyzed intelligence assessments at or after age 7 years. They concluded that children delivered by midforceps had lower mean intelligence quotients compared with children delivered by outlet forceps. In yet another report from this same database, Dierker and colleagues (1986) compared long-term outcomes of children delivered by midforceps with those of children delivered by cesarean after dystocia. The strength of this study is the appropriateness of the control group. These investigators reported that delivery by midforceps was not associated with neurodevelopmental disability. Last, Nilsen (1984) evaluated 18-year-old men and found that those delivered by Kielland forceps had higher intelligence scores than those delivered spontaneously, by vacuum extraction, or by cesarean. As discussed on Rotation from Occiput Transverse Positions, Burke and coworkers (2012) reported 144 cases of attempted Kielland forceps rotation and described minimal morbidity.

Trial of Operative Vaginal Delivery

If an attempt to perform an operative vaginal delivery is expected to be difficult, then it should be considered a trial. Delivery is conducted preferably in an operating room equipped and staffed for immediate cesarean delivery. If forceps cannot be satisfactorily applied, then the procedure is stopped and either vacuum extraction or cesarean delivery is performed. With the former, if there is no descent with traction, the trial should be abandoned and cesarean delivery performed.

With such caveats, cesarean delivery after an attempt at operative vaginal delivery was not associated with adverse neonatal outcomes if there was a reassuring fetal heart rate tracing (Alexander, 2009). A similar study evaluated 122 women who had a trial of midcavity forceps or vacuum extraction in a setting with full preparations for cesarean delivery (Lowe, 1987). Investigators found no significant difference in immediate neonatal or maternal morbidity compared with that of 42 women delivered for similar indications by cesarean but without such a trial. Conversely, in 61 women who had "unexpected" vacuum or forceps failure in which there was no prior preparation for immediate cesarean delivery, neonatal morbidity was higher.

Factors associated with operative delivery failure are persistent occiput posterior position, absence of regional or general anesthesia, and birthweight > 4000 g (Ben-Haroush, 2007). In general, to avert morbidity with failed forceps or vacuum delivery, the American College of Obstetricians and Gynecologists (2012) cautions that these trials should be attempted only if the clinical assessment is highly suggestive of a successful outcome. We also emphasize proper training.

Sequential instrumentation most frequently involves an attempt at vacuum extraction followed by one with forceps. This most likely stems from the higher completion rate with forceps compared with vacuum extraction noted earlier (Indications). There is no evidence to justify this practice, as it significantly increases risks for fetal trauma (Dupuis, 2005; Murphy, 2001; Gardella, 2001). Because of these adverse outcomes, the American College of Obstetricians and Gynecologists (2012) recommends against the sequential use of instruments unless there is a "compelling and justifiable reason."

Training

As the rate of operative vaginal delivery has declined, so have opportunities for training. Fifteen years ago, Hankins and colleagues (1999) reported that fewer than half of residency directors expected proficiency with midforceps delivery. From the data shown in Figure 29-1, we, and others, would expect that number to be much lower today (Miller, 2014). In many programs, training in even low and outlet forceps procedures has reached critically low levels. For residents completing training in 2012, the Accreditation Council for Graduate Medical Education (2012) lists a median of only six forceps deliveries, and that for vacuum deliveries was 16.

Because traditional hands-on training has evolved, residency programs should have readily available skilled operators to teach these procedures by simulation as well as through actual cases (Spong, 2012). And, the effectiveness of simulation training has been reported (Bahl, 2009; Dupuis, 2006, 2009; Leslie, 2005). In one program, there were lowered rates of maternal and neonatal morbidity associated with operative vaginal delivery after the implementation of a formal education program that included a manikin and pelvic model (Cheong, 2004). In another, assignment of a labor and delivery attending with the specific goal to increase forceps delivery education led to a 59-percent increase in forceps-assisted vaginal delivery rates.

Forceps Delivery

Forceps Design

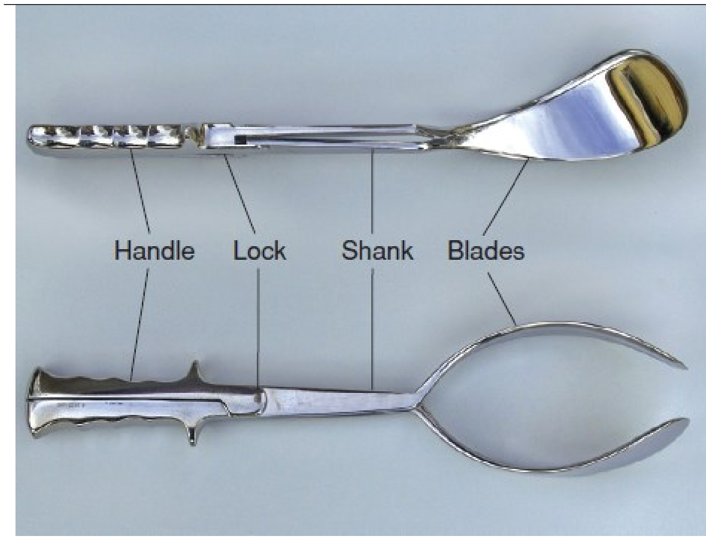
These instruments consist basically of two crossing branches. Each branch has four components: blade, shank, lock, and handle. Each blade has two curves: the outward cephalic curve conforms to the round fetal head, and the upward pelvic curve corresponds more or less to the axis of the birth canal. Some varieties have an opening within or a depression along the blade surface and are termed *fenestrated* or *pseudofenestrated*, respectively (Fig. 29-2). These blade modifications permit a firmer grasp of the fetal head, but at the expense of increased blade thickness, which may increase vaginal trauma. In general, Simpson or Elliot forceps, with their fenestrated blades, are used to deliver a fetus with a molded head, as is common in nulliparous women. The Tucker-McLane forceps have thin smooth blades and are often used for a fetus with a rounded head, which is more characteristic in multiparas (Fig. 29-3). In most situations, however, any of these are appropriate.

Figure 29-2

Elliot forceps. **A.** Note the ample pelvic curve in the blades. **B.** The cephalic curve, which accommodates the fetal head, is evident in the articulated blades. The fenestrated blade and the overlapping shank in front of the English-style lock characterize these forceps.

Figure 29-3

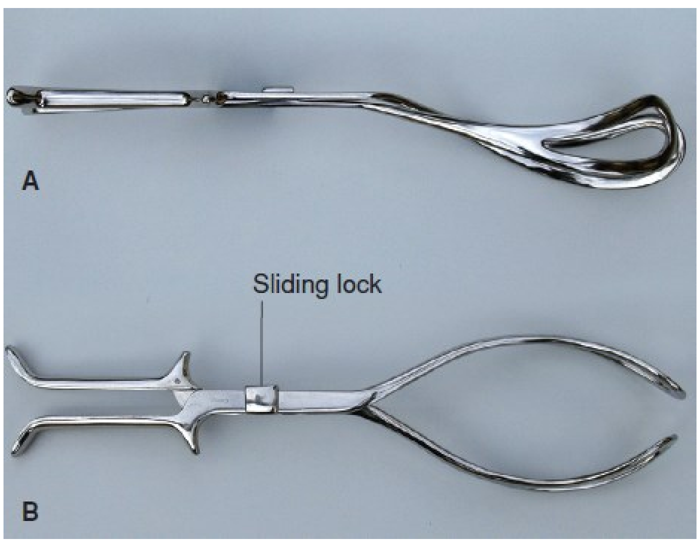
Tucker–McLane forceps. The blade is solid, and the shank is narrow.



The blades are connected to the handles by shanks. The common method of articulation, the English lock, consists of a socket located on the shank at the junction with the handle, into which fits a socket similarly located on the opposite shank (see Fig. 29-3). A sliding lock is used in some forceps, such as Kielland forceps (Fig. 29-4).

Figure 29-4

Kielland forceps. The characteristic features are minimal pelvic curvature **(A)**, sliding lock **(B)**, and light weight.



Forceps Blade Application and Delivery

Forceps blades grasp the head and are applied according to fetal head position. If the head is in an occiput anterior position, two or more fingers of the right hand are introduced inside the left posterior portion of the vulva and then into the vagina beside the fetal head. The handle of the left branch is grasped between the thumb and two fingers of the left hand (Fig. 29-5). The blade tip is then gently passed into the vagina between the fetal head and the palmar surface of the fingers of the right hand (Fig. 29-6). For application of the right blade, two or more fingers of the left hand are introduced into the right posterior portion of the vagina to serve as a guide for the right blade. This blade is held in the right hand and introduced into the vagina as described for the left blade. After positioning, the branches are articulated (Fig. 29-7). If the head is positioned in a left occiput anterior or right occiput anterior position, then the lower of the two blades is typically placed first.

Figure 29-5

The left handle of the forceps is held in the left hand. The blade is introduced into the left side of the pelvis between the fetal head and the fingers of the operator's right hand.

Figure 29-6

A. Continued insertion of the left blade. The right hand, not shown here, guides the blade during placement. Note the arc of the handles as they rotate to be applied to the mother's left. **B.** First blade in place. An assistant's hand can hold this handle in place as the second blade is applied.

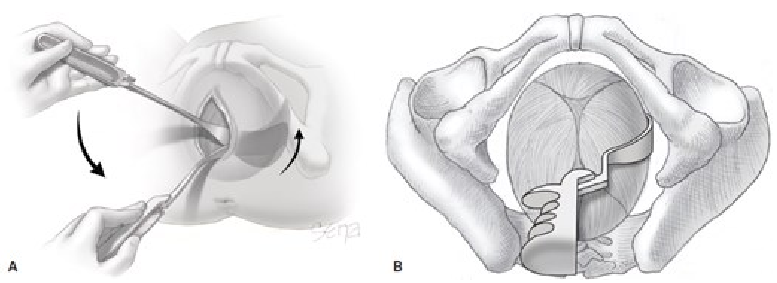
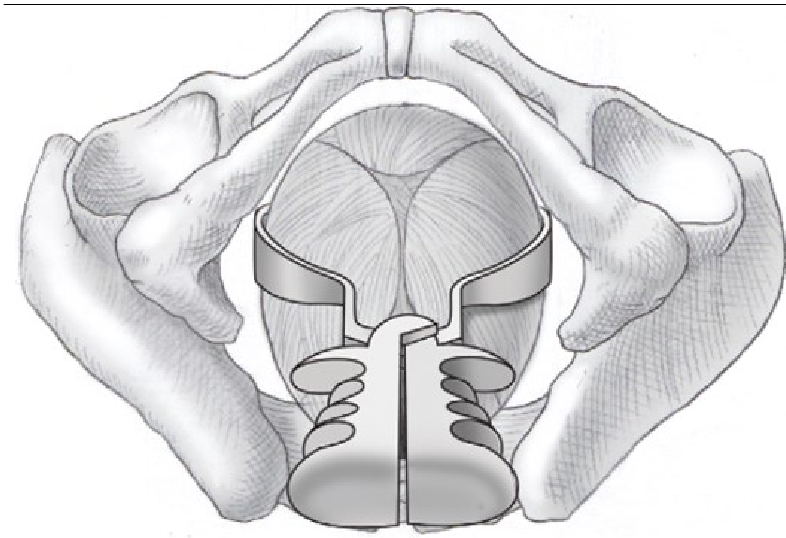


Figure 29-7

The vertex is now occiput anterior, and the forceps are symmetrically placed and articulated.

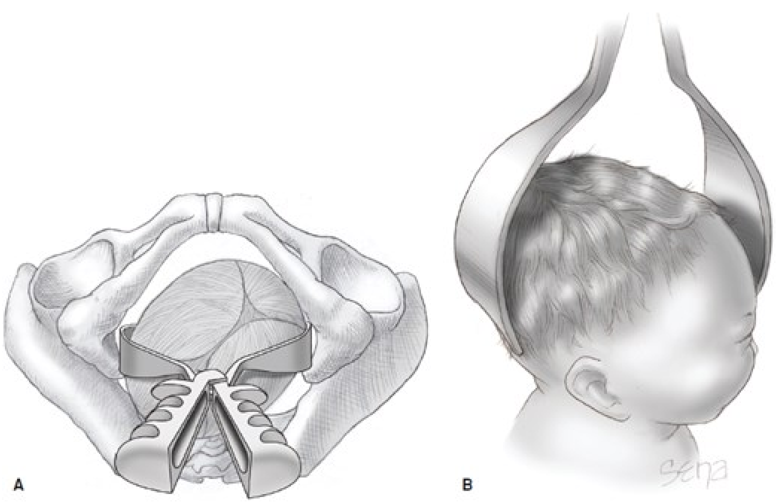


The blades are constructed so that their cephalic curve is closely adapted to the sides of the fetal head. The biparietal diameter of the fetal head corresponds to the greatest distance between appropriately applied blades. Consequently, the fetal head is perfectly grasped only when the long axis of the blades corresponds to the occipitomental diameter. These diameters are depicted in Figure 7-12 (Central Nervous System and Spinal Cord). As a result, most of the blade lies over the face. If the fetus is in an occiput anterior position, then the concave arch of the blades is directed toward the sagittal suture. If the fetus is in an occiput posterior position, then the concave arch is directed toward the fetal face.

For the occiput anterior position, appropriately applied blades are equidistant from the sagittal suture, and each blade is equidistant from its adjacent lambdoidal suture. In the occiput posterior position, the blades are equidistant from the midline of the face and brow. Also for occiput posterior position, blades are symmetrically placed relative to the sagittal suture and each coronal suture. Applied in this way, the forceps should not slip, and traction may be applied most advantageously. With most forceps, if one blade is applied over the brow and the other over the occiput, the instrument cannot be locked, or if locked, the blades will slip off when traction is applied (Fig. 29-8). For these reasons, the forceps must be applied directly to the sides of the fetal head along the occipitomental diameter.

Figure 29-8

Incorrect application of forceps. **A.** One blade over the occiput and the other over the brow. Forceps cannot be locked. **B.** With incorrect placement, blades tend to slip off with traction.



If necessary, rotation to occiput anterior is performed before traction is applied (Fig. 29-9). When it is certain that the blades are placed satisfactorily, then gentle, intermittent, horizontal traction is exerted concurrent with maternal efforts until the perineum begins to bulge (Fig. 29-10). With traction, as the vulva is distended by the occiput, an episiotomy may be performed if indicated. Additional horizontal traction is applied, and the handles are gradually elevated, eventually pointing almost directly upward as the parietal bones emerge (Figs. 29-11 and 29-12). As the handles are raised, the head is extended. During the birth of the head, spontaneous delivery should be simulated as closely as possible.

Figure 29-9

Forceps have been locked. Vertex is rotated from left occiput anterior to occiput anterior (*arrow*).

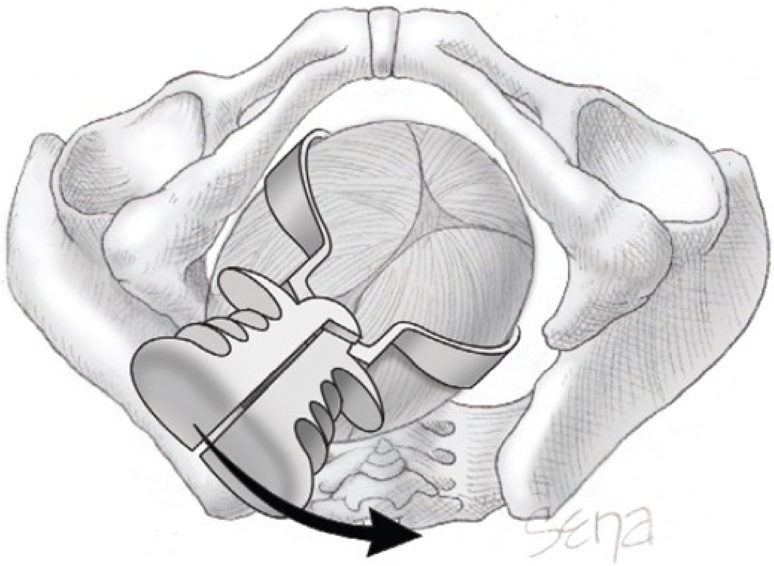


Figure 29-10

Occiput anterior. Delivery by low forceps. The direction of gentle traction for delivery of the head is indicated (*arrow*).

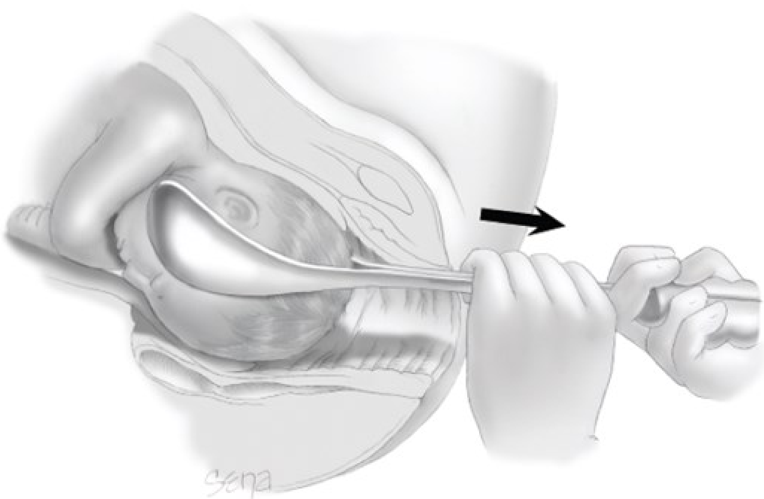


Figure 29-11

Upward arching traction (*arrow*) is used as the head is delivered.

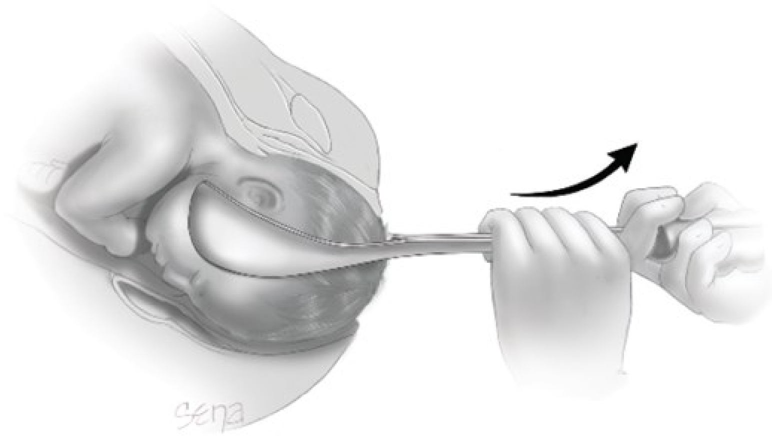
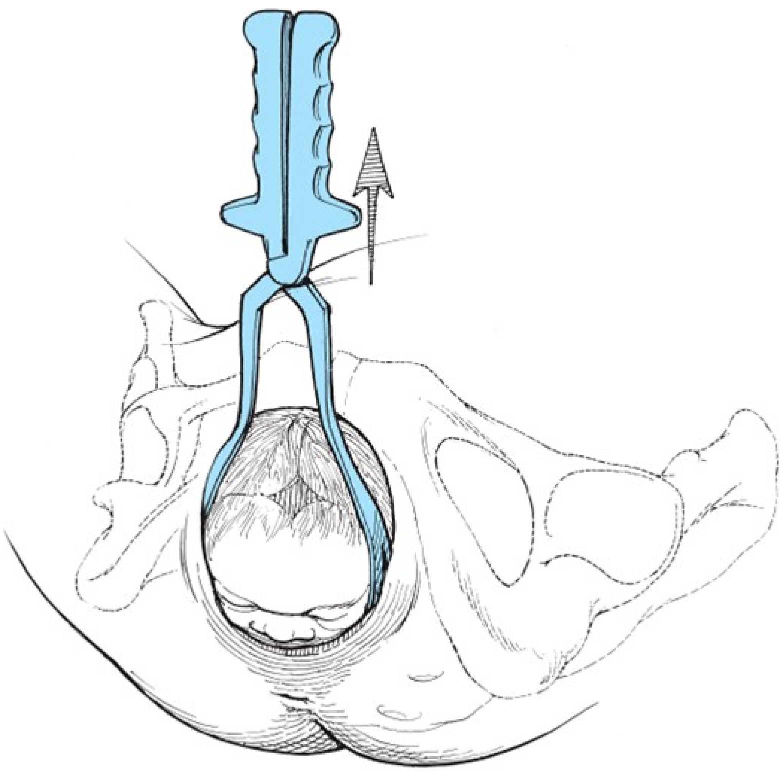


Figure 29-12

Upward traction is continued as the head is delivered.

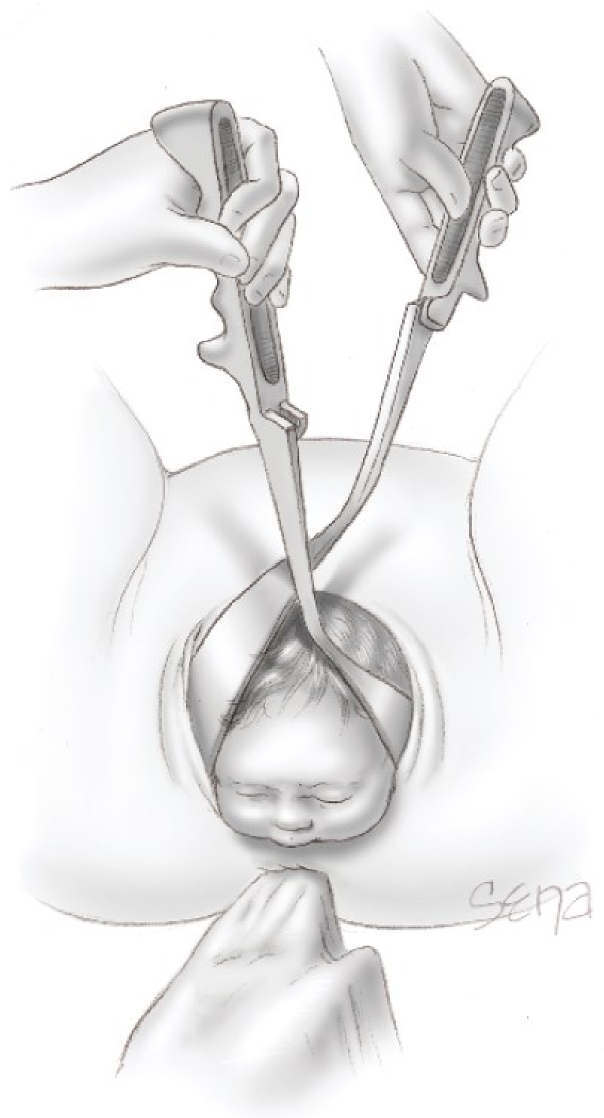


The force produced by the forceps on the fetal skull is a complex function of both traction and compression by the forceps, as well as friction produced by maternal tissues. It is impossible to ascertain the amount of force exerted by forceps for an individual patient. Traction should therefore be intermittent, and the head should be allowed to recede between contractions, as in spontaneous labor. Except when urgently indicated, as in severe fetal bradycardia, delivery should be sufficiently slow, deliberate, and gentle to prevent undue head compression. It is preferable to apply traction only with each uterine contraction. Maternal pushing will augment these efforts.

After the vulva has been well distended by the head, the delivery may be completed in several ways. Some clinicians keep the forceps in place to control the advance of the head. If done, however, the thickness of the blades adds to vulvar distention, thus increasing the likelihood of laceration or necessitating a large episiotomy. To prevent this, the forceps may be removed, and delivery is then completed by maternal pushing (Fig. 29-13). Importantly, if blades are disarticulated and removed too early, the head may recede and lead to a prolonged delivery. Pushing in some cases may be aided by addition of the modified Ritgen maneuver.

Figure 29-13

Forceps may be disarticulated as the head is delivered. Modified Ritgen maneuver may be used to complete delivery of the head.



Delivery of Occiput Posterior Positions

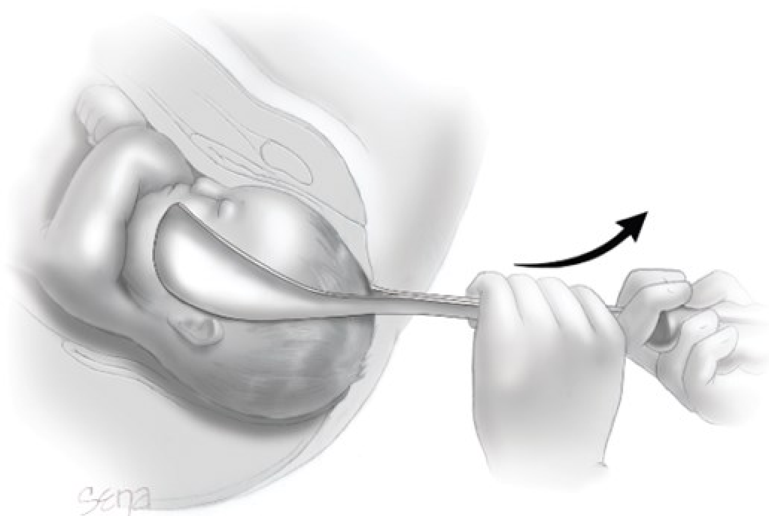
Prompt delivery may at times become necessary when the small occipital fontanel is directed toward one of the sacroiliac synchondroses, that is, in right occiput or left occiput posterior positions. When delivery is required in either instance, the head is often imperfectly flexed. In some cases, when the hand is introduced into the vagina to locate the posterior ear, the occiput rotates spontaneously toward the anterior, indicating that manual rotation of the fetal head might easily be accomplished.

With manual rotation, an open hand is inserted into the vagina. The palm straddles the sagittal suture of the fetal head. The operator's fingers wrap around one side of the fetal face and thumb extends along the other side. If the occiput is in a right posterior position, rotation is clockwise to bring it to a right occiput anterior or to a straight occiput anterior position. With left occiput posterior position, rotation is counterclockwise. If resistance is met during rotation, the head may be slightly elevated but should not be disengaged, as this risks cord prolapse. After the occiput has reached the anterior position, labor may be allowed to continue, or forceps can be applied. Le Ray and colleagues (2007, 2013) reported a success rate of greater than 90 percent with manual rotation.

Manual rotations are most easily completed in multiparas. If manual rotation cannot be easily accomplished, application of forceps blades to the head in the posterior position and delivery from the occiput posterior position may be the safest procedure (Fig. 29-14). In many cases, the cause of the persistent occiput posterior position and of the difficulty in accomplishing rotation is an anthropoid pelvis. This architecture opposes rotation and predisposes to posterior delivery (Fig. 2-20, The four parent pelvic types of the Caldwell–Moloy classification).

Figure 29-14

Outlet forceps delivery from an occiput posterior position. The head should be flexed after the bregma passes under the symphysis.



With forceps delivery from an occiput posterior position, horizontal traction should be applied until the base of the nose is under the symphysis. The handles should then be slowly elevated until the occiput gradually emerges over the anterior margin of the perineum. Then, the forceps are directed in a downward motion, and the nose, mouth, and chin successively emerge from the vulva.

Occiput posterior delivery causes greater distention of the vulva, and a large episiotomy may be needed. Pearl and associates (1993) reviewed 564 occiput posterior deliveries and compared them with 1068 occiput anterior deliveries as controls. The occiput posterior group had a higher incidence of severe perineal lacerations and extensive episiotomy compared with the occiput anterior group. From The Netherlands, de Leeuw and associates (2008) studied more than 28,500 operative vaginal deliveries and reported similar findings. Consequences of these perineal tears are discussed in Chapter 27 (Route of Delivery). Also, infants delivered from the occiput posterior position had a higher incidence of Erb and facial nerve palsies, 1 and 2 percent, respectively, than did those delivered from the occiput anterior position. As expected, rotations to occiput anterior ultimately decrease perineal delivery trauma (Bradley, 2013).

For rotations from the occiput posterior position, Tucker-McLane, Simpson, or Kielland forceps may be used. The oblique occiput may be rotated 45 degrees to the posterior position, or 135 degrees to the anterior position. If rotation is performed with Tucker-McLane or Simpson forceps, the head must be flexed, but this is not necessary with Kielland forceps because they have a less pronounced pelvic curve. In rotating the occiput anteriorly with Tucker-McLane or Simpson forceps, the pelvic curvature, originally directed upward, is, at the completion of rotation, inverted and directed posteriorly. Attempted delivery with the instrument in this position is likely to cause vaginal sulcus tears and sidewall lacerations. To avoid such trauma, it is essential to remove and reapply the instrument as previously described for occiput anterior delivery.

Rotation from Occiput Transverse Positions

When the occiput is obliquely anterior, it gradually rotates spontaneously to the symphysis pubis as traction is exerted. When it is directly transverse, however, a rotary motion of the forceps is required. When the occiput is directed toward the patient’s left, rotation counterclockwise from the left side toward the midline is required. For right occiput transverse positions, clockwise rotation is required.

With experienced operators, high success rates with minimal maternal morbidity can be achieved (Burke, 2012; Stock, 2013). Either standard forceps, such as Simpson, or specialized forceps, such as Kielland, are employed. The latter have a sliding lock and almost no pelvic curve (see Fig. 29-4). On each handle is a small knob that indicates the direction of the occiput. The station of the fetal head must be accurately ascertained to be at, or preferably below, the level of the ischial spines, especially in the presence of extreme molding.

Kielland described two methods of applying the anterior blade. The first is the wandering or gliding method in which the anterior blade is introduced at the side of the pelvis over the brow or face. The blade is then arched around the brow or face to an anterior position, with the handle of the blade held close to the opposite maternal buttock throughout the maneuver. The second blade is introduced posteriorly and the branches are locked.

The second is the classic application in which the anterior blade is introduced first with its cephalic curve directed upward, curving under the symphysis. After it has been advanced far enough toward the upper vagina, it is turned on its axis through 180 degrees to adapt the cephalic curvature to the head. For a more detailed description of Kielland forceps procedures, see the second edition of *Operative Obstetrics* (Gilstrap, 2002).

Application of forceps to an occiput transverse positioned fetus in these women with a platypelloid pelvis should not be attempted until the fetal head has reached or approached the pelvic floor. Regardless of the original position of the head, after rotation, delivery eventually is accomplished by exerting traction downward until the occiput appears at the vulva. After this, the rest of the operation is completed as previously described for occiput anterior delivery.

Face Presentation Forceps Delivery

With a mentum anterior face presentation, forceps can be used to effect vaginal delivery. The blades are applied to the sides of the head along the occipitomental diameter, with the pelvic curve directed toward the neck. Downward traction is exerted until the chin appears under the symphysis. Then, by an upward movement, the face is slowly extracted, with the nose, eyes, brow, and occiput appearing in succession over the anterior margin of the perineum. Forceps should not be applied to the mentum posterior presentation because vaginal delivery is impossible except in very small fetuses.

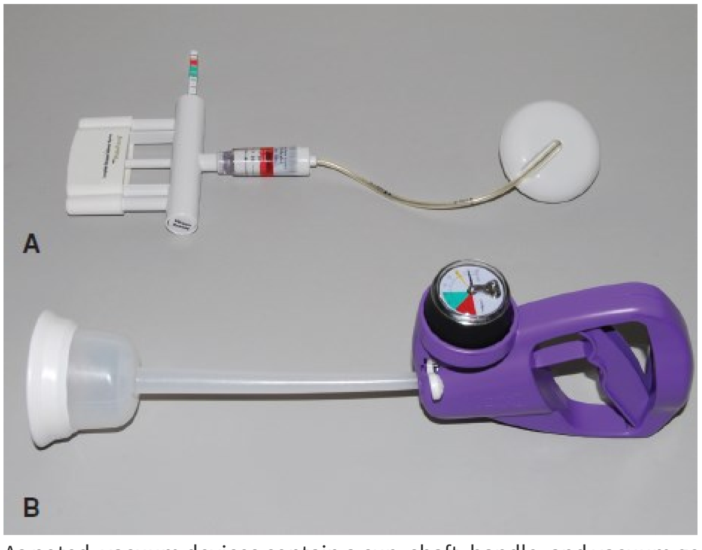
Vacuum Extraction

Vacuum Extractor Design

With vacuum delivery technique, suction is created within a cup placed on the fetal scalp such that traction on the cup aids fetal expulsion. In the United States, *vacuum extractor* is the preferred term for the devices shown in Figure 29-15, whereas in Europe it is commonly called a *ventouse*—from French, literally, "soft cup." Theoretical advantages of this tool compared with forceps include simpler requirements for precise positioning on the fetal head and avoidance of space-occupying blades within the vagina, thereby lowering maternal trauma rates.

Figure 29-15

Vacuum delivery systems. **A.** The *Kiwi OmniCup* contains a handheld vacuum-generating pump, which is attached via flexible tubing to a rigid plastic mushroom cup. **B.** The *Mityvac Mystic II MitySoft Bell Cup* has a soft bell cup attached by a semirigid shaft to a handheld pump.



As noted, vacuum devices contain a cup, shaft, handle, and vacuum generator. Vacuum cups may be metal, hard plastic, or soft plastic and may also differ in their shape, size, and reusability. In the United States, nonmetal cups are generally preferred, and there are two main types. The soft cup is a pliable funnel- or bell-shaped dome, whereas the rigid type has a firm flattened mushroom-shaped cup and circular ridge around the cup rim (Table 29-2). When compared, rigid mushroom cups generate significantly more traction force (Hofmeyr, 1990; Muise, 1993). With occiput posteriorly positioned heads or with asynclitism, the flatter cup also permits improved placement at the flexion point, which is typically less accessible with these head positions. The trade-off is that the flatter cups have higher scalp laceration rates. Thus, many manufacturers recommend soft bell cups for more straightforward occiput anterior deliveries. Rigid mushroom cups may be preferred for occiput posterior or transverse presentation or for asynclitism.

TABLE 29-2

Vacuum Cups for Operative Vaginal Delivery

Cup Style	Manufacturer
Soft Bell Cup	
GentleVac	OB Scientific
Kiwi ProCup	Clinical Innovations
Mityvac MitySoft Bell	CooperSurgical
Pearl Edge Bell Cup	CooperSurgical
Secure Cup	Utah Medical Products
Soft Touch	Utah Medical Products
Tender Touch	Utah Medical Products
Tender Touch Ultra	Utah Medical Products
Velvet Touch[a]	Utah Medical Products
Reusable vacuum delivery cup[a]	CooperSurgical
Rigid Mushroom Cup	
Flex Cup	Utah Medical Products
Mityvac M-Style	CooperSurgical
Super M-Style	CooperSurgical
Mityvac M-Select[b]	CooperSurgical
Kiwi OmniCup[b]	Clinical Innovations
Kiwi Omni-C Cup[c]	Clinical Innovations

[a]Reusable cups.

[b]Suitable for occiput posterior positions or asynclitism.

[c]For extractions through a hysterotomy incision during cesarean delivery.

Several investigators have compared outcomes with various rigid and soft cups. Metal cups provide higher success rates but greater rates of scalp injuries, including cephalohematomas (O'Mahony, 2010). In another study, Kuit and coworkers (1993) found that the only advantage of the soft cups was a lower incidence of scalp injury. They reported a 14-percent episiotomy extension rate with both rigid and pliable cups. Associated perineal lacerations occurred with 16 percent of rigid cup extractions and 10 percent with the pliable cup. In a review, Vacca (2002) concluded that there were fewer scalp lacerations with the soft cup, but that the rate of cephalohematomas and subgaleal hemorrhage was similar between soft and rigid cups. Importantly, high-pressure vacuum generates large amounts of force regardless of the cup used (Duchon, 1998).

Aside from the cup, the shaft that connects the cup and handle may be flexible or semiflexible. Tubing-like flexible shafts may be preferred for occiput posterior or asynclitic presentation to permit better seating of the cup (see Fig. 29-15A). Last, the vacuum generator may be handheld and actuated by the operator or may be held and operated by an assistant.

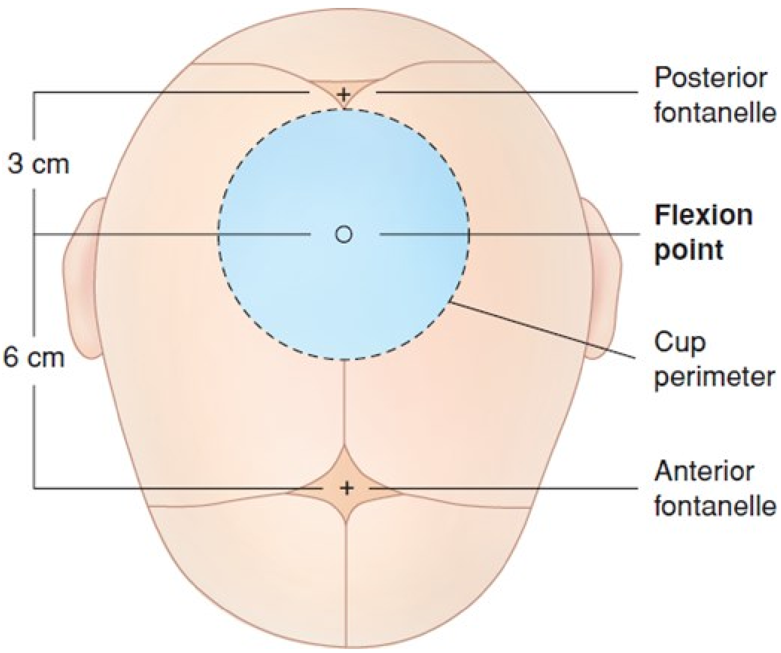
Technique

An important step in vacuum extraction is proper cup placement over the *flexion point*. This pivot point maximizes traction, minimizes cup detachment, flexes but averts twisting of the fetal head, and delivers the smallest head diameter through the pelvic outlet. This improves success rates, lowers fetal scalp injury rates, and lessens perineal trauma because the smallest fetal head diameter distends the vulva (Baskett, 2008).

The flexion point is found along the sagittal suture, approximately 3 cm in front of the posterior fontanel and approximately 6 cm from the anterior fontanel. Because cup diameters range from 5 to 6 cm, when properly placed, the cup rim lies 3 cm from the anterior fontanel (Fig. 29-16). Placement of the cup more anteriorly on the fetal cranium—near the anterior fontanel—should be avoided as it leads to cervical spine extension during traction unless the fetus is small. Such placement also delivers a wider fetal head diameter through the vaginal opening. Last, asymmetrical placement relative to the sagittal suture may worsen asynclitism. For elective use, cup placement in occiput anterior positions is seldom difficult. In contrast, when the indication for delivery is failure to descend caused by occipital malposition—with or without asynclitism or deflexion—cup positioning can be difficult.

Figure 29-16

Drawing demonstrates correct cup placement at the flexion point. Along the sagittal suture, this spot lies 3 cm from the posterior fontanel and 6 cm from the anterior fontanel.



During cup placement, maternal soft tissue entrapment predisposes the mother to lacerations and virtually ensures cup dislodgement. Thus, the entire cup circumference should be palpated both before and after the vacuum has been created as well as prior to traction to exclude such entrapment. Gradual vacuum creation is advocated by some and is generated by increasing the suction in increments of 0.2 kg/cm^2 every 2 minutes until a total negative pressure of 0.8 kg/cm^2 is reached (Table 29-3). That said, other studies have shown that negative pressure can be increased to 0.8 kg/cm^2 in < 2 minutes without a significant difference in efficacy or in maternal and fetal outcomes (Suwannachat, 2011, 2012).

TABLE 29-3

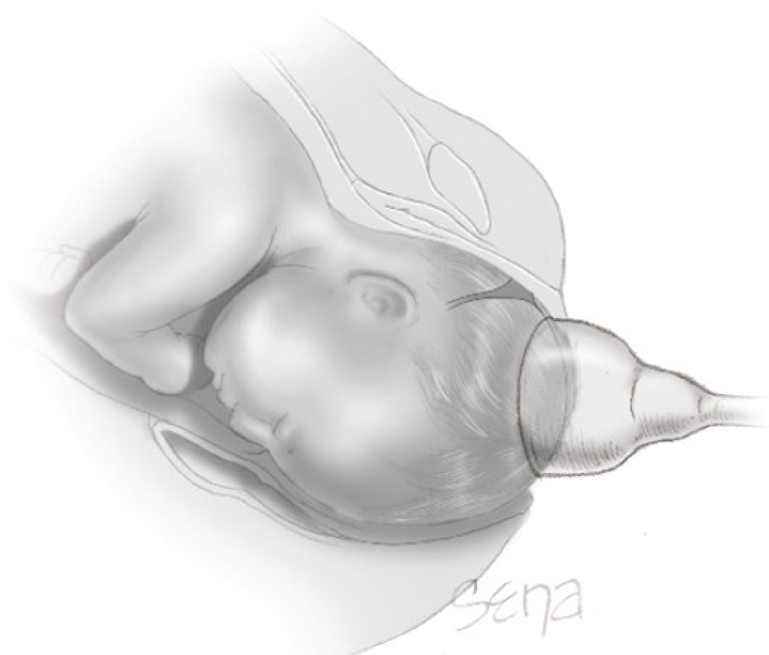
Vacuum Pressure Conversions

mm Hg	cm Hg	inches Hg	lb/in2	kg/cm2
100	10	3.9	1.9	0.13
200	20	7.9	3.9	0.27
300	30	11.8	5.8	0.41
400	40	15.7	7.7	0.54
500	50	19.7	9.7	0.68
600	60	23.6	11.6	0.82

Once suction is created, the instrument handle is grasped, and traction is initiated (Fig. 29-17). Effort should be intermittent and coordinated with maternal expulsive efforts. Similar to forceps delivery, traction is usually directed initially downward, then progressively extended upward as the head emerges. Manual torque to the cup is avoided as it may cause cup displacement or cephalohematomas and with metal cups, "cookie-cutter"–type scalp lacerations. Thus, occiput anterior oblique positions are corrected not by rotation, but solely by downward outward traction. During pulls, the operator should place the nondominant hand within the vagina, with the thumb on the extractor cup and one or more fingers on the fetal scalp. So positioned, descent of the presenting part can be judged and the traction angle can be adjusted with head descent. In addition, the relationship of the cup edge to the scalp can be assessed to help detect cup separation.

Figure 29-17

Cup placed before application of traction.



Between contractions, some physicians will lower the suction levels to decrease rates of scalp injury, whereas others will maintain suction in cases of nonreassuring fetal heart tones to aid rapid delivery. No differences in maternal or fetal outcome could be demonstrated if the level of vacuum was decreased between contractions or if an effort was made to prevent fetal loss of station (Bofill, 1997). Once the head is extracted, the vacuum pressure is relieved, the cup removed, and the usual techniques to complete vaginal delivery are followed.

Vacuum extraction should be considered a trial. Without early and clear evidence of descent toward delivery, an alternative delivery approach should be considered. As a general guideline, progressive descent should accompany each traction attempt. Neither data nor consensus are available regarding the number of pulls required to effect delivery, the maximum number of cup “pop-offs” that can be tolerated, or optimal total duration of the procedure. Some manufacturers have recommendations regarding these in their instructional literature (Clinical Innovations, LLC, 2013; CooperSurgical, 2011).

During a vacuum extraction trial, cup dislodgement due to technical failure or less than optimal placement should not be equated with dislodgement under ideal conditions of exact cup placement and optimal vacuum maintenance. These cases may merit either additional attempts at placement or alternatively, a trial of forceps (Ezenagu, 1999; Williams, 1991). The least desirable cases are those in which traction without progress or multiple disengagements occur following correct cup application and appropriate traction. As with forceps procedures, there should be a willingness to abandon attempts at vacuum extraction if satisfactory progress is not made (American College of Obstetricians and Gynecologists, 2012).

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