Operative delivery

- The precise incidence of operative vaginal delivery in the United States is unknown, but forceps or vacuum delivery was coded on the birth certificate as the method of delivery for 8 percent

Forceps Delivery

- Invention and modification have led to a description and use of more than **700 varieties** of forceps instruments.
- Most of them are of historic interest only, but many common features remain among those still in use.
- True forceps were first devised in the late 16th or beginning of the 17th century.

Design of Forceps

- Forceps are paired instruments, except when used at cesarean delivery and are broadly categorized according to their intended use:

  a) "Classic" forceps,
  b) Rotational forceps, and
  c) Specialized forceps designed to assist vaginal breech deliveries.

- Each forceps type consists of two halves joined by a lock, which may be **sliding or fixed**.
- The key structures of forceps include the **blade, shank, lock, finger guards, and handle**.
- The **toe** refers to the tip of the blade and the **heel** to the end of the blade that is attached to the shank at the posterior lip of the fenestration (if present).
- The **cephalic curve** is defined by the radius of the two blades when in opposition and the **pelvic curve** by the upward(or reverse as in the case of Kielland and Piper forceps) curve of the blades from the shank. The handles transmit the applied force, the screw or lock represent the fulcrum, and the blades transmit the load

- Each blade has two curves. The cephalic curve conforms to the shape of the fetal head, and the pelvic curve corresponds more or less to the axis of the birth canal.
- Some varieties are fenestrated or pseudofenestrated to permit a firmer hold on the fetal head
- The pelvic curve permits ease of application along the maternal pelvic axis. Forceps have two functions, traction and rotation, both of which can only be accomplished by some degree of compression on the fetal head.

- The cephalic curvature of the blade is designed to aid in the even distribution of force about the fetal parietal bone and fetal malar eminence. Blades may be solid (Tucker-McLane), **fenestrated (Simpson), or pseudofenestrated (Luikart-Simpson**).
- The pseudofenestration modification can be applied to the design of any type of forceps and is known as the Luikart modification. In general, use of solid or pseudofenestrated blades results in less risk of maternal soft tissue injury, especially during rotation, but fenestrated blades provide improved traction in comparison to solid blades.
- The blades are connected to the handles by the shanks, which are either parallel as in Simpson forceps, or crossing as in Tucker–McLane forceps.

- 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. A **sliding lock** is used in some forceps, such as Kielland forceps.

''Classic" Forceps

- Classic forceps instruments are typically used when rotation of the vertex is not required for delivery.
- However, they may be used for rotations such as the Scanzoni-Smellie maneuver.
- **All classic forceps have a cephalic curve, a pelvic curve, and an English lock, in which the articulation is fixed in a slot into which the shank of the opposite blade fits**. The type of classic forceps instrument is determined by its shank, whether overlapping or parallel. Examples of classic forceps with parallel shanks include **Simpson, DeLee, Irving, and Hawks-Dennen** forceps.
- Classic forceps with overlapping shanks include **Elliott and Tucker-McLane**.
- Because these instruments have a more rounded cephalic curve than the Simpson forceps, they are often used for assisting delivery of the unmolded head, such as that commonly encountered in the multiparous patient. In addition, because the Tucker-McLane forceps have a shorter, solid blade and overlapping shanks, they are more often used for rotations than other classic instruments.

Rotational Forceps

- Forceps instruments used for rotation are characterized as having a cephalic curve amenable to application to the molded vertex, **and either only a slight pelvic curve or none at all**.
- The absence of a pelvic curve in these instruments facilitates rotation of the vertex without moving the handles of the instrument through a wide arch, as is necessary when using one of the classic instruments to accomplish rotation. Forceps that may be used for rotation include some of the classic instruments (e.g., Tucker-McLane) and those with minimal pelvic curvature (e.g., Kielland and Leff).

- Following their introduction, Kielland forceps have become a frequently used instrument for rotation of the vertex. These forceps have a slightly backward pelvic curve with overlapping shanks and a sliding lock. The advantages of the Kielland forceps compared with the classic instruments for rotation include:

- A straight design that places the handle and shanks in the same plane as the long axis of the fetal head, permitting the toe to travel through a very small arch during rotation.
- The distance between the heel and the intersecting point of the shanks is long, which accommodates heads of various shapes and sizes associated with unusual molding.
- A slight degree of axis traction is produced by the reverse pelvic curve.
- The sliding lock permits placement of the handles at any level on the shank to accommodate the asynclitic head and subsequent correction of asynclitism.

Other Specialized Instruments

- Forceps to assist with delivery of the aftercoming head during vaginal breech delivery (Piper forceps) **have a cephalic curve, a reverse pelvic curve, long parallel shanks and an English lock** . This design provides easy application to the aftercoming head, stabilizing and protecting the fetal head and neck during delivery. The long shanks permit the body of the breech to rest against it during delivery of the head.
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Classification of Forceps Deliveries

- A current classification (American College of Obstetricians and Gynecologists, 2000; American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2002) for forceps and vacuum operations is summarized.
- This classification **emphasizes the two most important discriminators of risk for both mother and infant**: station and rotation. Station is measured in 0 to 5 centimeters, although some clinicians prefer to divide the lower pelvis into thirds—1+, 2+, and 3+, corresponding to +2 cm, +4 cm, and +5 cm, respectively.
- Deliveries are categorized as **outlet, low, and midpelvic procedures.**
- High operations are those in which instruments are **applied above 0 station**, and thus before engagement. These have no place in contemporary obstetrics.

Classification of Forceps and Vacuum Delivery According to Station and Rotation	
Procedure	Criteria

Outlet	1. Scalp is visible at introitus without separating the labia 2. Fetal skull has reached pelvic floor 3. Sagittal suture is in anteroposterior diameter or right or left occiput anterior or posterior position 4. Fetal head is at or on the perineum 5. Rotation does not exceed 45 degrees
Low	Leading point of fetal skull is at station ≥+2 cm, and not on pelvic floor
	Rotation is 45 degrees or less (left or right occiput anterior to occiput anterior, or left or right occiput posterior to occiput posterior)
	Rotation is greater than 45 degrees
Midpelvic	Station above +2 cm but head is engaged
High	Not included in classification (**applied above 0 station)**

Incidence of Forceps Delivery

- In general, there has been a decline in operative vaginal deliveries with a parallel increase in cesarean deliveries over the past two decades.

Training

- Although resident experience obviously varies among programs, it is doubtful that the majority of residents graduating today are adequately trained or skilled in the art of midpelvic delivery with either forceps or vacuum.

Effects of Regional Analgesia on Instrumental Delivery

- Epidural analgesia may be associated with failure of spontaneous rotation to an occiput anterior position, as well as slowing of second-stage labor and decreasing maternal expulsive efforts.
- Women given epidural analgesia had a **twofold increased rate of forceps delivery** compared with those given intravenous analgesia—13 versus 7 percent

Function of Forceps

- Although the most important function of forceps is **traction**, forceps may be invaluable for **rotation**, particularly for occiput transverse and posterior positions.

- In general, **Simpson forceps** are used to deliver the fetus with a molded head, as is common in nulliparous women.
- The **Tucker–McLane** instrument is often used for the fetus with a rounded head, which more characteristically is seen in multiparas. In most situations, however, either instrument is appropriate.

Forces Exerted by the Forceps

- The force produced by the forceps on the fetal skull is a complex function of pull and compression by the forceps and friction produced by the maternal tissues. It is impossible to ascertain the amount of force exerted by forceps for an individual patient.

Indications for Forceps

- Termination of the second stage of labor by forceps delivery or vacuum extraction is indicated in any condition threatening the mother or fetus that is likely to be relieved by delivery.
- Some **maternal indications** include heart disease, pulmonary injury or compromise, **intrapartum infection**, certain neurological conditions, exhaustion, or prolonged second-stage labor.
- Shortening of second-stage labor for maternal reasons should generally be accomplished with either **outlet or low forceps.**
- **Fetal indications** for operative vaginal delivery with either forceps or vacuum include prolapse of the **umbilical cord**, with the other requisites for instrument delivery present; premature **separation of the placenta; or a nonreassuring fetal heart rate pattern**.

Elective and Outlet Forceps

- Forceps generally should not be used electively until the criteria for outlet forceps have been met.
- The fetal head must be on the perineal floor with the sagittal suture **no more than 45** degrees from the anteroposterior diameter.
- In these circumstances, forceps delivery is a simple and safe operation.
- There is, however, **no evidence that use of prophylactic forceps is beneficial in the otherwise normal term labor and delivery.**

Prophylactic Outlet Forceps for Low-Birthweight Fetuses

- Currently, it would appear that there is no obvious advantage to routine outlet forceps delivery of a small fetus.

Prerequisites for Forceps Application

There are at least six prerequisites for successful application of forceps:

1. The head must be engaged. Extensive caput succedaneum formation and molding sometimes make determination of the station of the fetal head difficult. When difficulties of station assignment occur, it is important to realize that a "low-forceps" procedure may actually be a more difficult midforceps operation.
2. The fetus must present as a vertex or by the face with the chin anterior.
3. The position of the fetal head must be precisely known.
4. The cervix must be completely dilated.
5. The membranes must be ruptured.
6. There should be no suspected cephalic–pelvic disproportion.

Preparation for Forceps Delivery

- Although pudendal block analgesia may prove adequate for outlet forceps operations, either regional analgesia or general anesthesia usually is preferred for low-forceps or midpelvic procedures.
- The bladder should be emptied.

Forceps Application

- Forceps 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 the appropriately applied blades.
- Consequently, the head of the fetus is perfectly grasped only when **the long axis of the blades corresponds to the occipitomental diameter**.
- Thus, the major portion of the blade is lying over the face, while the concave margins of the blades are directed toward either the sagittal suture (occiput anterior position) or the face (occiput posterior position).
- Applied as such, 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 slip off when traction is applied.
- For these reasons, the forceps must be applied directly to the sides of the fetal head along the **occipitomental diameter**.

Identification of Position

- Knowledge of the exact position of the fetal head is essential to a proper cephalic application.
- With the head low in the pelvis, determination of position is made by examination of the sagittal suture and the fontanels.

- When the head is at a higher station, an absolute determination can be made by locating the posterior ear.

Outlet Forceps Delivery

- Delivery by outlet forceps of the occiput anterior fetal head, the small (posterior) fontanel is directed toward the symphysis pubis.
- The forceps, if applied to the sides of the pelvis, grasp the head ideally. The forceps are applied as follows:
- Two or more fingers of the right hand are introduced inside the left posterior portion of the vulva and into the vagina beside the fetal head.
- The handle of **the left branch is then grasped between the thumb and two fingers** of the left hand and the tip of the blade is gently passed into the vagina between the fetal head and the palmar surface of the fingers of the right hand.
- 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, which is held in the right hand and introduced into the vagina as described for the left blade. After positioning, the branches are articulated.

Appropriateness of Application

- For the occiput anterior position, appropriately applied blades are **equidistant from the sagittal suture.**
- In the occiput posterior position, the blades are **equidistant from the midline of the face and brow.**

Traction

- When it is certain that the blades are placed satisfactorily, then gentle, intermittent, horizontal traction is exerted until the perineum begins to bulge.
- If necessary, **rotation to occiput anterior is performed before traction is applied. With traction, as the vulva is distend**ed by the occiput, an episiotomy may be performed if indicated.
- More horizontal traction is applied, and the handles are gradually elevated, eventually pointing almost directly upward as the parietal bones emerge.
- As the handles are raised, the head is extended. During upward traction, the four fingers should grasp the upper surface of the handles and shanks, while the thumb exerts the necessary force on their lower surface.
- During the birth of the head, spontaneous delivery should be simulated as closely as possible.
- **Traction should therefore be intermittent**, and the head should be allowed to recede in intervals, 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**.
- 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. However, the thickness of the blades adds to the distention of the vulva, thus increasing the likelihood of laceration or necessitating a large episiotomy. In such cases, the forceps may be removed and delivery completed by the modified Ritgen maneuver .
- If the forceps are removed prematurely, the modified Ritgen maneuver may prove to be a tedious and inelegant procedure.

Low- and Midforceps Operations

- When the head lies above the perineum, the sagittal suture usually occupies an oblique or transverse diameter of the pelvis. In such cases, the forceps should always be applied to the sides of the head.

Left Occiput Anterior Position

- The right hand, introduced into the left posterior segment of the vagina, should identify the posteriorly located left ear. At the same time, the right hand serves as a guide for introduction of the left branch of the forceps, which is held in the left hand and applied over the left ear.
- Two fingers of the left hand are **then introduced into the right posterior portion of the pelvis.**
- The right branch of the forceps, held in the right hand, is then introduced along the left hand as a guide. It must then be applied over the anterior ear of the fetus by gently sweeping the blade anteriorly until it lies directly opposite the blade that was introduced first.

Right Occiput Anterior Position

- In right positions, the blades are introduced similarly but in opposite directions. After the blades have been applied to the sides of the head, the left handle and shank lie above the right.
- Consequently, the forceps do not immediately articulate. Locking of the branches is easily effected, however, by rotating the left around the right to bring the lock into proper position.

Occiput Transverse Positions

- If the occiput is in a transverse position, the forceps are introduced similarly, with the first blade applied over the posterior ear and the second rotated anteriorly to a position opposite the first. In this case, one blade lies in front of the sacrum and the other behind the symphysis.
- Simpson or Tucker–McLane forceps , or one of their modifications, or the specialized Kielland forceps may be used.

Rotation from Anterior and 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.
- Rotation counterclockwise from the left side toward the **midline is required when the occiput is directed toward the left and in the reverse direction** when it is directed toward the right side of the pelvis.
- Infrequently, when forceps are used in transverse positions in anteroposteriorly flattened (platypelloid) pelves, rotation should not be attempted until the fetal head has reached or approached the pelvic floor.
- Regardless of the original position of the head, 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.

Occiput Posterior Positions

- Prompt delivery may at times become necessary when the small (occipital) fontanel is directed toward one of the sacroiliac synchondroses, viz., in right occiput posterior 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.

Manual Rotation

- A hand with the palm upward is inserted into the vagina and the fingers are brought in contact with the side of the fetal head that is to be rotated toward the anterior position, while the thumb is placed over the opposite side of the head. With the occiput in a right posterior position, the left hand is used to rotate the occiput anteriorly in a clockwise direction; the right hand is used for the left occiput posterior position. The head must not be disengaged during rotation.
- After the occiput has reached the anterior position, labor may be allowed to continue, or forceps can be used. First one blade is applied to that side of the head that is held by the

fingers that are maintaining the occiput in the anterior position. The other blade is immediately applied and delivery accomplished.

Forceps Delivery of Occiput Posterior

- If manual rotation cannot be easily accomplished, application of the blades to the head in the posterior position and delivery from the occiput posterior position may be the safest procedure.
- In many cases, the cause of the persistent occiput posterior position and of the difficulty in accomplishing rotation is an anthropoid pelvis, the architecture of which predisposes to posterior delivery and opposes rotation.
- When the occiput is directly posterior, 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, face, and chin successively emerge from the vulva.
- Occiput posterior delivery causes greater distention of the vulva, and a large episiotomy may be needed.

Forceps Rotations of Occiput Oblique Posterior

- Tucker–McLane, Simpson, or Kielland forceps may be used to rotate the fetal head. 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 more straightened pelvic curve.
- In rotating the occiput anteriorly with Tucker–McLane or Simpson forceps, the pelvic curvature, originally directed upward, at the completion of rotation is inverted and directed posteriorly. Attempted delivery with the instrument in that 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 described below

Forceps Rotation of Occiput Transverse

- Specialized skill and training are essential when performing this technically difficult operative vaginal procedure. Either standard forceps, such as pseudofenestrated Simpson, or specialized forceps, such as Kielland, are employed.
- The latter have **a sliding lock and almost no pelvic curve**. 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. In the wandering or gliding method, 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 method is the direct or classical application, in which the anterior blade is introduced first with its cephalic curve directed upward, curving under the symphysis.
- After it has entered sufficiently far into the uterine cavity, it is turned on its axis through 180 degrees to adapt the cephalic curvature to the head.

Forceps Delivery of Face Presentation

- In the face presentation, with the chin directed toward the symphysis—mentum anterior—forceps occasionally are 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 as such.**

Morbidity from Forceps Operations

Maternal Morbidity

When considering maternal morbidity from operative vaginal delivery, it is important to compare it with the morbidity from cesarean delivery and not to that from spontaneous vaginal delivery. **Some generalizations can be made**.

1. Elective outlet forceps with rotations not exceeding 45 degrees are associated with little, if any, increase in maternal morbidity.
2. Maternal injury increases significantly with rotations of greater than 45 degrees and at higher stations.
3. The need for blood transfusions is increased with operative vaginal delivery, viz., vacuum extraction (6.1 percent) and forceps (4.2 percent), compared with 1.4 percent with uncomplicated cesarean delivery.

Lacerations and Episiotomy

- The very conditions that lead to the **indications for operative vaginal delivery also increase the need for episiotomy.**
- That said, women randomized to delivery with low forceps had no increase in perineal lacerations relative to those delivering spontaneously.

Urinary and Rectal Incontinence

- There are a now a number of studies that **indicate that even spontaneous vaginal delivery will be followed by urinary and fecal incontinence in some women.**
- In some, incontinence is temporary and improves with time. In others, it persists and may worsen over time.
- Extensive episiotomies or lacerations, especially of the anal sphincter, **are more likely to cause problems with incontinence than spontaneous vaginal delivery alone**.
- Because forceps deliveries are associated with an increased incidence of episiotomy, episiotomy with second- or third-degree extension, or deep lacerations, it is not surprising that use of forceps has been associated in some reports with a higher rate of incontinence.
- Thus, the anterior **compartment (responsible for bladder function) or the posterior compartment (responsible for anal function**) or both may be involved.
- Short-term effects of forceps and vacuum deliveries, especially midcavity deliveries, include postpartum urinary retention and bladder dysfunction.
- Anal sphincter dysfunction, although associated with spontaneous delivery, also is increased with instrumental vaginal delivery, episiotomy extensions, and deep lacerations. With or without an episiotomy or laceration following forceps delivery.
- Although the short-term effects on anorectal function associated with operative vaginal delivery are of concern, it is unclear what role these have in long-term morbidity
- Other factors have been associated with fecal incontinence in older women**. Some of these are high parity, menopause, prior hysterectomy, and irritable bowel syndrom**e.

Febrile Morbidity

- Postpartum metritis is more frequent, and often more severe, in women following cesarean delivery compared with that following operative vaginal delivery

Perinatal Morbidity

- Operative vaginal delivery, especially if performed from the midpelvic level, may be associated with increased neonatal morbidity.

Morbidity from Midforceps Deliveries

- Numerous studies have described the **association of neonatal morbidity and midforceps operations.**

- Several factors must be considered when interpreting these results. **First and foremost, most were conducted prior to the redefined classification of forceps** in 1988 by the American College of Obstetricians and Gynecologists (2000). Thus, midforceps were not defined clearly and included deliveries from relatively high stations (0 to +1), as well as difficult rotations.
- Second, spontaneous vaginal deliveries are not appropriate controls for midforceps**. Finally, there is no uniformity in the criteria used to define immediate fetal morbidity.**
- There are a few studies that used the updated 1988 classification. Specifically, Robertson and associates (1990) reported significantly higher neonatal morbidity in the midforceps group compared with that of cesarean delivery.
- Because of increased maternal and neonatal morbidity compared with that of low-forceps operations, midforceps deliveries are seldom performed now.

Long-Term Infant Morbidity

- Over decades of their use, forceps have been at the center of an evolving controversy regarding possible long-term infant morbidity.
- Particularly **controversial has been the possible association between forceps delivery and decreased measures of intelligence**.
- The investigators reported that neuro developmental disability was not associated with delivery by midforceps.

Conclusions Regarding Morbidity from Forceps

- It is clear that the greatest risk is incurred with true midforceps operations and when rotations of greater than 45 degrees are performed. Most studies in which morbid events were reported were from an era when cesarean delivery rates were still around 5 percent. Thus, they undoubtedly included many forceps deliveries that would, in all likelihood, never be attempted today.
- The impact of epidural analgesia on the incidence of low- and midforceps deliveries cannot be discounted. The majority of such cases result from inadequate maternal expulsive forces against a relaxed pelvic sling, and thus they are not usually associated with either relative or absolute cephalopelvic disproportion.
- Although it is prudent in these cases to allow a longer second stage of labor, in some women and under some circumstances, delivery is indicated sooner. Low-forceps rotations for epidural-associated labor abnormalities are likely to be safer than the same operation performed in women with prolonged labor or midpelvic arrest unassociated with conduction analgesia.
- It seems reasonable to conclude that outlet and low-forceps operations with rotation of 45 degrees or less, classified by the scheme proposed by the American College of Obstetricians and Gynecologists (2000), **can be performed with safety** for both mother and fetus if the basic guidelines set forth in this chapter are carefully observed.

Trial of Forceps and Failed Forceps

- If an attempt at operative vaginal delivery is anticipated to be difficult, the attempt should be considered a trial.
- With an operating room both equipped and staffed for immediate cesarean delivery, the trial may proceed. **If a satisfactory application of the forceps cannot be achieved, then the procedure is abandoned and delivery accomplished by use of either vacuum extraction** or cesarean.
- Once application has been achieved, gentle **downward pulls are made on the forceps. If there is no descent, the procedure is abandoned**. In some situations, vacuum extraction may be successful. If not deemed safe or if it also fails to effect vaginal delivery, then cesarean delivery is performed.
- American College of Obstetricians and Gynecologists (2000), which cautions that these trials are attempted only if the clinical assessment is highly suggestive of a successful outcome.

Vacuum Extraction

- The Malmstrom device is the most commonly used instrument for vacuum extraction in the world. This device consists of a mushroom-shaped stainless steel cup, two vacuum hoses, a traction chain and attached metallic disk, a traction handle, and a vacuum source.
- The cup is available **in 40-, 50-, and 60-mm diameter sizes** and is designed such that the diameter of the opening is smaller than the internal diameter of the cup. Therefore, when vacuum is established, the fetal scalp fills the internal dimension of the cup and an artificial caput succedaneum is formed (the "chignon"). This allows for appropriate traction force to be applied to the vertex without a "pop off" or detachment
- In the United States, the device is referred to as the vacuum extractor, whereas in Europe it is commonly referred to as a ventouse (from French, literally, **soft cup**).
- The Swedish obstetrician, Tage Malmstrom was credited with the introduction of the first successful vacuum cup into the field of modern obstetrics in 1953. It consisted of a metal cup, suction tubing, and a traction chain.
- Vacuum devices are classified by the material used to make the cup: either stainless steel or plastic (silicone). Plastic ("soft") cups are used much more commonly in the United States than the stainless steel cups owing to the lower rates of scalp trauma associated with these devices. These devices consist of the cup, which is connected to a handle grip and tubing that connects them both to a vacuum source.
- The vacuum generated through this tubing attaches the fetal scalp to the cup and allows traction on the vertex. The vacuum force can be generated either from wall suction or by a hand-held device with a pumping mechanism.
- The theoretical advantages of the vacuum extractor over forceps include the

    a. Avoidance of insertion of **space-occupying steel** blades within the vagina and of the requirement for precise positioning over the fetal head;
    b. Ability to **rotate the fetal head** without impinging on maternal soft tissues; and the

c. Decreased **intracranial pressure** during traction.

- All previously described instruments were unsuccessful until **Malmström (1954)** applied a new principle, viz., traction on a metal cap designed so that the suction **creates an artificial caput, or chignon,** within the cup that holds firmly and allows adequate traction.
- As with forceps choice, the decision to use a metal or a soft cup appears regional.
- In the United States, the metal cup generally has been replaced by newer soft cup vacuum extractors.
- As emphasized by Duchon and associates, however, **high-pressure vacuum generates** large amounts of force regardless of the cup used.
- The **Silastic cup** vacuum device is a reusable instrument with a soft, 65-mm-diameter cup.
- The **Mityvac** instrument uses a disposable 60-mm-diameter cup, and the

Indications and Prerequisites

- Generally, the indications and prerequisites for the use of the vacuum extractor for delivery are the same as for forceps delivery (American College of Obstetricians and Gynecologists, 2000).
- The tendency to attempt vacuum deliveries at stations higher than is usually attempted with forceps is worrisome.
- In a recent review of vacuum extraction, Koscica and Gimovsky (2002) concluded that contraindications to vacuum extraction include operator **inexperience**, inability to assess fetal position, high station, and suspicion of cephalopelvic disproportion.
- Relative contraindications for delivery using vacuum extraction include face or other **nonvertex presentations, fetal coagulopathy, known macrosomia, and recent scalp blood sampling**. Generally, vacuum extraction is reserved for **fetuses 34 weeks or older**.

Technique

- Proper cup placement is the most important determinant of success in vacuum extraction.
- The center of the cup should be over the sagittal suture and **about 3 cm in front** of the posterior fontanelle toward the face.
- Anterior placement on the fetal cranium—near the anterior fontanelle rather than over the occiput—will result in cervical spine extension unless the fetus is small.
- Similarly, asymmetrical placement relative to the sagittal suture may **worsen asynclitism**. Cup placement for elective use 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 placement can be very difficult.
- Entrapment of maternal soft tissue predisposes the mother to lacerations and hemorrhages and virtually assures **cup "pop-off."**
- The full circumference of the cup should be palpated both before and after the vacuum has been created, as well as prior to traction.

- When using rigid cups, it is recommended that the vacuum be created gradually by increasing the suction by **0.2 kg/cm2 every 2 minutes** until a negative pressure of 0.8 kg/cm2 is reached.
- With soft cups, negative pressure can be increased to 0.8 kg/cm2 over as little as 1 minute.
- Some authors suggest that 0.6 kg/cm2 is the optimal peak pressure.
- Listed in Table 23–5 are conversions of various units of pressures used by different instruments

Vacuum Pressure Conversions			
mm Hg	in Hg	lb/in2	kg/cm2
100	3.9	1.9	0.13
200	7.9	3.9	0.27
300	11.8	5.8	0.41
400	15.7	7.7	0.54
500	19.7	9.7	0.68
600	23.6	11.6	0.82

- Traction should be intermittent and coordinated with maternal expulsive efforts.
- Traction may be initiated by using a two-handed technique, viz., the fingers of one hand are placed against the suction cup, while the other hand grasps the handle of the instrument.
- A theoretical advantage of the vacuum cup is that it usually will detach prior to creating tractive forces sufficient to cause fetal injury.
- Vacuums offer no advantage for avoidance of shoulder dystocia.
- Manual torque to the cup should be avoided as it may cause cephalohematomas and, with metal cups, **"cookie-cutter"–type scalp lacerations**.
- Vacuum extraction should be considered a trial, and without early and clear evidence of descent toward delivery, an alternate 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 detachments that can be tolerated, or optimal total duration of the procedure.
- A cup pop-off due to technical failure or less than optimal placement should not be equated with a pop-off under ideal conditions of exact cup placement and optimal vacuum maintenance.
- The former may merit either several additional attempts at placement and delivery or, alternatively, a trial of forceps.

- Conversely, the latter situation is highly suggestive of relative or absolute disproportion or asynclitism. As with forceps procedures, there should be a willingness to abandon attempts at vacuum extraction if satisfactory progress is not made.

Complications

- Complications of the vacuum extractor include scalp lacerations and bruising, subgaleal hematomas, cephalohematomas, intracranial hemorrhage, neonatal jaundice, subconjunctival hemorrhage, clavicular fracture, shoulder dystocia, injury of sixth and seventh cranial nerves, Erb palsy, retinal hemorrhage, and fetal death .
- American College of Obstetricians and Gynecologists (1998) issued a Committee Opinion recommending the continued use of vacuum-assisted delivery devices when appropriate. They estimated that there is approximately **one adverse event per 45,455 vacuum extractions per year.**

Recommendations Regarding Vacuum Delivery

Considering the 1998 FDA Public Health Advisory, the following recommendations seem reasonable:

1. The classification of vacuum deliveries should be the same as that utilized for forceps deliveries (including station).
2. The same indications and contraindications utilized for forceps deliveries should be applied to vacuum-assisted deliveries.
3. The vacuum should not be applied to an unengaged vertex, that is, above 0 station.
4. The individual performing or supervising the procedure should be an experienced operator.

- The operator should be willing to abandon the procedure if it does not proceed easily or if the cup pops off more than three times.

Comparison of Vacuum Extraction with Forceps

- There have been numerous studies comparing vacuum extraction with forceps deliveries.
- The data are sparse regarding long-term neurological outcome in newborns delivered by vacuum extraction. These authors also reported that there were no significant differences in child development in the two groups