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Operative Vaginal Delivery: Past, Present, and Future

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Learning Objectives: *After participating in this activity, physicians should be better able to:*

1. *Select appropriate patients for operative vaginal delivery (OVD).*
2. *Compare the risks and benefits of OVD versus cesarean delivery in the management of the second stage of labor.*
3. *Choose the optimal treatment (forceps vs vacuum) for various clinical presentations.*

The incidence of operative vaginal delivery (OVD) in the United States has been declining, and OVD is currently performed in approximately 4.5% of vaginal deliveries. In addition, it has been observed that the proportion of forceps deliveries is declining as compared with vacuum extraction. The Northeast United States has the lowest rate of forceps use, whereas the use of forceps remains highest in the South; this may be due to training differences among providers. There are several hypotheses as to why a decline in OVD has occurred during the past half-century. One reason is that cesarean delivery (CD) has become much safer with the ease of accessibility of blood products, improved antibiotics, and better anesthetic options. Another important factor has been the almost universal application of continuous fetal heart rate monitoring during the second stage of labor. In addition, OVD has likely decreased because of a fear of litigation and patient misconception.

The result of diminished use of OVD is fewer providers capable of teaching new generations of obstetricians how to use these specialized instruments. Given these trends, there is an emerging gap between the present paradigm and ideal practice of OVD. The goal of this article is to address this gap and better enable practicing obstetricians to elect OVD or CD on the basis of the available evidence.

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History of OVD

The history of OVD is rich and vibrant. Hindu writings from 1000 BC refer to the use of instruments to facilitate deliveries complicated by obstructed labor.[1] Soranus, an eminent Greek physician who practiced gynecology in the second century AD, wrote about fetal extraction with instruments to protect the life of the mother after fetal demise or impaction. Avicenna, an Arabian obstetrician in about 1000 AD, was the first to propose a "saving forceps," which could save both mother and child.[2]

The invention of modern obstetric forceps is attributed to the Chamberlen family. This family of French Huguenots immigrated to England to flee religious persecution. The Chamberlen men became the obstetricians of the royal family of England. This was unusual at the time, as mainly women practiced midwifery. The Chamberlen family had a "secret tool" passed from father to son for 4 generations between 1600 and 1728, which they used to assist in their most difficult deliveries. This secret tool remained a mystery that died with Hugh Chamberlen Jr, the last of the Chamberlen obstetricians. This tool, later to be revealed as forceps, was serendipitously discovered in an undisclosed receptacle under a closet floorboard in the Chamberlen attic in 1813, and the secret was revealed.[3]

The more modern forceps, similar to those used by obstetricians today, were introduced by James Young Simpson in 1848. George Elliott added modifications in 1858. Both Simpson's and Elliott's forceps are the most popular designs and are the most commonly used today.[3] In the 20th century, Piper forceps and Kielland forceps were added as alternatives to be used under specialized circumstances.

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There are hundreds of different types of forceps; the most common types are listed in Table 1.

The concept of a vacuum as a tool to aid in the medical field is also an ancient one and can be initially attributed to the art of cupping and the treatment of depressed skull fractures. James Young Simpson was the first obstetrician to introduce the concept of a vacuum extractor for OVD in the 1840s.[4] His "air tractor" consisted of a metal breast pump combined with a syringe and a soft rubber cup. The vacuum device was not widely used until Malmstrom, a Swedish physician, modified the device in the early 20th century to use a metal cup. This modification created a stronger suction and allowed for the development of a "chignon," which facilitated the traction process. The next significant modification is attributed to Geoffrey Bird who separated the traction and suction ports in the 1970s to make it easier to perform an OVD. The soft plastic cup, introduced in the 1980s, was a further technologic advance.

Indications and Contraindications To OVD

Techniques of OVD can be employed to shorten the second stage of labor for either maternal or fetal benefit (Table 2). Examples may include, but are not limited to, minor degrees of fetal malposition, delivery of the second twin, and maternal exhaustion. Before a trial of OVD is undertaken, all prerequisites must be met (Table 3).

In addition, the physician must be assured that there are no contraindications to OVD. Contraindications include noncephalic presentation, unengaged vertex, incompletely dilated cervix, clinical evidence of cephalopelvic disproportion, less than 34 weeks' gestation (vacuum), need for device rotation (vacuum), deflexed attitude of fetal head, or fetal medical conditions (eg, thrombocytopenia, maternal drug ingestion).

OVD Versus CD

A common clinical question that providers face is whether to perform an OVD or a CD during the second stage of labor. This decision is often based on provider experience, comfort level, and patient acceptance with a view to safety of one approach over the other. Available statistical data can be helpful in clinical decision making and in counseling a patient with respect to delivery alternatives.

In a large study by Towner et al[5] of more than 500,000 singleton infants born to nulliparous women, neonatal outcomes of OVD were compared with CD in the second stage of labor. The authors concluded that CD and OVD have similar complication rates. OVD is associated with increased rates of brachial plexus injury and facial nerve injury. CD increases rates of seizure activity, feeding difficulty, use of mechanical ventilation, and neonatal death. Sequential use of forceps and vacuum results in the poorest outcome and highest risk of death and intracranial hemorrhage, suggesting that CD should be recommended after failed OVD rather than consideration given to an alternative OVD technique.

Similar conclusions were reported by Contag et al[6] in a study of 5314 nulliparous women with singleton pregnancies. This study[6] compared OVD versus CD in the second stage of labor and demonstrated no difference in rate of neonatal trauma with regard to Apgar scores, pH, seizures, or neonatal intensive care unit stay.

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Table 1. Modern Forceps and Their Uses

Type	Indication
Elliot	Nonmolded head
Tucker-McLane	
Simpson	Molded head
Luikart-Simpson	
Kielland	Rotational
Piper	Aftercoming head in breech presentation
Barton	Vertex in transverse position

The most important conclusions from these 2 studies are that low and outlet OVD (Table 4) have equal outcomes for the neonate compared with CD in the second stage of labor, and that abnormal labor is most responsible for poor neonatal outcomes, not the mode of delivery. Additional research[7] has demonstrated that OVD has a lower estimated blood loss and shorter hospital stay but an increased incidence of perineal injury compared with CD. CD has consequences attributable to surgery including increased blood loss, increased infection rate, disruption in uterine integrity, and increased risk of abnormal placentation for future deliveries.

The current classification system for OVD is summarized in the American Congress of Obstetricians and Gynecologists (ACOG) practice bulletin (*ACOG Practice Bulletin #17*). (Table 4.)

Forceps Versus Vacuum

The comparative safety of either of the operative vaginal approaches, forceps versus vacuum, is an obvious critical question for the practicing obstetrician. As stated in the *ACOG Practice Bulletin* of June, 2000 (reaffirmed in 2009),[8] selection of instruments and "decisions about the maternal and fetal consequences should be based on clinical findings at the time of delivery" (Table 5). One important issue that has not been well studied is the impact of operator skill and instrument preference (forceps vs vacuum) on both maternal and fetal outcomes. This critical factor is difficult to quantify, which adds to the difficulties of these studies. Many operators (and patients) prefer the labor room for an OVD, whereas others prefer an operating room setting to facilitate CD if the trial of OVD is unsuccessful.[9]

Complications associated with OVD include facial and scalp injuries, intracranial injuries, and brachial plexus injury.[10] Cephalohematomas occur on average in 10% of vacuum extractions and 4% of forceps deliveries.[10] In a study by Boo et al,[11] 21% of infants delivered via vacuum extraction demonstrated clinical evidence for subgaleal hemorrhages. The types of intracranial hemorrhages associated with OVD are subdural and subarachnoid hemorrhages rather than intraventricular.[10] Brachial plexus injury is more common in OVDs using forceps rather than vacuum extraction. Factors associated with brachial plexus injuries and OVD are, in decreasing order of significance, the occurrence of shoulder dystocia, birth weight, and fundal pressure, all of which can culminate in cephalopelvic disproportion.[12] Virtually all of the significant fetal injuries associated with both vaginal spontaneous delivery and OVD can be explained by the use of excessive force to overcome cephalopelvic disproportion.[12] A summary of the known complications of OVD is listed in Table 6.[3]

In 1998, the FDA released a warning regarding the fetal risks of vacuum extraction, including the potential for life-threatening subgaleal hemorrhage.[13] Subsequent studies evaluated this and other risks. One important study by Johnson et al,[14] recorded adverse maternal and neonatal events in a retrospective review of 508 forceps and vacuum deliveries. The authors demonstrated that maternal injury is more common with forceps, but that fetal injury is more common with the use of

Table 2. Operative Vaginal Delivery Indications

Shortening the second stage
Nonreassuring fetal heart tracing
Maternal cardiac disease
Maternal neurologic disease
Fetal malposition, that is, Ascynclitism
Maternal exhaustion
Assistance with the second twin

Table 3. Operative Vaginal Delivery Prerequisites

Informed consent
Vertex presentation
Engaged head
≥34 weeks (vacuum delivery)
Fully dilated cervix
Membranes ruptured
Adequate maternal pelvis
Adequate anesthesia
Maternal bladder empty
Backup plan for delivery
Ongoing fetal and maternal assessment
Physician with appropriate training

Table 4. Classification of Operative Vaginal Delivery

Outlet
Scalp visible at the introitus without separating labia
Fetal skull at the pelvic floor
Sagittal suture in anterior-posterior plane (or right occiput anterior/left occiput anterior)
Fetal head at or on perineum
Rotation <45 degrees
Low
Leading point of fetal skull ≥ +2 station
Rotation <45 degrees
Rotation >45 degrees
Mid
Station above +2 station but the head is engaged

Table 5. Recommendations Regarding Operative Vaginal Delivery

Based on good and consistent scientific evidence (Level A)

Both forceps and vacuum extractors are acceptable and safe instruments for operative vaginal delivery. Operator experience should determine which instrument should be used in a particular situation.

The vacuum extractor is associated with an increased incidence of neonatal cephalohematoma, retinal hemorrhages, and jaundice when compared with forceps delivery.

Based on limited or inconsistent scientific evidence (Level B)

Operators should attempt to minimize the duration of vacuum application, because cephalohematoma is more likely to occur as the interval increases.

Midforceps operations should be considered an appropriate procedure to teach and to use under the correct circumstances by an adequately trained individual.

The incidence of intracranial hemorrhage is highest among infants delivered by cesarean after a failed vacuum or forceps delivery. The combination of vacuum and forceps has a similar incidence of intracranial hemorrhage. Therefore, an operative vaginal delivery should not be attempted when the probability of success is very low.

Based primarily on consensus and expert opinion (Level C)

Operative vaginal delivery is not contraindicated in cases of suspected macrosomia or prolonged labor; however, caution should be used because the risk of shoulder dystocia increases with these conditions.

Neonatal care providers should be made aware of the mode of delivery to observe for potential complications associated with operative vaginal delivery.

Adapted with permission from *ACOG Practice Bulletin 17*.

vacuum extraction. In a trial of 4120 OVDs at term, Caughey et al[15] confirmed these results and also documented that shoulder dystocia is more common with vacuum deliveries. A Cochrane review in 2010 concluded that forceps are more likely to succeed in achieving a vaginal birth but with more maternal complications than with vacuum. Furthermore, the Cochrane review concluded that vacuum delivery causes less pain and maternal trauma but more fetal trauma (cephalohematoma) than forceps delivery does.[16,17] There was no difference in fetal death rate between the 2 groups.[16,17]

Perineal Lacerations, Sphincter Injury, and Risk of Prolapse

In addition to the potential for immediate trauma to the birth canal at the time of OVD in the form of vaginal lacerations and pelvic-floor dysfunction, nerve damage and anal sphincter injury may also occur. Several studies can be found in current medical literature indicating higher rates of third- and fourth-degree vaginal lacerations in the presence of risk factors such as episiotomy, forceps use, parity, and macrosomia. Handa et al[18,19] concluded from their population-based, retrospective study of over 2 million vaginal deliveries, that anal sphincter lacerations were strongly associated with primiparity, macrosomia, and OVD. An important clinical consideration when performing OVD is whether or not an episiotomy is useful for preventing third- and fourth-degree lacerations. In a report of 2832 OVDs, Combs et al[7] demonstrated that mediolateral episiotomy was most likely to protect against third- and fourth-degree lacerations, closely followed by no episiotomy. The most likely group to suffer a third- or fourth-degree laceration was the midline episiotomy group.[7]

Forceps delivery has a stronger association with anal sphincter injury than does vacuum delivery.[18] However, Bollard et al[20] demonstrated that long-term anal incontinence is not increased for women with forceps-related anal sphincter injury. Maternal ethnicity may also play a role in risk for more severe genital-tract trauma. African American women are less likely to have a major laceration, whereas Asian American women are more likely to experience significant injury.[18]

In addition, there are long-term data suggesting that OVD increases risk for genitourinary prolapse. In a longitudinal cohort study of 1011 women 5 to 10 years after their first delivery, the mode of delivery was compared with respect to the risk of prolapse. The 5 modes of delivery studied were CD without labor, CD during active labor, CD after complete cervical dilation, spontaneous vaginal birth, and OVD. Results showed that OVD significantly increased the odds for all pelvic-floor disorders, especially prolapse.[19] There

Table 6. Maternal and Fetal Complications of Operative Vaginal Delivery

Forceps	Vacuum
Maternal perineal trauma	Maternal trauma
Fetal subdural, subarachnoid, intracranial, intraventricular hemorrhage	Fetal retinal hemorrhage
Skull fracture	Intracranial bleeding
Facial nerve paralysis	Scalp laceration
Brachial plexus injury	Skull fractures
Cephalohematoma	Cephalohematoma

Table 7. Future Goals for the Practice of Operative Vaginal Delivery

Need for education
Teach clinical pelvimetry
Teach operative vaginal delivery
Need for simulation training
Practice clinical pelvimetry
Practice operative vaginal delivery

was no difference in nerve injury among OVDs, spontaneous vaginal deliveries, or CDs, with all modes resulting in about 25% of patients sustaining some type of injury.[21]

Conclusion

This article should have helped the reader select appropriate patients for OVD, compare the risks and benefits of OVD versus CD, and compare the risks and benefits associated with the use of forceps versus vacuum. Although CD has largely replaced OVD, it is important for obstetricians to learn and maintain these skills for use in select circumstances. As with all technical and surgical skill acquisition, training can be enhanced through the adjunct use of focused education, facilitated practice, and even advanced obstetric simulators. The Accreditation Council for Graduate Medical Education has begun to emphasize the assessment of "milestones" in the evaluation of competency in graduate medical education. We can expect that in the future, specialty milestone groups will be convened to develop milestones and identify assessment tools with respect to OVD. The milestones, assessment tools, and common curriculum components may likely be prerequisites for obtaining privileges to perform these procedures.[22] Future goals for the practice of OVD are listed in Table 7.

A growing body of data suggest that the rising CD rate, along with multiple repeat CDs, substantially increases the risks of maternal morbidity and mortality. The selective use of OVD can play a significant role in ameliorating this trend.

Practice Pearls

- Patient selection—always evaluate the active phase of labor before making to decisions about OVD versus CD.
- Patient counseling—the patient should be part of the decision-making process, which should begin in the antepartum setting.
- "When to say to when"—whenever undertaking a trial of OVD, the physician must be cognizant of when the trial has exceeded safe guidelines.
- Team approach—anesthesiologists and pediatricians need to be included in this process.

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1. Which of the following is/are an indication for an OVD?
- **A.** Nonreassuring fetal heart tracing
- **B.** Failure to progress
- **C.** Prolonged second stage
- **D.** Maternal cardiac disease
- **E.** All of the above

2. Prerequisites for OVD include
- **A.** full dilation
- **B.** rupture of membranes
- **C.** empty bladder
- **D.** adequate anesthesia
- **E.** all of the above

3. According to the 1995 study by Towner et al, the overall level of risk associated with OVD in labor is
- **A.** increased compared with CD
- **B.** decreased compared with CD
- **C.** equivalent to that of CD

4. Vacuum delivery is more likely than forceps delivery to
- **A.** fail and cause maternal trauma
- **B.** succeed and cause maternal trauma
- **C.** fail and cause neonatal trauma
- **D.** succeed and cause neonatal trauma

5. A G2P1 is pushing in the second stage of labor; you decide that an OVD is appropriate because of a nonreassuring fetal heart tracing, but you are worried about the potential for lacerations. Existing evidence shows that the patient is least likely to sustain a fourth-degree laceration if the operator
- **A.** performs a midline episiotomy
- **B.** performs a mediolateral episiotomy
- **C.** performs no episiotomy

6. A G1P0 is fully dilated and at +3 station. Shortening of the second stage is indicated because of maternal pulmonary hypertension. You decide to attempt a vacuum delivery rather than a forceps delivery. Studies have shown that the choice of vacuum delivery increases risk of all of the following *except*
- **A.** cephalohematoma in the neonate
- **B.** brachial plexus injury in the neonate
- **C.** retinal hemorrhage in the neonate
- **D.** jaundice in the neonate

7. In the patient described in question 6, if the attempted vacuum delivery fails, which one of the following should be the next step in management?
- **A.** Trial of forceps
- **B.** Trial of a different vacuum
- **C.** Proceed to CD

8. Which one of the following types of forceps typically is recommended if fetal rotation is necessary?
- **A.** Barton
- **B.** Simpson
- **C.** Kielland
- **D.** Tucker-McLane

9. A G4P3 at 33 weeks reports exhaustion and is pushing ineffectively. The fetus is at +4 station. The next step in management may include all the following *except*
- **A.** therapeutic rest
- **B.** CD
- **C.** trial of vacuum extraction
- **D.** administration of oxytocin

10. A patient is admitted to the emergency department by a lay midwife after a 7-hour second stage of labor. The fetal head is at +2 station with extensive molding. The most appropriate approach to delivery is
- **A.** vacuum extraction
- **B.** forceps delivery
- **C.** CD
- **D.** for the patient to continue pushing