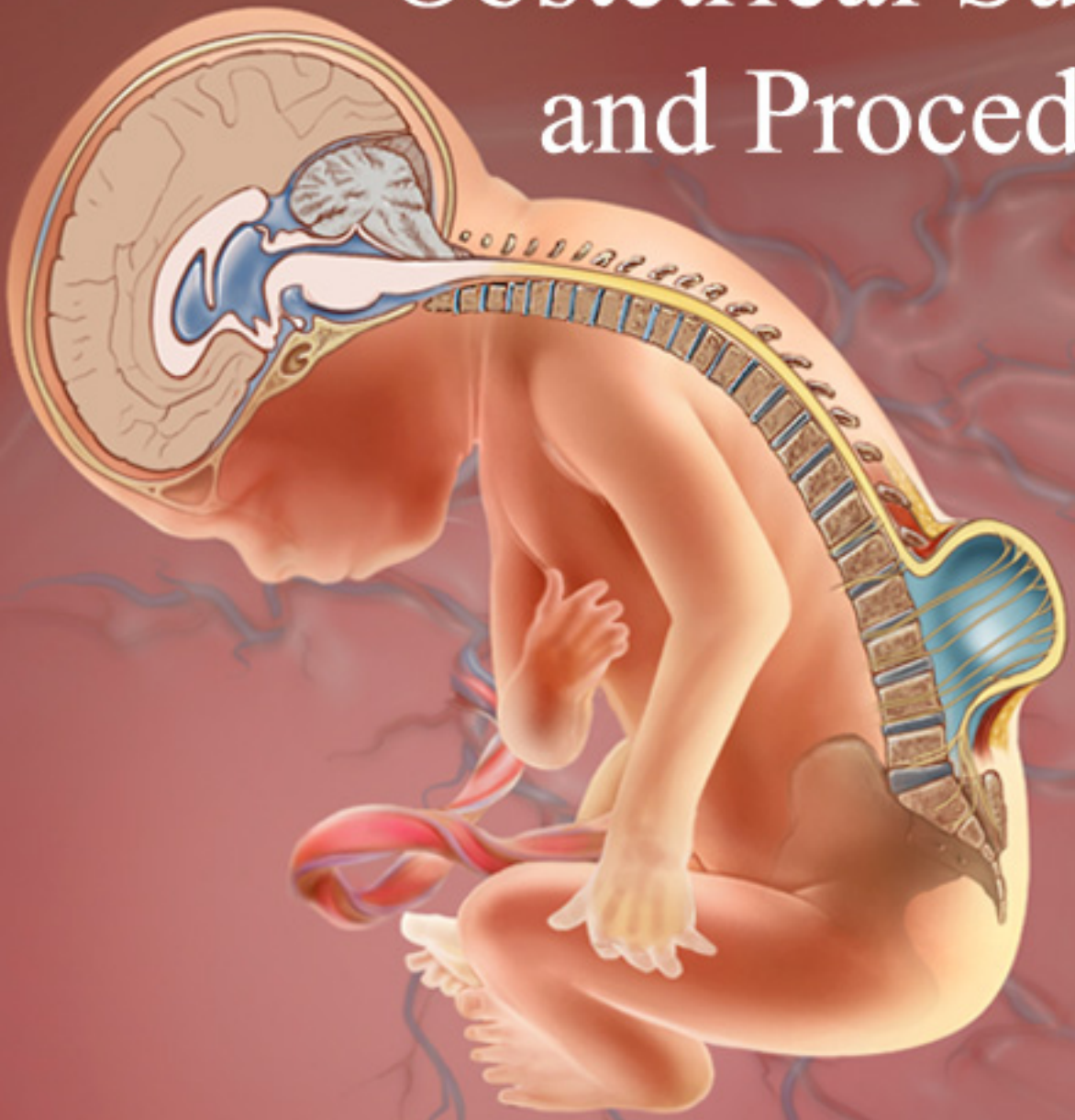
Obstetrical Surgeries and Procedures



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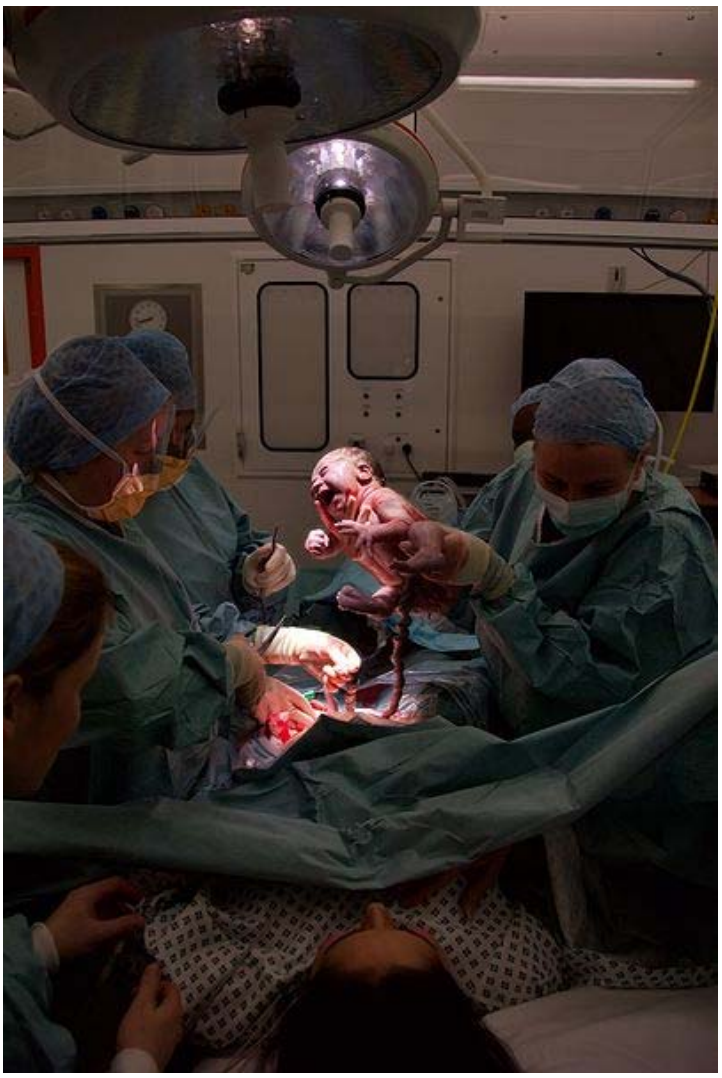
Chapter 1

Caesarean Section and Elective Caesarean Section

Caesarean section



A team of obstetricians performing a Caesarean section in a modern hospital.

A **Caesarean section**, (also **C-section**, **Caesarian section**, **Cesarean section**, **Caesar**, etc.) is a surgical procedure in which one or more incisions are made through a mother's abdomen (laparotomy) and uterus (hysterotomy) to deliver one or more babies, or, rarely, to remove a dead fetus. A late-term abortion using Caesarean section procedures is termed a hysterotomy abortion and is very rarely performed.

A Caesarean section is usually performed when a vaginal delivery would put the baby's or mother's life or health at risk, although in recent times it has been also performed upon request for childbirths that could otherwise have been natural. In recent years the rate has risen to a record level of 46% in China and to levels of 25% and above in many Asian countries, Latin America, and the USA.

Etymology

The Roman *Lex Regia*, (later the *Lex Caesarea*) of Numa Pompilius (715-673 BC), required that the child of a mother dead in childbirth be cut from her womb. This seems to have begun as a religious requirement that mothers not be buried pregnant, and to have evolved into a way of saving the fetus, with Roman practice requiring a living mother be in her 10th month of pregnancy before the procedure was resorted to, reflecting the knowledge that she could not survive the delivery. Rumours that the term refers to the birth of the Roman dictator Julius Caesar are false; although Caesarean sections were performed in Roman times, no classical source records a mother surviving such a delivery, (The earliest recorded survival dates to 1500 AD.) and Caesar's mother Aurelia Cotta bore six children after him and lived to serve him as an advisor in his adulthood.

The term has also been explained as deriving from the verb *caedo*, 'to cut', with children delivered this way referred to as *caesones*. And Pliny the Elder does refer to a certain Julius Caesar (not the dictator, but a remote ancestor) as *ab utero caeso*, "cut from the womb", a godly attribute comparable to rumors about the birth of Alexander the Great. This and Caesar's name may have led to a false etymological connection with the dictator.

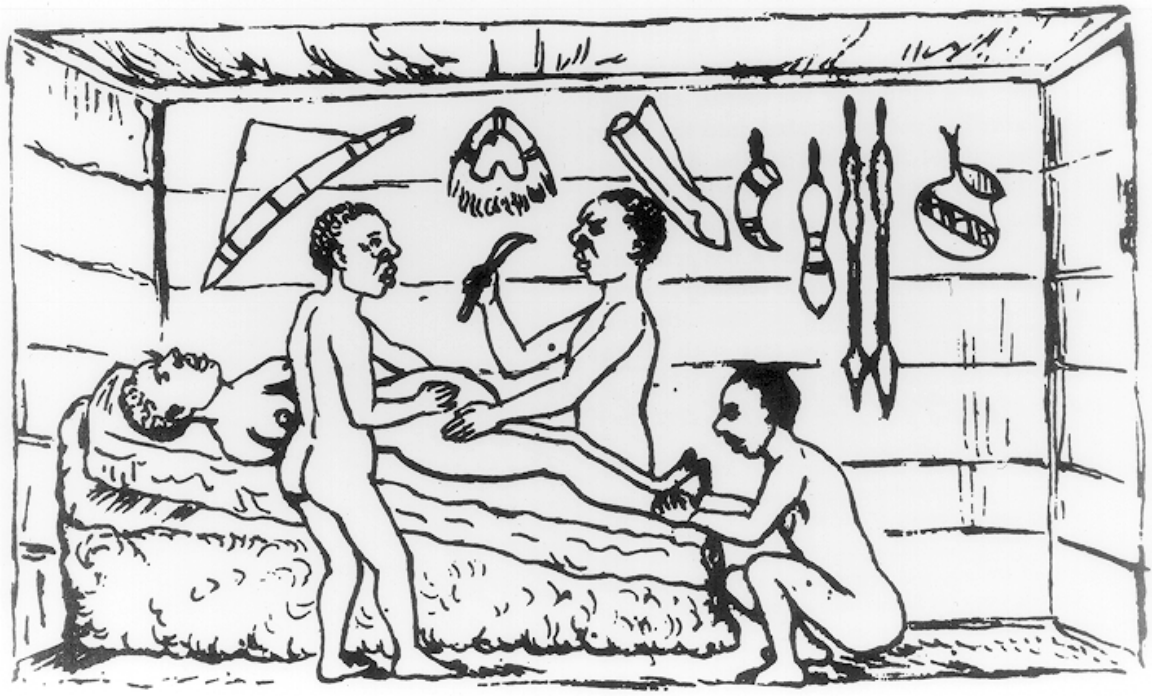
Some link with the Roman dictator Julius Caesar, or with Roman Emperors generally, exists in other languages as well. For example, the modern German, Danish, Dutch and Hungarian terms are respectively *Kaiserschnitt*, *kejsersnit*, *keizersnede*, and *császármetszés* (literally: "Emperor's cut"). The German term has also been imported into Japanese and Korean, both literally meaning "emperor incision." Similar in Western Slavic (Polish) *cesarskie ciecie* (literally "imperial cut"), whereas the South Slavic term is *carski rez*, which literally means *tzar cut*. The Russian term *kesarevo secheniye* literally means *Caesar's section*. The Arabic term also means pertaining to Caesar or literally Caesarean. The Hebrew term translates literally as Caesarean Surgery. In Romania and Portugal it is usually called *cesariana*, meaning from (or related to) Caesar. According to Shahnameh ancient Persian book, the hero Rostam was the first person who was born with this method and term (Rostamineh) is corresponded to Caesarean.

Finally, the Roman praenomen (given name) Caeso was said to be given to children who were born via c-section. While this was probably just folk etymology made popular by Pliny the Elder, it was well-known by the time the term came into common use.

Orthography

- The e/ae/æ variation reflects American and British English spelling differences.
- The cap-versus-lowercase variation reflects a style of lowercasing some eponymous terms (e.g., *cesarean, eustachian, fallopian, mendelian, parkinsonian, parkinsonism*). Cap and lowercase stylings coexist in prevalent usage. Intradocument style consistency is usually advocated.

History



Successful Caesarean section performed by indigenous healers in Kahura, Uganda. As observed by R. W. Felkin in 1879.

Bindusara (Born c. 320 BC, ruled: 298 - c.272 BC) , the second Mauryan emperor of India after Chandragupta Maurya the Great, is said to be first child born by surgery. His mother, wife of Chandragupta Maurya, when she was pregnant and was about to deliver, accidentally consumed poison and died. Chanakya, the Chandragupta's teacher and advisor, made up his mind that the baby should survive. He cut open the belly of the queen and took out the baby, thus saving the baby's life.

Pliny the Elder theorized that Julius Caesar's name came from an ancestor who was born by Caesarean section, but the truth of this is debated. The Ancient Roman Caesarean section was first performed to remove a baby from the womb of a mother who died during childbirth. Caesar's mother, Aurelia, lived through childbirth and successfully gave birth to her son, ruling out the possibility that the Roman Dictator and General was born by Caesarean section. The Catalan saint Raymond Nonnatus (1204–1240), received his surname—from the Latin *non natus* ("not born")—because he was born by Caesarean section. His mother died while giving birth to him.

In 1316 the future Robert II of Scotland was delivered by Caesarean section—his mother, Marjorie Bruce, died. This may have been the inspiration for Macduff in Shakespeare's play *Macbeth"*.

Caesarean section usually resulted in the death of the mother; the first recorded incidence of a woman surviving a Caesarean section was in the 1580s, in Siegershausen, Switzerland: Jakob Nufer, a pig gelder, is supposed to have performed the operation on his wife after a prolonged labour. For most of the time since the sixteenth century, the procedure had a high mortality rate. However, it was long considered an extreme measure, performed only when the mother was already dead or considered to be beyond help. In Great Britain and Ireland the mortality rate in 1865 was 85%. Key steps in reducing mortality were:

- Adherence to principles of asepsis.
- The introduction of uterine suturing by Max Sänger in 1882.
- Extraperitoneal CS and then moving to low transverse incision (Krönig, 1912).
- Anesthesia advances.
- Blood transfusion.
- Antibiotics.

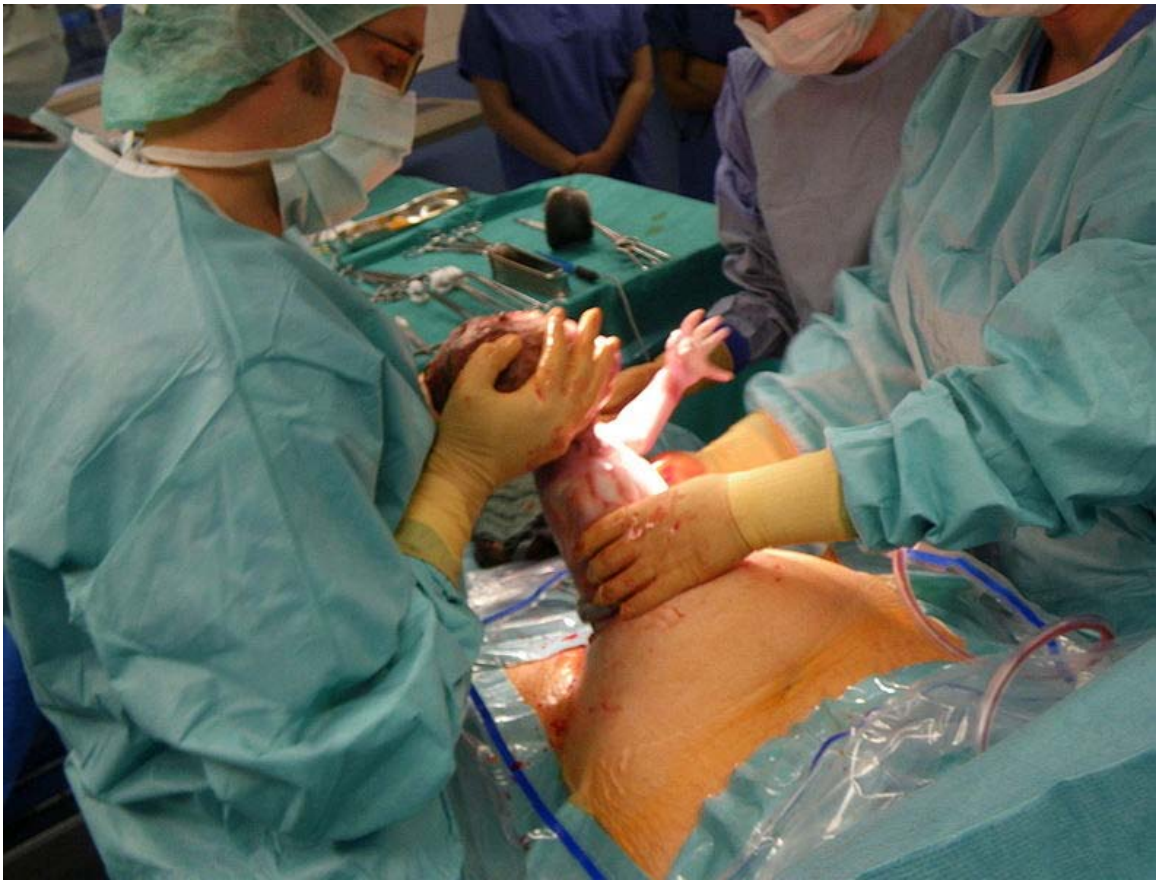
European travelers in the Great Lakes region of Africa during the 19th century observed Caesarean sections being performed on a regular basis. The expectant mother was normally anesthetized with alcohol, and herbal mixtures were used to encourage healing. From the well-developed nature of the procedures employed, European observers concluded that they had been employed for some time.

The first successful Caesarean section to be performed in America took place in what was formerly Mason County Virginia (now Mason County West Virginia) in 1794. The procedure was performed by Dr. Jesse Bennett on his wife Elizabeth.

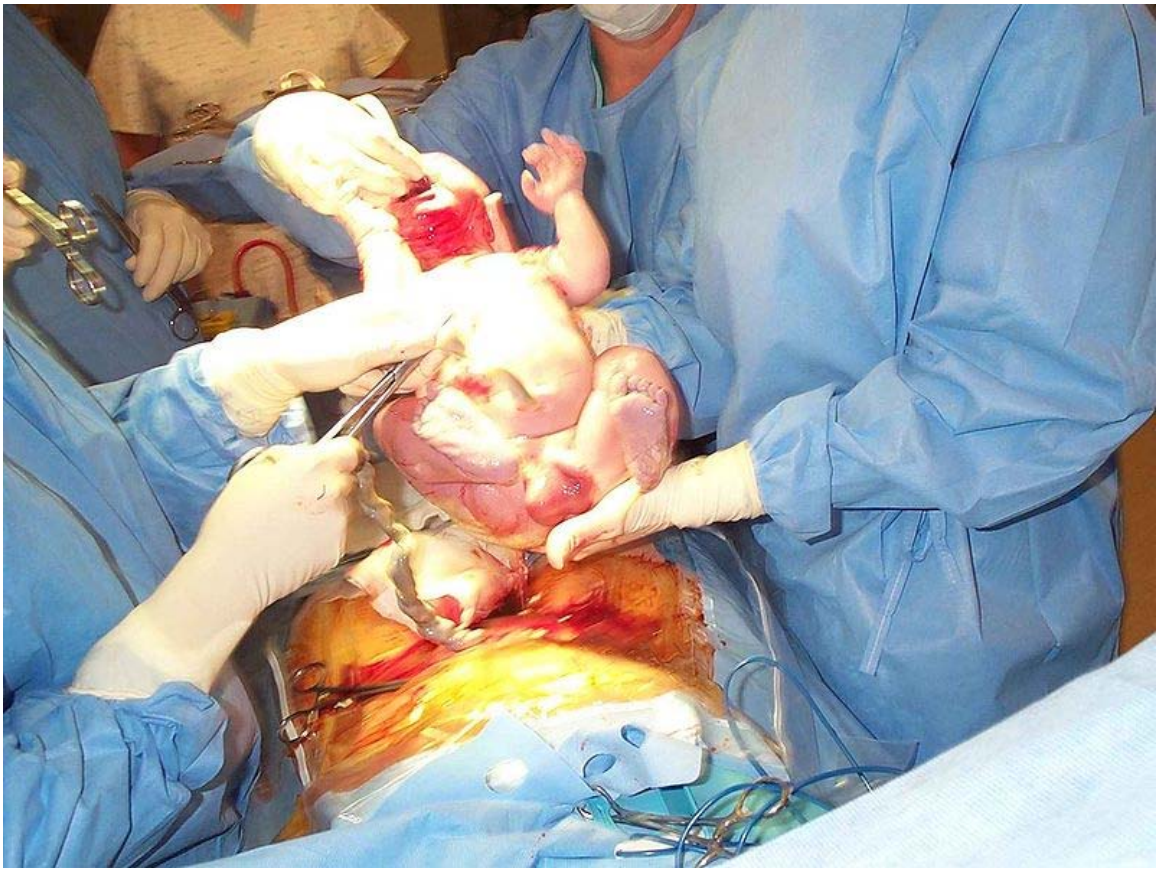
On March 5, 2000, Inés Ramírez performed a Caesarean section on herself and survived, as did her son, Orlando Ruiz Ramírez. She is believed to be the only woman to have performed a successful Caesarean section on herself.

An early account of Caesarean section in Iran is mentioned in the book of Shahnameh, written around 1000 AD, and relates to the birth of Rostam, the national legendary hero of Iran.

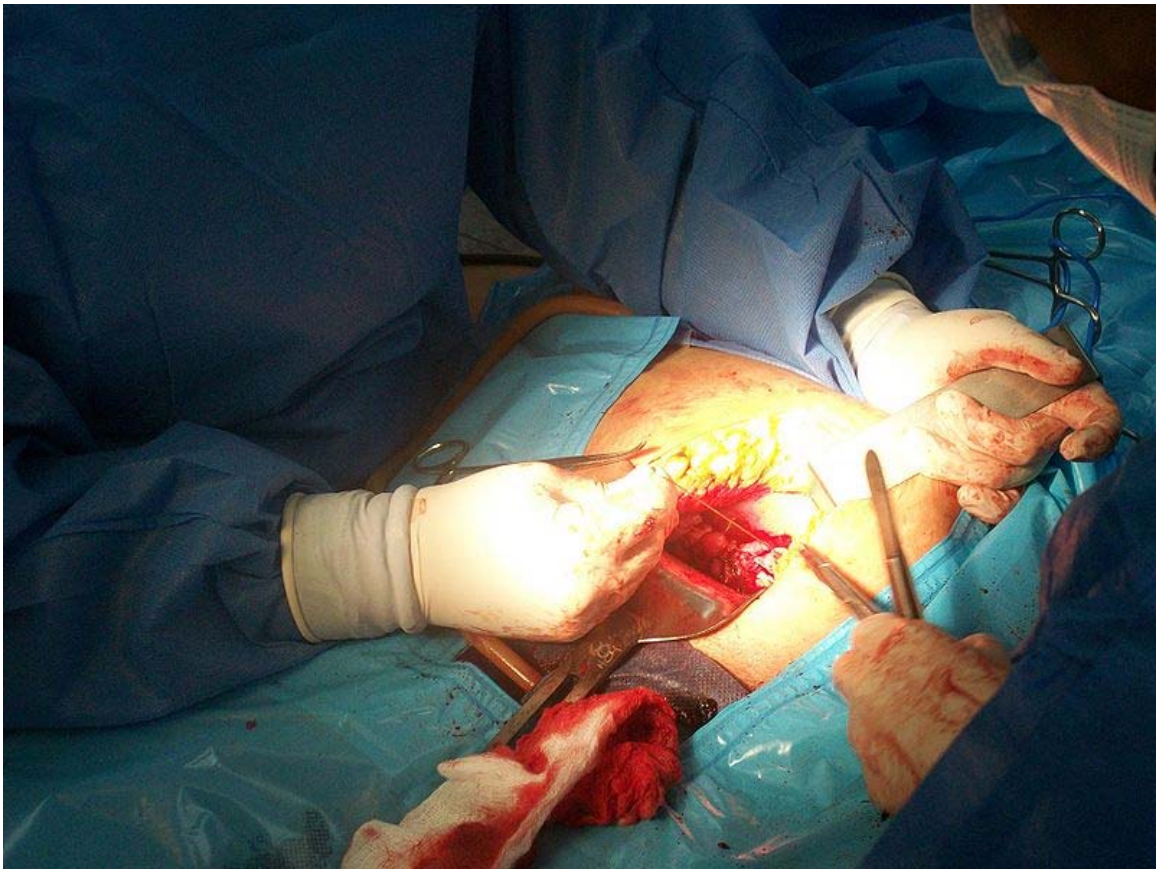
Types



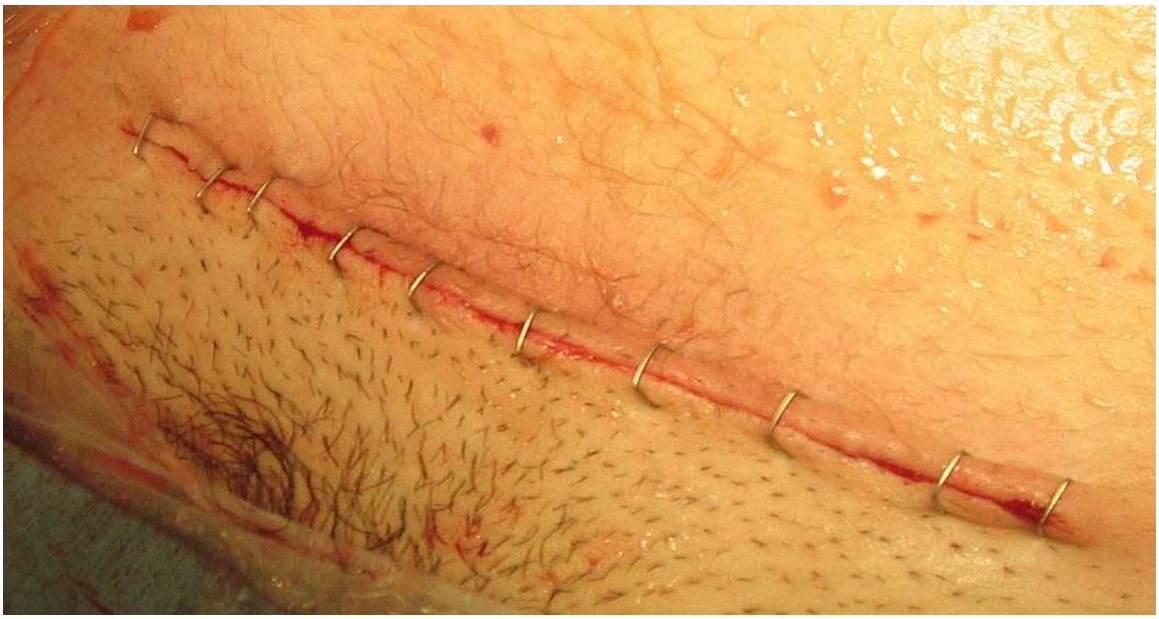
Pulling out the baby.



A Caesarean section in progress.



Suturing of the uterus after extraction.



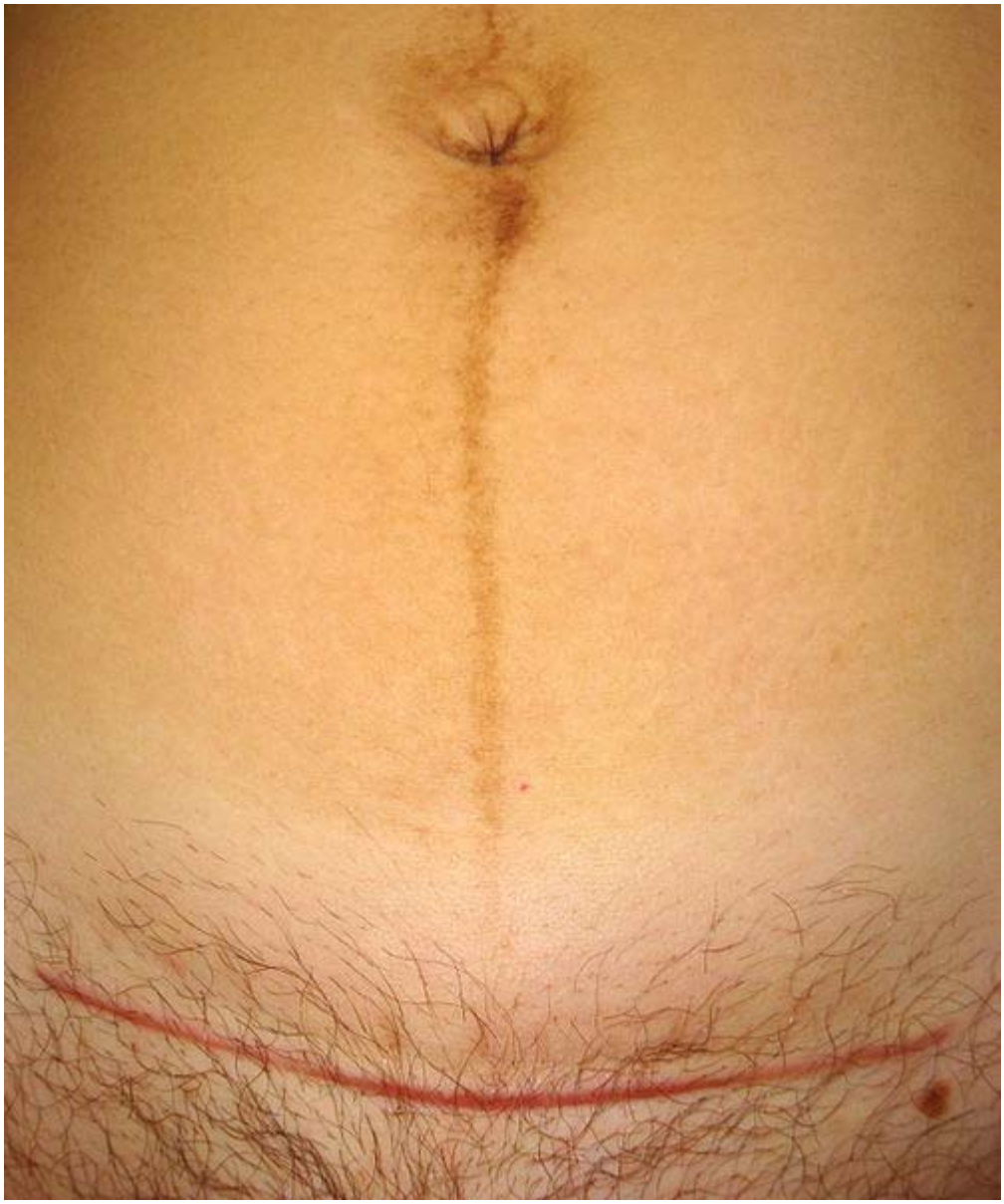
Closed Incision for *low transverse abdominal incision* after stapling has been completed.

There are several types of Caesarean section (CS). An important distinction lies in the type of incision (longitudinal or latitudinal) made on the uterus, apart from the incision on the skin.

- The *classical Caesarean section* involves a midline longitudinal incision which allows a larger space to deliver the baby. However, it is rarely performed today as it is more prone to complications.
- The lower uterine segment section is the procedure most commonly used today; it involves a transverse cut just above the edge of the bladder and results in less blood loss and is easier to repair.
- An *emergency Caesarean section* is a Caesarean performed once labour has commenced.
- A *crash Caesarean section* is a Caesarean performed in an obstetric emergency, where complications of pregnancy onset suddenly during the process of labour, and swift action is required to prevent the deaths of mother, child(ren) or both.
- A *Caesarean hysterectomy* consists of a Caesarean section followed by the removal of the uterus. This may be done in cases of intractable bleeding or when the placenta cannot be separated from the uterus.
- Traditionally other forms of Caesarean section have been used, such as extraperitoneal Caesarean section or Porro Caesarean section.
- a *repeat Caesarean section* is done when a patient had a previous Caesarean section. Typically it is performed through the old scar.

In many hospitals, especially in Argentina, the United States, United Kingdom, Canada, Norway, Sweden, Australia, and New Zealand the mother's birth partner is encouraged to attend the surgery to support the mother and share the experience. The anaesthetist will usually lower the drape temporarily as the child is delivered so the parents can see their newborn.

Indications



A 7-week old Caesarean section scar and linea nigra visible on a 31-year-old mother.

Caesarean section is recommended when vaginal delivery might pose a risk to the mother or baby. Not all of the listed conditions represent a mandatory indication, and in many cases the obstetrician must use discretion to decide whether a Caesarean is necessary. Some indications for Caesarean delivery are:

Complications of labor and factors impeding vaginal delivery such as

- prolonged labor or a failure to progress (dystocia)

- fetal distress
- cord prolapse
- uterine rupture
- increased blood pressure (hypertension) in the mother or baby after amniotic rupture
- increased heart rate (tachycardia) in the mother or baby after amniotic rupture
- placental problems (placenta praevia, placental abruption or placenta accreta)
- abnormal presentation (breech or transverse positions)
- failed labor induction
- failed instrumental delivery (by forceps or ventouse. Sometimes a 'trial of forceps/ventouse' is tried out - This means a forceps/ventouse delivery is attempted, and if the forceps/ventouse delivery is unsuccessful, it will be switched to a Caesarean section.
- overly large baby (macrosomia)
- umbilical cord abnormalities (vasa previa, multi-lobate including bi-lobate and succenturiate-lobed placentas, velamentous insertion)
- contracted pelvis

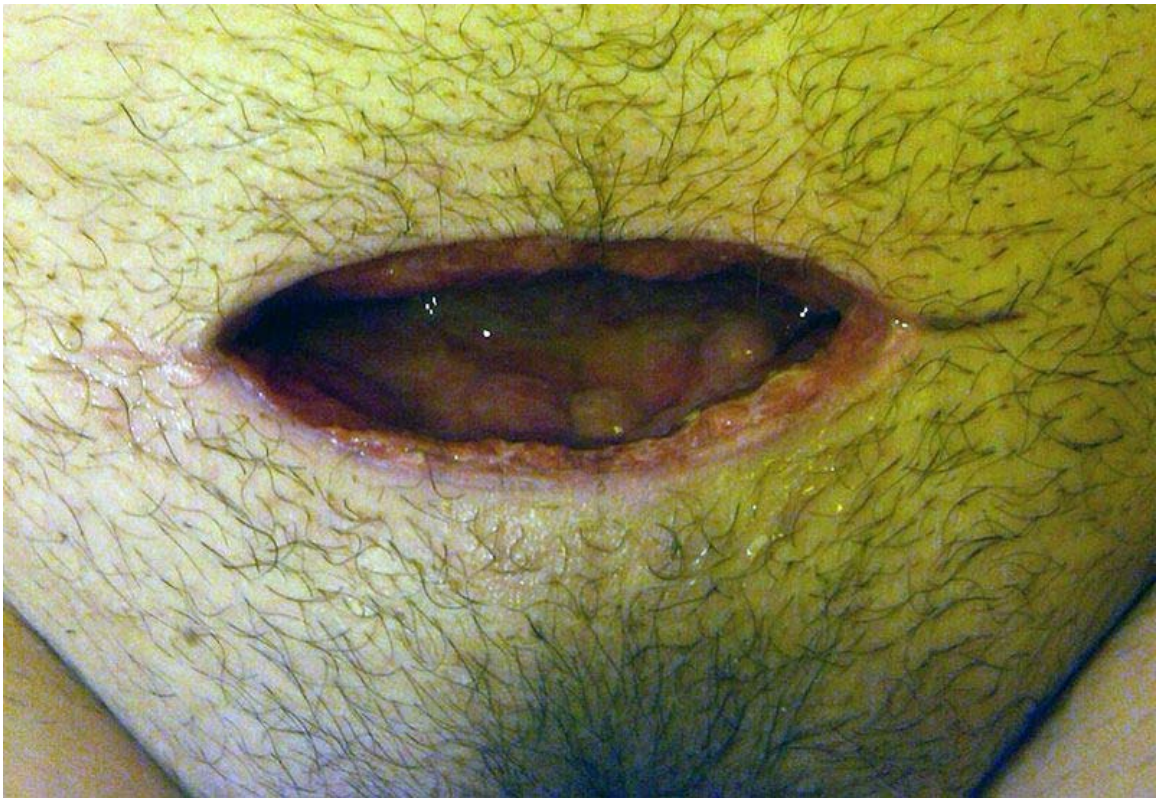
Other complications of pregnancy, preexisting conditions and concomitant disease such as

- pre-eclampsia
- hypertension
- multiple births
- precious (High Risk) Fetus
- HIV infection of the mother
- Sexually transmitted infections such as genital herpes (which can be passed on to the baby if the baby is born vaginally, but can usually be treated in with medication and do not require a Caesarean section)
- previous Caesarean section
- prior problems with the healing of the perineum (from previous childbirth or Crohn's Disease)
- Bi-corniute uterus

Other

- Lack of Obstetric Skill (Obstetricians not being skilled in performing breech births, multiple births, etc. [In most situations women can birth under these circumstances naturally. However, obstetricians are not always trained in proper procedures])
- Improper Use of Technology (Electric Fetal Monitoring [EFM])

Risks



One of the most common risks: 2 weeks after the Caesarean section, fluid retention in the wound. Incision had to be opened to use a negative pressure wound therapy unit to drain the body fluids to prevent infection.

Risks for the mother

The mortality rate for both Caesarian sections and vaginal birth, in the Western world, continues to drop steadily. In 2000, the mortality rate for Caesareans in the United States were 20 per 1,000,000. The UK National Health Service gives the risk of death for the mother as three times that of a vaginal birth. However, it is misleading to directly compare the mortality rates of vaginal and Caesarean deliveries. Women with severe medical conditions, or higher-risk pregnancies, often require a Caesarean section which can distort the mortality figures.

A study published in the 13 February 2007 issue of the *Canadian Medical Association Journal* found that the absolute differences in severe maternal morbidity and mortality was small, but that the additional risk over vaginal delivery should be considered by women contemplating an elective Caesarean delivery and by their physicians.

As with all types of abdominal surgery, a Caesarean section is associated with risks of post-operative adhesions, incisional hernias (which may require surgical correction) and

wound infections. If a Caesarean is performed under emergency situations, the risk of the surgery may be increased due to a number of factors. The patient's stomach may not be empty, increasing the anaesthesia risk. Other risks include severe blood loss (which may require a blood transfusion) and post spinal headaches.

A study published in the June 2006 issue of the journal *Obstetrics and Gynecology* found that women who had multiple Caesarean sections were more likely to have problems with later pregnancies, and recommended that women who want larger families should not seek Caesarean section as an elective. The risk of placenta accreta, a potentially life-threatening condition, is only 0.13% after two Caesarean sections but increases to 2.13% after four and then to 6.74% after six or more surgeries. Along with this is a similar rise in the risk of emergency hysterectomies at delivery. The findings were based on outcomes from 30,132 Caesarean deliveries.

It is difficult to study the effects of Caesarean sections because it can be difficult to separate out issues caused by the procedure itself versus issues caused by the conditions that require it. For example, a study published in the February 2007 issue of the journal *Obstetrics and Gynecology* found that women who had just one previous Caesarean section were more likely to have problems with their second birth. Women who delivered their first child by Caesarean delivery had increased risks for malpresentation, placenta previa, antepartum hemorrhage, placenta accreta, prolonged labor, uterine rupture, preterm birth, low birth weight, and stillbirth in their second delivery. However, the authors conclude that some risks may be due to confounding factors related to the indication for the first Caesarean, rather than due to the procedure itself.

Risks for the child

This list is currently incomplete and should not be taken as comprehensive or reflective of current research. It covers three of the most commonly discussed risks to the child. Some risks are rare, and as with most medical procedures the likelihood of any risk is highly dependent on individual factors such as whether other pregnancy complications exist, whether the operation is planned or done as an emergency measure, and how and where it is performed.

- Neonatal depression: babies may have an adverse reaction to the anesthesia given to the mother, causing a period of inactivity or sluggishness after delivery.
- Fetal injury: injury may occur to the baby during uterine incision and extraction.
- Potential for early delivery and complications: One study found an increased risk of complications if a repeat elective Caesarean section is performed even a few days before the recommended 39 weeks.
- Wet lung: retention of fluid in the lungs not expelled by the pressure of contractions during labor.

Risks for both mother and child

Due to extended hospital stays, both the mother and child are at risk for developing a hospital-borne infection.

Studies have shown that mothers who have their babies by Caesarean take longer to first interact with their child when compared with mothers who had their babies vaginally.

Incidence

The World Health Organization estimates the rate of Caesarean sections at between 10% and 15% of all births in developed countries. In 2004, the Caesarean rate was about 20% in the United Kingdom, while the Canadian rate was 22.5% in 2001-2002.

In Italy the incidence of Caesarean sections is particularly high, although it varies from region to region. In Campania, 60% of 2008 births reportedly occurred via Caesarean sections. In the Rome region, the mean incidence is around 44%, but can reach as high as 85% in some private clinics.

In the United States the Caesarean rate has risen 48% since 1996, reaching a level of 31.8% in 2007. A 2008 report found that fully one-third of babies born in Massachusetts in 2006 were delivered by Caesarean section. In response, the state's Secretary of Health and Human Services, Dr. Judy Ann Bigby, announced the formation of a panel to investigate the reasons for the increase and the implications for public policy.

Among developing countries, Brazil has one of the highest rates of Caesarean sections in the world. In the public health network, the rate reaches 35%, while in private hospitals the rate approaches 80%.

Studies have shown that continuity of care with a known carer may significantly decrease the rate of Caesarean delivery but there is also research that appears to show that there is no significant difference in Caesarean rates when comparing midwife continuity care to conventional fragmented care.

More emergency Caesareans—about 66%—are performed during the day rather than during the night.

Analyzing the rise in Caesarean section rates

The US National Institutes of Health says that rises in rates of Caesarean sections are not, in isolation, a cause for concern, but may reflect changing reproductive patterns:

The World Health Organization has determined an “ideal rate” of all cesarean deliveries (such as 15 percent) for a population. One surgeon's opinion is that there is no consistency in this ideal rate, and artificial declarations of an ideal rate should be

discouraged. Goals for achieving an optimal cesarean delivery rate should be based on maximizing the best possible maternal and neonatal outcomes, taking into account available medical and health resources and maternal preferences. This opinion is based on the idea that if left unchallenged, optimal cesarean delivery rates will vary over time and across different populations according to individual and societal circumstances.

However, some commentators are concerned by the rise and have noted several evidence-based studies. Louise Silverton, deputy general-secretary of the Royal College of Midwives, says that not only has society's tolerance for pain and illness been "significantly reduced", but also that women are scared of pain and think that if they have a Caesarean there will be less, if any, pain. It is the opinion of Silverton and the Royal College of Midwives that "women have lost their confidence in their ability to give birth."

Silverton's analysis is controversial among some surgeons. Dr Maggie Blott, a consultant obstetrician at University College Hospital, London and then a Royal College of Obstetricians and Gynaecologists (RCOG) spokeswoman on Caesareans (and Vice President of the RCOG), responded: 'There isn't any evidence to support Louise Silverton's view that increasingly pain-averse women are pushing up the Caesarean rate. There's an undercurrent that Caesarean sections are a bad thing, but they can be life-saving.'

A previously unexplored hypothesis for the increasing section rate is the evolution of birth weight and maternal pelvis size. It is proposed that since the advent of successful Caesarean birth over the last 150 years, mothers with a small pelvis and babies with a large birth weight have survived and contributed to these traits increasing in the population. Such a hypothesis is based upon the idea that even without fears of malpractice, without maternal obesity and diabetes, and without other widely quoted factors, the C-section rate would continue to rise simply due to slow changes in population genetics.

Elective Caesarean sections

Caesarean sections are in some cases performed for reasons other than medical necessity. Reasons for elective Caesareans vary, with a key distinction being between hospital or doctor-centric reasons and mother-centric reasons. Critics of doctor-ordered Caesareans worry that Caesareans are in some cases performed because they are profitable for the hospital, because a quick Caesarean is more convenient for an obstetrician than a lengthy vaginal birth, or because it is easier to perform surgery at a scheduled time than to respond to nature's schedule and deliver a baby at an hour that is not predetermined. Another reason for doctors to recommend C-section is money. In China, doctors are compensated based on the monetary value of medical treatments offered. As a result, doctors have an incentive to persuade mothers to choosing the more expensive C-section.

In this context, it is worth remembering that many studies have shown that operations performed out-of-hours tend to have more complications (both surgical and anaesthetic).

For this reason if a Caesarean is anticipated to be likely to be needed for a woman, it may be preferable to perform this electively (or pre-emptively) during daylight operating hours, rather than wait for it to become an emergency with the increased risk of surgical and anaesthetic complications that can follow from emergency surgery.

Another contributing factor for doctor-ordered procedures may be fear of medical malpractice lawsuits. Italian gynaecologyst Enrico Zupi, whose clinic in Rome Mater Dai was under media attention for carrying a record of caesarian sections (90% over total birth), explained: “We shouldn't be blamed. Our approach must be understood. We doctors are often sued for events and complications that cannot be classified as malpractice. So we turn to defensive medicine. We will keep acting this way as long as medical mistakes are not depenalized. We are not martyrs. So if a pregnant woman is facing an even minimum risk, we suggest she gets a C-section”

Studies of United States women have indicated that married white women giving birth in private hospitals are more likely to have a Caesarean section than poorer women even though they are less likely to have complications that may lead to a Caesarean section being required. The women in these studies have indicated that their preference for Caesarean section is more likely to be partly due to considerations of pain and vaginal tone. In contrast to this, a recent study in the British Medical Journal retrospectively analysed a large number of Caesarean sections in England and stratified them by social class. Their finding was that Caesarean sections are not more likely in women of higher social class than in women in other classes. While such mother-elected Caesareans do occur, the prevalence of them does not appear to be statistically significant, while a much larger number of women wanting to have a vaginal birth find that the lack of support and medico-legal restrictions led to their Caesarean. Some have suggested that due to the comparative risks of Caesarean section with an uncomplicated vaginal delivery, patients should be discouraged or forbidden from choosing it.

Some 42% of obstetricians believe the media and women are responsible for the rising Caesarean section rates. Some studies, however, conclude that relatively few women wish to be delivered by Caesarean section.

Anaesthesia

Both general and regional anaesthesia (spinal, epidural or combined spinal and epidural anaesthesia) are acceptable for use during Caesarean section. Regional anaesthesia is preferred as it allows the mother to be awake and interact immediately with her baby. Other advantages of regional anesthesia include the absence of typical risks of general anesthesia: pulmonary aspiration (which has a relatively high incidence in patients undergoing anesthesia in late pregnancy) of gastric contents and Oesophageal intubation.

Regional anaesthesia is used in 95% of deliveries, with spinal and combined spinal and epidural anaesthesia being the most commonly used regional techniques in scheduled Caesarean section. Regional anaesthesia during Caesarean section is different to the analgesia (pain relief) used in labor and vaginal delivery. The pain that is experienced

because of surgery is greater than that of labor and therefore requires a more intense nerve block. The dermatomal level of anesthesia required for Caesarean delivery is also higher than that required for labor analgesia.

General anesthesia may be necessary because of specific risks to mother or child. Patients with heavy, uncontrolled bleeding may not tolerate the hemodynamic effects of regional anesthesia. General anesthesia is also preferred in very urgent cases, such as severe fetal distress, when there is no time to perform a regional anesthesia.

Vaginal birth after Caesarean

While vaginal birth after Caesarean (VBAC) are not uncommon today, their numbers are shrinking. The medical practice until the late 1970s was "once a Caesarean, always a Caesarean" but a consumer-driven movement supporting VBAC changed the medical practice. Rates of VBAC in the 80s and early 90s soared, but more recently the rates of VBAC have dramatically dropped owing to medico-legal restrictions.

In the past, Caesarean sections used a vertical incision which cut the uterine muscle fibres in an up and down direction (a classical Caesarean). Modern Caesareans typically involve a horizontal incision along the muscle fibres in the lower portion of the uterus (hence the term lower uterine segment Caesarean section, LUSCS/LSCS). The uterus then better maintains its integrity and can tolerate the strong contractions of future childbirth. Cosmetically the scar for modern Caesareans is below the "bikini line".

Obstetricians and other caregivers differ on the relative merits of vaginal and Caesarean section following a Caesarean delivery; some still recommend a Caesarean routinely, others do not. What should be emphasized in modern obstetric care is that the decision should be a mutual decision between the obstetrician and the mother/birth partner after assessing the risks and benefits of each type of delivery. As is the case for all surgical procedures a patient signed form relating to informed consent **must** be obtained prior to surgery attesting the **completeness** of patient information because of reasonable and viable alternatives to maternal choice CS.

In the United States of America, the American College of Obstetricians and Gynecologists (ACOG) modified the guidelines on vaginal birth after previous Caesarean delivery in 1999 and again in 2004. This modification to the guideline included the addition of the following recommendation:

Because uterine rupture may be catastrophic, VBAC should be attempted in institutions equipped to respond to emergencies with physicians immediately available to provide emergency care.

This recommendation has, in some cases, had a major impact on the availability of VBACs to birthing mothers in the United States. For example, a study of the change in frequency of VBAC deliveries in California after the change in guidelines, published in 2006, found that the VBAC rate fell to 13.5% after the change, compared with 24%

VBAC rate before the change. The new recommendation has been interpreted by many hospitals as indicating that a full surgical team must be standing by to perform a Caesarean section for the full duration of a VBAC woman's labor. Hospitals that prohibit VBACs entirely are said to have a 'VBAC ban'. In these situations, birthing mothers are forced to choose between having a repeat Caesarean section, finding an alternate hospital in which to deliver their baby or attempting delivery outside the hospital setting.

Recovery Period

Typically the recovery time depends on the patient and their pain/ inflammation levels. Doctors do recommend no strenuous work i.e. lifting objects over 10 lbs., running, walking up stairs, or athletics for up to two weeks.

Elective caesarean section

Elective caesarean section (AE elective cesarean section) refers to a caesarean section (CS) that is performed on a pregnant woman on the basis of an obstetrical or medical indication or at the request of the pregnant patient. The elective CS is usually also a "planned CS" and executed prior to labor. In contrast, a CS done during labor by necessity is termed an *emergency caesarean section*.

Indication based

When it is clear during a pregnancy, but prior to labor, that there is a medical or obstetrical reason to choose delivery via caesarean section, physicians will commonly perform the operation at a scheduled time, rather than waiting for the onset of labor. Such planned caesarean sections are performed for many reasons, including history of previous caesarean section, placenta previa, abnormal presentations, multiple pregnancy, known obstructions of labor, medical conditions (such as heart disease). The advantages of performing the delivery at a scheduled time include use of daytime services when hospital resources are optimal, and the ability to plan and prepare for the event. The approach has risk in that the surgery may be scheduled too early resulting in premature or compromised delivery. Prenatal testing mitigates this risk.

Critics of elective caesarean section, maintain that decision metrics are ambiguous, and that trial of labor would often be successful without open abdominal surgery. The cost to the patient and the baby for unnecessary surgery may be substantial. Critics also argue that because physicians and institutions may benefit by reducing night time and weekend work, that an inappropriate incentive exists to suggest elective surgery.

The fear of litigation is cited to drive the elective caesarean section rate higher: While a repeat caesarean section can be avoided for many women who wish to labour after a caesarean, (a process called vaginal birth after caesarean section, or VBAC), some argue that this can lead to an increase likelihood of uterine rupture.

Patient request

Increasingly, caesarean sections are performed in the absence of obstetrical or medical necessity at the patient's request, and the term *Caesarean delivery on maternal request* has been used. Another term that has been used is "planned elective cesarean section". As of 2006, there is no ICD code, thus the extent of the use of this indication is difficult to determine. The mother is the only party who may request such an intervention without indication.

Complications

There are number of steps that can be taken during abdominal or pelvic surgery to minimize postoperative complications, such as the formation of adhesions. Such techniques and principles may include:

• Handling all tissue with absolute care • Using powder-free surgical gloves • Controlling bleeding • Choosing sutures and implants carefully • Keeping tissue moist • Preventing infection

However, despite these proactive measures, abdominal or pelvic surgery can result in trauma that can lead to adhesions. In order to prevent adhesions from forming following a pelvic (gynecologic) surgery, such as hysterectomy, myomectomy or caesarean section, adhesion barrier can be placed during surgery to minimize the risk of adhesions between the uterus and ovaries, the small bowel, and almost any tissue in the abdomen or pelvis.

Adhesions can cause complications, such as:

• Infertility, which may result when adhesions twist the tissues of the ovaries and tubes, blocking the normal passage of the egg (ovum) from the ovary to the uterus. One in five infertility cases is estimated to be adhesion related (stoval) • Chronic pelvic pain, which may result when adhesions are present in the pelvis. Almost 50 percent of chronic pelvic pain cases are estimated to be adhesion related (stoval) • Small bowel obstruction – the disruption of normal bowel flow, which can result when adhesions twist or pull the small bowel. 75% of small bowel obstructions are directly related to adhesions. (Scovill)

Chapter 2

Fetal Surgery

Fetal surgery is any of a broad range of surgical techniques that are used to treat birth defects in fetuses who are still in the pregnant uterus.

- **Open fetal surgery** involves completely opening the uterus to operate on the fetus.
- Minimally invasive **fetoscopic surgery** (fetendo) uses small incisions and is guided by fetoscopy and sonography.
- Some fetal surgery can sometimes be done without either an incision in the uterus or an endoscopic view inside the uterus: it is done entirely with a real-time cross-sectional view provided by the sonogram.

Types

Open fetal surgery

Technique

Tocolytics are generally given to prevent labor. However, these should not be given if the risk is higher for the fetus inside the womb than if delivered, such as may be the case in intrauterine infection, unexplained vaginal bleeding and fetal distress.

Regarding anesthesia, an H_2 antagonist is usually given the evening before and the morning of the operation, and an antacid is usually given before induction to reduce the risk of acid aspiration. Rapid sequence induction is usually used for sedation and intubation.

Open fetal surgery is similar in many respects to a normal cesarean section performed under general anesthesia, except that the fetus remains dependent on the placenta and is returned to the uterus. A hysterotomy is performed on the pregnant woman. Once the

uterus is open and the fetus is exposed, the fetal surgery begins. Typically, this surgery consists of an interim procedure intended to allow the fetus to remain in utero until it has matured enough to survive delivery and neonatal surgical procedures.

Upon completion of the fetal surgery, the fetus is put back inside the uterus and the uterus and abdominal wall are closed up. Before the last stitch is made in the uterine wall, the amniotic fluid is replaced.

The mother remains in the hospital for 3–7 days for monitoring and is required to subsequently deliver the baby via a **second** cesarean section. Often babies who have been operated on in this manner are born pre-term.

Safety and complications

The main priority is maternal safety, and, secondary, avoiding preterm labor and achieving the aims of the surgery. Open fetal surgery is possible first after approximately 18 weeks of gestation due to fetal size and fragility before that, and up to approximately 30 weeks of gestation due to increased risk of premature labor and, practically, the preferability of delivering the child and performing the surgery *ex utero* instead. The risk of premature labor is increased by comcomitant risk factors such as multiple gestation, a history of maternal smoking, and very young or old maternal age.

Open fetal surgery has proven to be reasonably safe for the mother. For the fetus, safety and effectiveness are variable, and depend on the specific procedure, the reasons for the procedure, and the gestational age and condition of the fetus. The overall perinatal mortality after open surgery has been estimated to be approximately 6%, according to a study in the United States 2003.

All future pregnancies for the mother require cesarean delivery because of the hysterotomy. However, there is no presented data suggesting decreased fertility for the mother.

Indications

Open prenatal surgery is very rare and of unproven benefit. There are estimated to be 600 candidates annually in the US, with only a fraction of these resulting in successful surgeries. Most prenatal procedures may be considered high-risk and experimental. A major complication is fetal expulsion resulting in miscarriage, as the primate uterus is extraordinarily sensitive to external stimuli compared with that of other species such as the sheep.

Fetal closure of neural tube defects is an option for some families as part of the Management of Myleomeningocle Study (MOMS) in the United States.

Other conditions that potentially are treated by open fetal surgery include:

- Congenital diaphragmatic hernia (if indicated at all, it is now more likely to be treated by endoscopic fetal surgery)
- Congenital cystic adenomatoid malformation
- Congenital heart disease
- Pulmonary sequestration
- Sacrococcygeal teratoma

Minimally invasive fetal surgery

Minimally-invasive fetoscopic surgery (aka Fetendo) uses real-time video imagery from fetoscopy and ultrasonography to guide very small surgical instruments into the uterus in order to surgically help the fetus. The name Fetendo was adopted for the procedure because of how the video-based manipulation recalls a child's video game.

Less invasive than open fetal surgery, some fetal surgeries can be achieved with just a small guided wire sent through a needle-puncture of the skin (percutaneous), though in some cases it may require that a small opening be made in the mother's abdomen. The fact that it is less invasive reduces the mother's postoperative recovery and lessens the troubles with preterm labor.

Minimally-invasive fetoscopic surgery (or Fetendo) has proven to be very useful for some, but not all, fetal conditions. Some examples include:

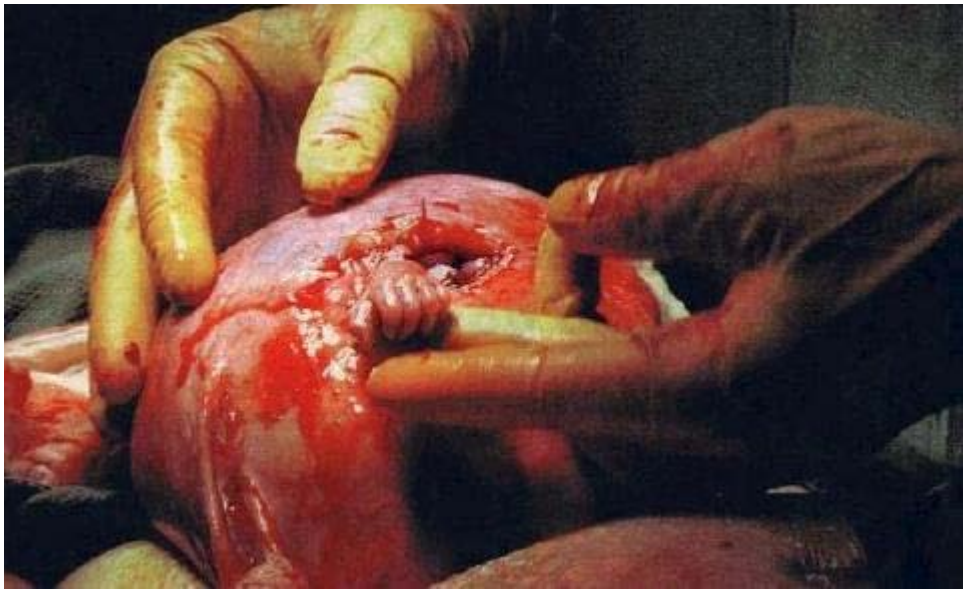
- Twin-twin transfusion syndrome - Laser Ablation of Vessels
- Fetal bladder obstructions
- Aortic or Pulmonary Valvuloplasty - opening the Aortic or Pulmonary fetal heart valves to allow blood flow
- Atrial Septostomy - opening the inter-atrial septum of the fetal heart to allow unrestricted blood flow between the atriums
- Congenital diaphragmatic hernia - Balloon tracheal occlusion
- Spina bifida - Fetoscopic closure of the malformation

History

Fetal surgical techniques using animal models were first developed at the University of California, San Francisco in 1980 by Dr. Michael R. Harrison and his research colleagues.

In 1981, the first human open fetal surgery in the world was performed at University of California, San Francisco under the direction of Dr. Michael Harrison. The fetus in question had a congenital hydronephrosis, a blockage in the urinary tract that caused the bladder to dangerously extend. To correct this a vesicostomy was performed placing a catheter in the fetus allowing the urine to be released normally. The blockage itself was removed surgically after birth.

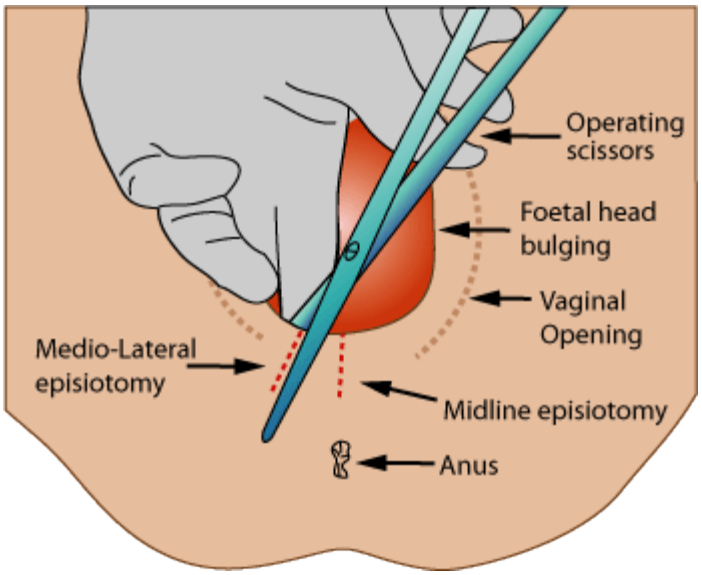
Further advances have been made in the years since this first operation. New techniques have allowed additional defects to be treated and for less invasive forms of fetal surgical intervention.



Samuel Armas's arm slipping out of the uterus of his mother, Julie Armas. Doctor's hands are Dr. Joseph Bruner. Photographed by Michael Clancy during open fetal surgery for spina bifida

Chapter 3

Episiotomy



Medio-lateral episiotomy as baby crowns.

An **episiotomy** is a surgically planned incision on the perinium and the posterior vaginal wall during second stage of labour. The incision, which can be midline or at an angle from the posterior end of the vulva, is performed under local anaesthetic (pudendal anesthesia), and is sutured closed after delivery. It is one of the most common medical procedures performed on women, and although its routine use in childbirth has steadily declined in recent decades, it is still widely practiced in many parts of the world including Latin America, Poland, Bulgaria, India and Taiwan.

Uses

Episiotomy is done as prophylaxis against soft-tissue-trauma. Vaginal tears can occur during childbirth, most often at the vaginal opening as the baby's head passes through, especially if the baby descends quickly. Tears can involve the perineal skin or extend to

the muscles and the anal sphincter and anus. The midwife or obstetrician may decide to make a surgical cut to the perineum with scissors or scalpel (episiotomy) to make the baby's birth easier and prevent severe tears that can be difficult to repair. The cut is repaired with stitches (sutures). Some childbirth facilities have a policy of routine episiotomy.

Though indications on the need for episiotomy vary, and may even be controversial, where the technique is applied, there are two main variations. Both are depicted in the above image. In one variation, the midline episiotomy, the line of incision is central over the anus. This technique bifurcates the perineal body, which is essential for the integrity of the pelvic floor. Precipitous birth can also sever-and more severely sever-the perineal body, leading to undesired birth sequelae such as incontinence. Therefore, the oblique technique is often applied (also pictured above). In the oblique technique, the perineal body is avoided, cutting only the vagina epithelium, skin and muscles (transversalius and bulbospongiosus). This technique aids in avoiding trauma to the perineal body by either surgical or traumatic means.

In 2009, a Cochrane meta-analysis based on studies with over 5000 women concluded that: "Restrictive episiotomy policies appear to have a number of benefits compared to policies based on routine episiotomy. There is less posterior perineal trauma, less suturing and fewer complications, no difference for most pain measures and severe vaginal or perineal trauma, but there was an increased risk of anterior perineal trauma with restrictive episiotomy." The authors were unable to find any good quality studies that compared mediolateral versus midline episiotomy.

Indications

- There is a serious risk to the mother of second or third degree tearing
- In cases where a natural delivery is adversely affected, but a Caesarean section is not indicated
- 'Natural' tearing will cause an increased risk of maternal disease being vertically transmitted
- The baby is very large
- When perineal muscles are excessively rigid
- When instrumental delivery is indicated
- When a woman has undergone FGM (female genital mutilation), indicating the need for an anterior and or mediolateral episiotomy
- Prolonged late decelerations or fetal bradycardia during active pushing
- The baby's shoulders are stuck (shoulder dystocia), or a bony association (Note that the episiotomy does not directly resolve this problem, but it is indicated to allow the operator more room to perform maneuvers to free shoulders from the pelvis)

Types

There are four main types of episiotomy:

- Medio-lateral: The incision is made downward and outward from midpoint of forchette either to right or left. It is directed diagonally in striaght line which runs about 2.5 cm away from the anus(midpoint between anus and ischial tuberosity).
- Median: The incision commences from center of the fouchette and extends on posterios side along midline for 2.5 cm.
- Lateral: The incision starts from about 1 cm away from the center of forchette and extends laterally. Drawback include chance of injury to Bartholin's duct. Thus some practiotioners have totally condemned it.
- 'J' shaped: The incision begins in the center of the forchette and is directed posteriorly along midline for about 1.5 cm and then directed downwards and outwards along 5 or 7 o'clock position to avoid the anal sphincter. This is also not done widely.

Controversy about common usage and history of the technique

Traditionally, physicians have used episiotomies in an effort to lessen perineal trauma, minimize postpartum pelvic floor dysfunction by reducing anal sphincter muscle damage, reduce the loss of blood during delivery, and protect against neonatal trauma. While episiotomy is employed to obviate issues such as post-partum pain, incontinence and sexual dysfunction, some studies suggest that in actuality, episiotomy surgery itself can cause all of these problems. Research has shown that natural tears typically are less severe (although this is perhaps not surprising since an episiotomy is designed for when natural tearing will cause significant risks or trauma). Slow delivery of the head in between contractions will result in the least perineal damage. Studies in 2010 based on interviews with postpartum women have concluded that limiting perineal trauma during birth is conducive to continued sexual function after birth. At least one study has recommended that routine episiotomy be abandoned for this reason.

In various countries, routine episiotomy has been accepted medical practice for many years. Since about the 1960s, routine episiotomies have been rapidly losing popularity among obstetricians and midwives in Europe, Australia and the United States. A nationwide US population study suggested that 31% of women having babies in U.S. hospitals received episiotomies in 1997, compared with 56% in 1979. In Latin America it remains popular, and is performed in 90% of hospital births, in most cases without the mother's consent.

Discussion

Having an episiotomy may increase perineal pain during postpartum recovery, resulting in trouble defecating, particularly in midline episiotomies. In addition it may complicate

sexual intercourse by making it painful and replacing erectile tissues in the vulva with fibrotic tissue.

In cases where an episiotomy is indicated, a mediolateral incision may be preferable to a median (midline) incision, as the latter is associated with a higher risk of injury to the anal sphincter and the rectum.

Impacts on sexual intercourse

Some midwives compare routine episiotomy to female circumcision. One study found that women who underwent episiotomy reported more painful intercourse and insufficient lubrication 12–18 months after birth, but did not find any problems with orgasm or arousal.

Lessening the Need for Episiotomy

Controlled delivery of the head that allows slow gradual stretching of the perineal tissue can help in minimizing damage to the perineum.

Perineal massage beginning around the 34th week has been shown to reduce perineal damage by 6%.

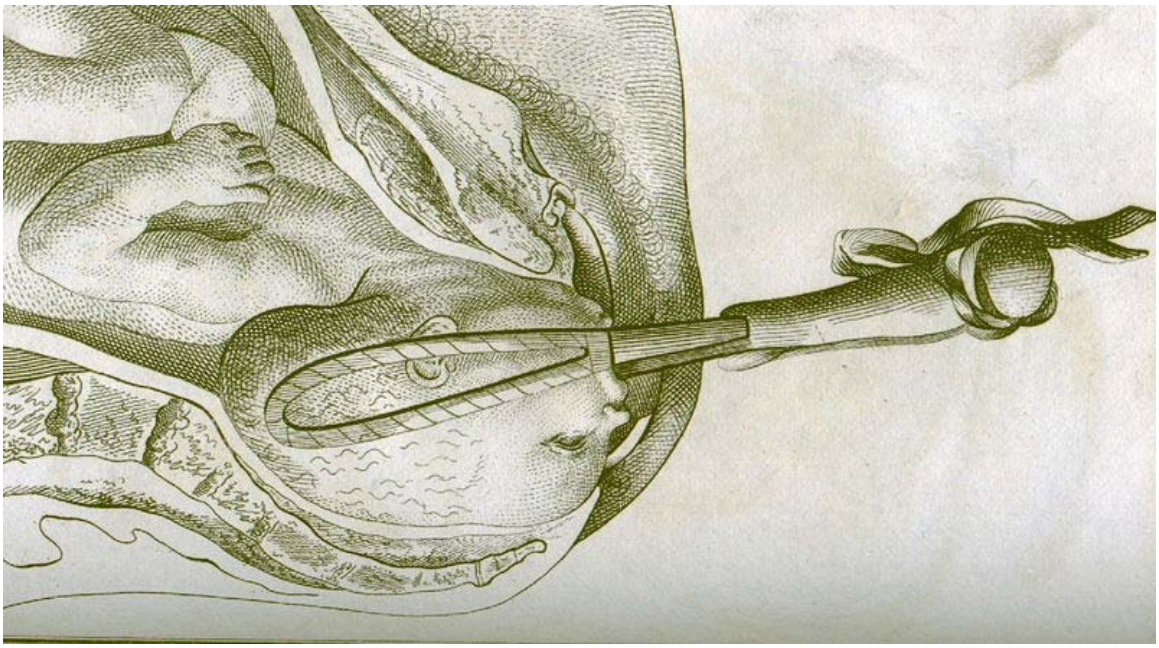
A perineal dilator can be used to stretch the perineal tissue gradually and train it in preparation for first births. The "Epi-no Birth Trainer" consists of a small inflatable silicone balloon pumped with the same pump as a sphygmomanometer. The Epi-no device has been shown to reduce perineal damage by 50% at first births. Where episiotomy is never practiced, the sutured tear rates for first birth were documented to be about 30%. Among 104 consecutive primiparous women who practiced with an Epi-No birth trainer before birth and had normal vaginal births, 10% had sutured perineums. Neither group suffered any third- or fourth-degree tears. The average birthweight was 3,400 g. This 10% rate of sutured perineums among first births who used EPINO birth trainer is the lowest reported for healthy primiparous women to date.

Chapter 4

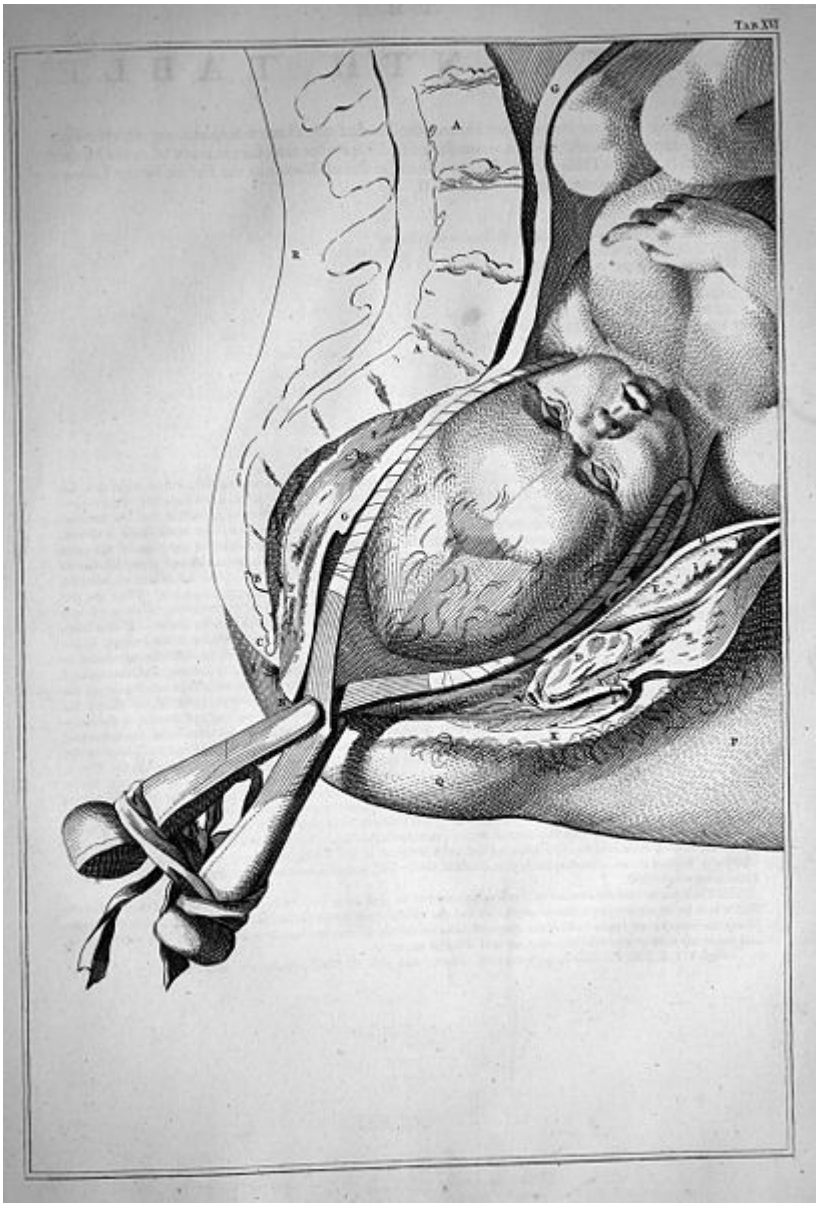
Forceps in Childbirth and Ventouse

Forceps in childbirth

Forceps is an instrument that resembles a pair of tongs and can be used in surgery for grabbing, maneuvering, or removing various things within or from the body.They can be used to assist the delivery of a baby as an alternative to the ventouse method.



Obstetrical Forceps, by Smellie (1792)



Drawing of childbirth by using a forceps by William Smellie

Structure

Obstetric forceps consist of two branches that are positioned around the fetal head. These branches are defined as left and right depending on which side of the mother's pelvis they will be applied. The branches usually, but not always, cross at a midpoint which called the articulation. Most forceps have a locking mechanism at the articulation, but a few have a sliding mechanism instead, allowing the two branches to slide along each other. Forceps with a fixed lock mechanism are used for deliveries where little or no rotation is required, as when the fetal head is in line with the mother's pelvis. Forceps with a sliding lock mechanism are used for deliveries requiring more rotation.

The blade of each forceps branch is the curved portion that is used to grasp the fetal head. The forceps should surround the fetal head firmly, but not tightly. The blade characteristically has two curves, the cephalic and the pelvic curves. The cephalic curve is shaped to conform to the fetal head. The cephalic curve can be rounded or rather elongated depending on the shape of the fetal head. The pelvic curve is shaped to conform to the birth canal and helps direct the force of the traction under the pubic bone. Forceps used for rotation of the fetal head should have almost no pelvic curve.

The handles are connected to the blades by shanks of variable lengths. Forceps with longer shanks are used if rotation is being considered.

Types

All American forceps are derived from French forceps (long forceps) or English forceps (short forceps). Short forceps are applied on fetal head already well down in the maternal pelvis (= near the vagina). Long forceps are the ones able to reach a fetal head still in the middle or even in the upper part of the maternal pelvis. At present practice, it is uncommon to try to use forceps for high positioned head. So, short forceps are preferred in UK and USA. Long forceps are still in use elsewhere as well as parallel branches forceps. Anyway American obstetricians discontinue to use long forceps and have no more practice of those instruments.

Simpson forceps (1848) Typical "English look". It is the most commonly used among the types of forceps with an elongated cephalic curve. These are used when there is substantial molding, that is, the fetal head temporary becomes more elongated as it moves through the birth canal.

Elliot forceps (1860) . Very similar to Simpson'forceps but with a screw and pin in the end of the handles which can be drawn out as a means of regulating the lateral pressure on the handles when the instrument is in position for use. They are used most often in women who have had at least one previous vaginal delivery because the muscles and ligaments of the birth canal provide less resistance during second and subsequent deliveries, allowing the fetal head to remain rounder.

Kielland forceps (1915, Norwegian) is very particular with its extremely small pelvic curve and its sliding lock. They are probably the most common forceps used for rotation. The sliding mechanism at the articulation can be helpful in asynclitic births, that is, when the fetal head is tilted to the side, causing the fetal head to no longer be in line with the birth canal. On the other hand, Kielland forceps do not provide much traction because they have almost no pelvic curve at all.

Wrigley's forceps are used in *low* or *outlet delivery*, when the maximum diameter is about 2.5 cm above the vulva. Wrigley's forceps were designed for use by general practitioner obstetricians, having the safety feature that they could not reach high into the pelvis.

Technique

The cervix must be fully dilated and retracted and the membranes ruptured. The urinary bladder should be empty, perhaps with the use of a catheter. High forceps are never indicated in this era. Mid forceps can occasionally be indicated but require operator skill and caution. The station of the head must be at least +2 in the lower birth canal. The woman is placed on her back, usually with the aid of stirrups or assistants to support her legs. A mild local or general anesthetic is administered (unless an epidural anesthesia has been given) for adequate pain control. Ascertaining the precise position of the fetal head is paramount, and though historically was accomplished by feeling the fetal skull suture lines and fontanelles, in the modern era, confirmation with ultrasound is essentially mandatory. At this point, the two blades of the forceps are individually inserted, the posterior blade first, then locked. The position on the baby's head is checked. The fetal head is then rotated to the occiput anterior position if it is not already in that position. An episiotomy may be performed if necessary. The baby is then delivered with gentle (maximum 30 lb_f or 130 Newton) traction in the axis of the pelvis.

Outlet, low, mid or high

The accepted clinical standard classification system for forceps deliveries according to station and rotation was developed by ACOG and consists of:

- *Outlet forceps delivery*, where the forceps are applied when the fetal head has reached the perineal floor and its scalp is visible between contractions. This type of assisted delivery is performed only when the fetal head is in a straight forward or backward vertex position or in slight rotation (less than 45 degrees to the right or left) from one of these positions.
- *Low forceps delivery*, when the baby's head is at +2 station or lower. There is no restriction on rotation for this type of delivery.
- *Midforceps delivery*, when the baby's head is above +2 station. There must be head engagement before it can be carried out.
- *High forceps delivery* is not performed in modern obstetrics practice. It would be a forceps-assisted vaginal delivery performed when the baby's head is not yet engaged.

Possible indicating factors

- Fetal or maternal distress
- If the baby is not delivering despite maternal effort
- When (further) pushing is contra-indicated
- Arterial hypertension (high blood pressure)

Comparisons to other forms of assisted delivery

Positive aspects

- Can be performed even if the baby is not in the correct position, although not if the head is presenting high in the pelvic canal
- Can be used to avoid caesarean delivery
- Delivery of the infant can occur more quickly than with emergency caesarean surgery

Negative aspects

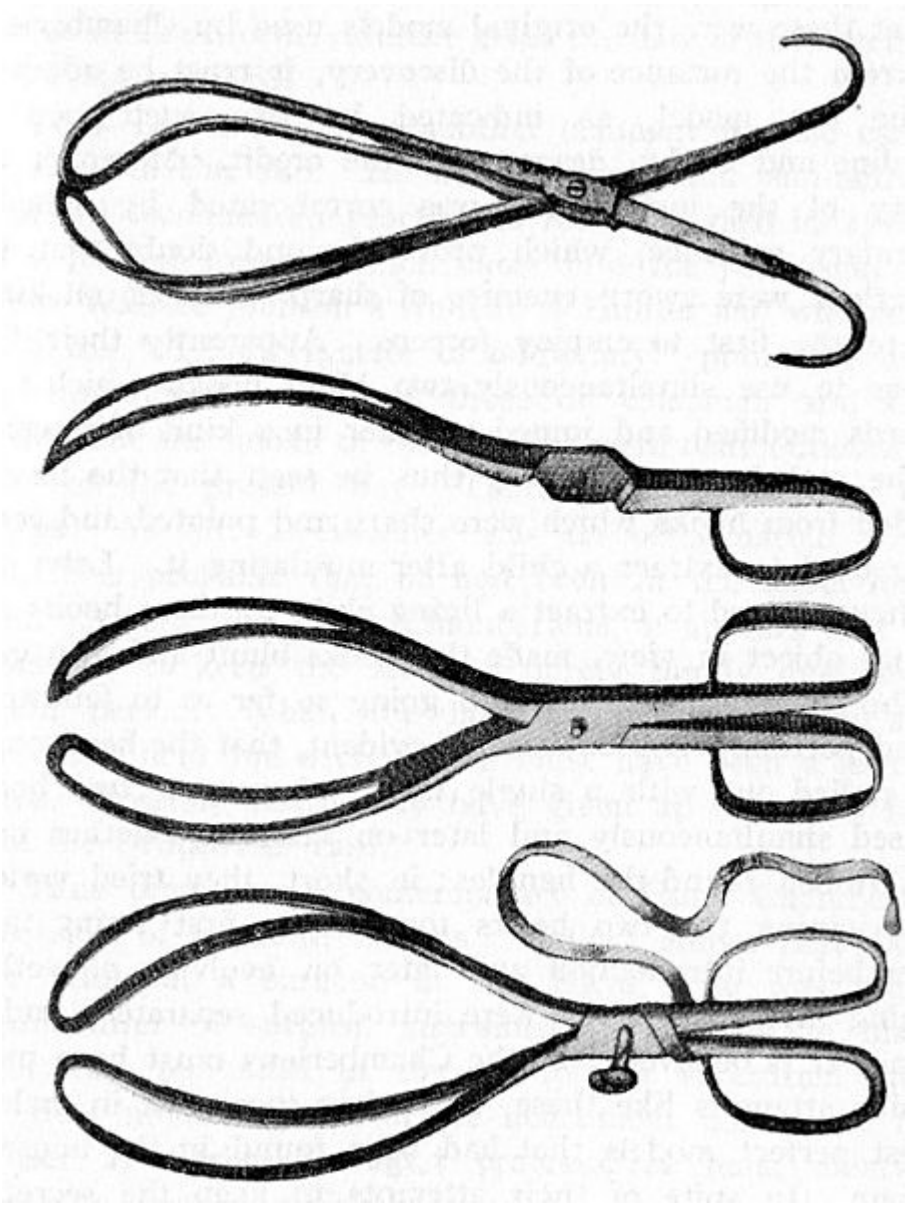
- The internal tissues, particularly the pelvic floor muscles, are bruised
- Facial bruising or temporary marks on the baby
- A rectovaginal fistula can result, where fecal material leaks from the bowel into the vagina
- Nerve damage (may be temporary or permanent)
- Skull fractures
- Cervical cord injury
- Descemet's membrane rupture (extraordinarily rare)

Note: The last five risks listed are from inappropriately used forceps. In appropriately selected cases with experienced operators, these risks are no higher than in normal spontaneous vaginal delivery.

History

The obstetrical forceps, allowing during birth, the extraction of a *living* child, was invented by the eldest son of the Chamberlen family of surgeons. The **Chamberlens** were French Huguenots working in Paris before they immigrated to England in **1569** to flee from religious violence perpetrated in France. William Chamberlen, the patriarch of the family, was most likely a surgeon; he had two sons, whom he both named Pierre, that became maverick surgeons that specialized in midwifery. William and the eldest son practiced in Southampton and then settled in London. The inventor was probably the eldest Pierre (then Peter in England), who became obstetrician-surgeon of Queen Henriette, wife of King Charles I of England and daughter of Henry IV, King of France.

He was succeeded by his nephew, Dr. Peter Chamberlen (also known as *Doctor Peter*, being the first to be graduated "Doctor", because *barbers-surgeons* were not Doctors), as royal obstetrician. The success of this dynasty of obstetricians with the Royal family and high nobles was related in part to the use of this "secret" instrument allowing release of live child in difficult cases.



Chamberlen forceps (Malden)

In fact, the instrument was kept *secret* for a 150 years by the Chamberlen family, although there is evidence for its presence of as far back as 1634. Hughes Chamberlen, Grand nephew of Peter the eldest, tried to sell the instrument in Paris in **1670**, but the demonstration he did in front of François Mauriceau, responsible for Paris Hotel-Dieu maternity, was a resounding failure which resulted in the death of child and mother. The secret may have been sold by Hughes Chamberlen to Dutch obstetricians at the start of the 18th century in Amsterdam, but there are doubts about the authenticity of what was actually provided to buyers, and even of this tractation...

The forceps were used most notably in hard and difficult childbirths, ones which would most probably result in the death of the baby, because in other situations hooks or other

instruments that would endanger the life of the infant were used. In the interest of secrecy, the forceps were carried into the birthing room in a lined box and would only be used once everyone was out of the room and the mother blindfolded.

Models derived from the Chamberlen instrument finally appeared gradually in England and Scotland in 1735. About 100 years after the invention of the forceps by Peter Chamberlen Sr. a surgeon by the name of **Jean Palfyn** presented his obstetric forceps to the Paris Academy of Sciences in **1723**. They contained parallel blades and were called the **Hands of Palfyn**.

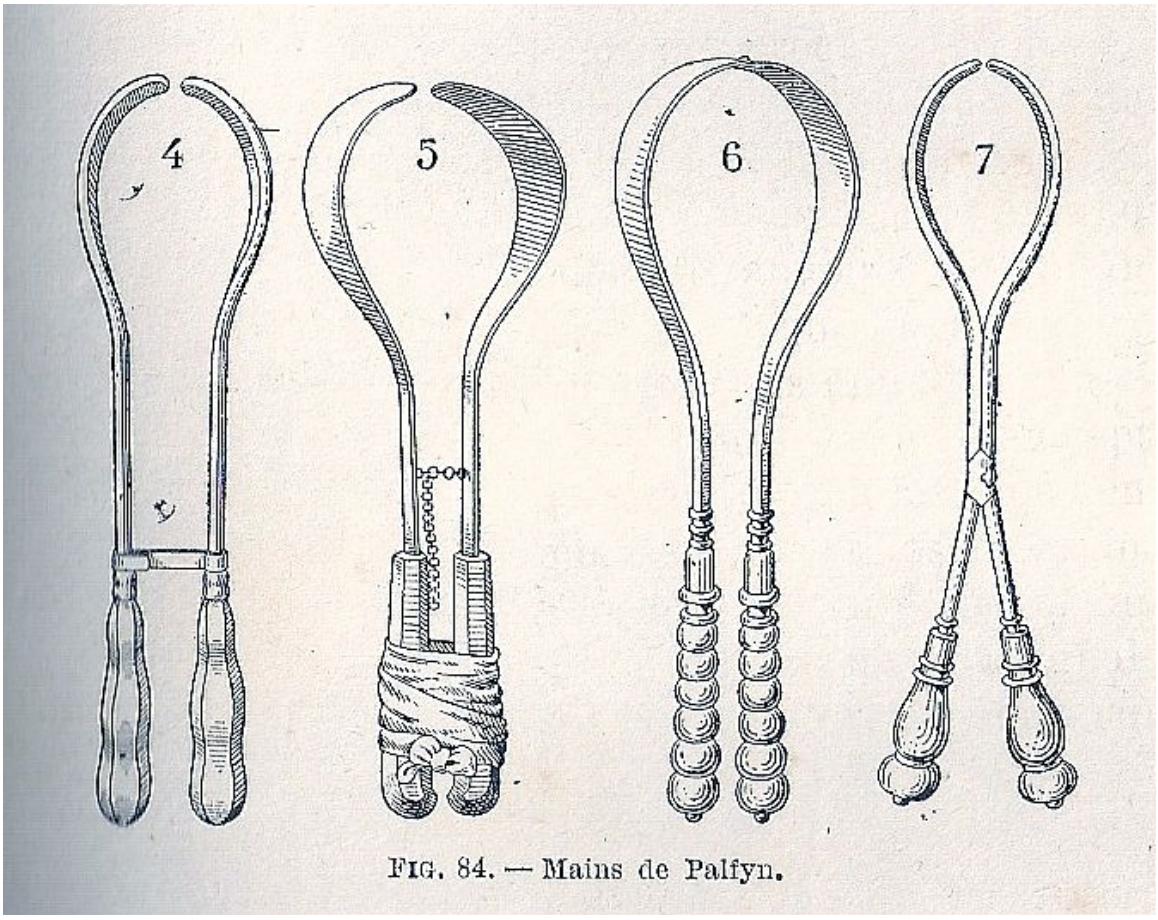
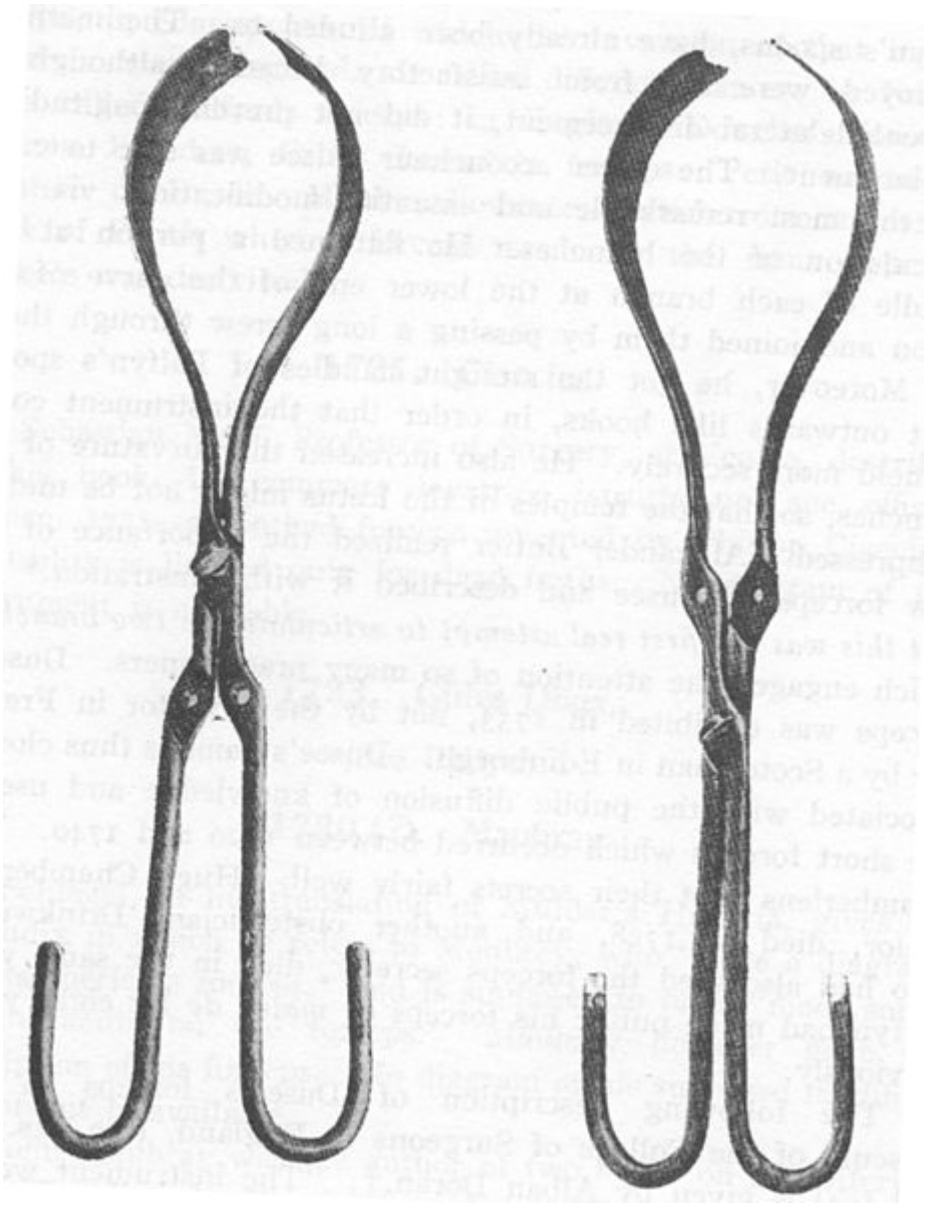


FIG. 84. — Mains de Palfyn.

Palfyn "hands" in different versions

These "hands" were possibly the instruments described by used in Paris by Gregoire father and son, Dussée and Jacques Mesnard.



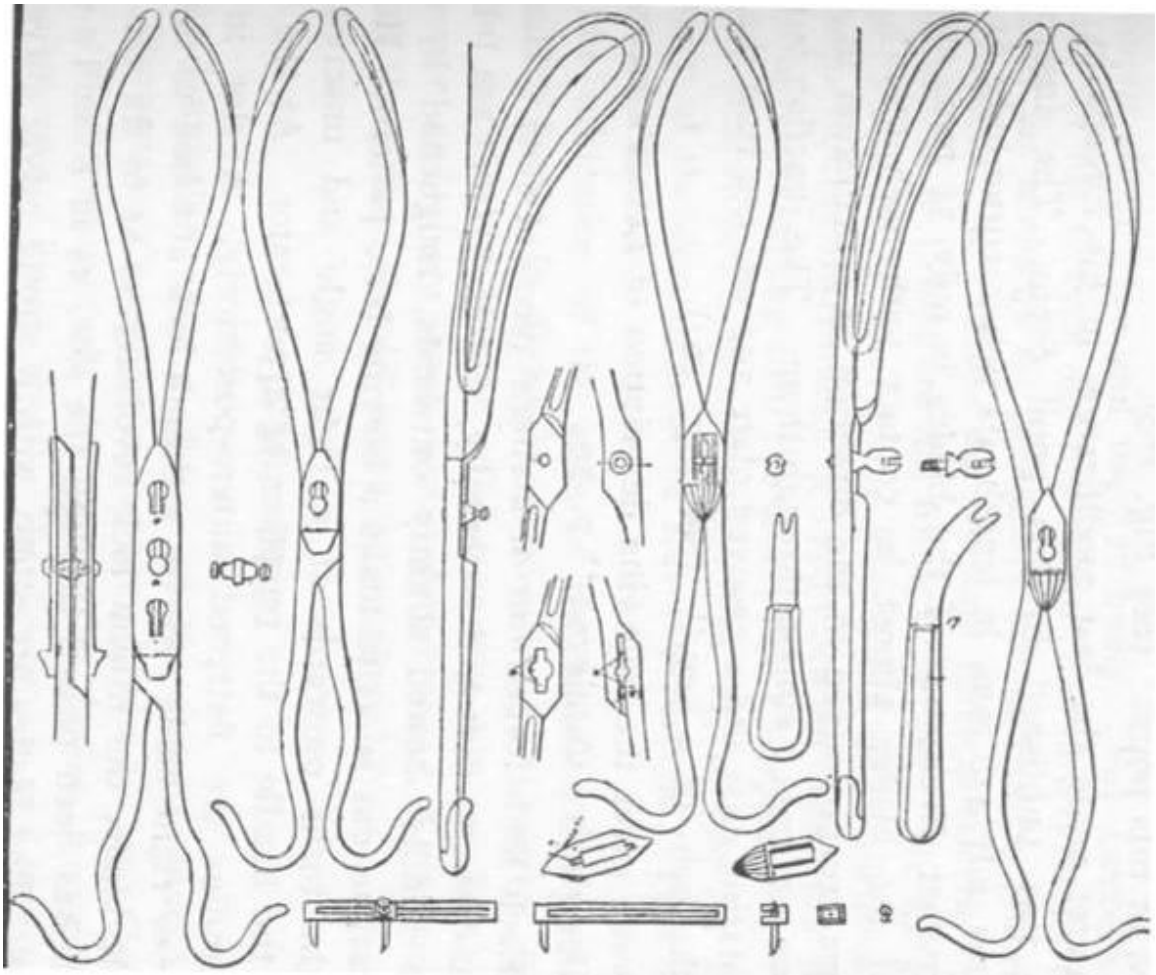
Dussee french forceps (circa 1725) with two different locks

In 1813, Peter Chamberlen's midwifery tools were discovered at Woodham Mortimer Hall in Malden (UK). In the attic of the house, the instruments were found along with gloves, old coins and trinkets. The tools discovered also contained a pair of forceps that were presumably invented by the father of Peter Chamberlen, assumed so because of the barbaric nature of the design.

The Chamberlen family's forceps were based on the idea of separating the two branches of sugar clamp, which were put in place one after another in the birth canal. This was not possible with conventional tweezers previously tested. However, they could only succeed in maternal pelvis of normal dimensions and on fetal heads already well engaged (i.e. well lowered into maternal pelvis). Abnormalities of pelvis were much more common in

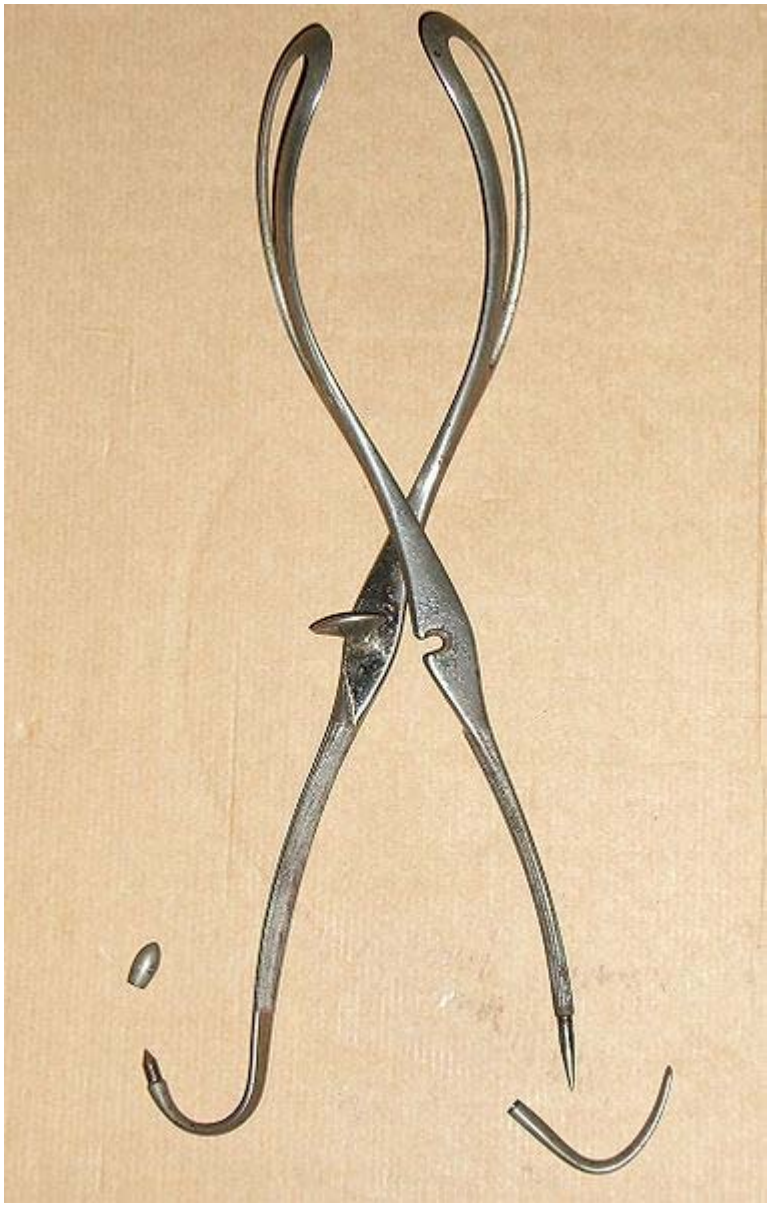
the past than today, which complicated the use of Chamberlen forceps. The absence of pelvic curvature of the branches (vertical curvature to accommodate the anatomical curvature of maternal sacrum) prohibited blades from reaching upper-part of the pelvis and exercising traction in the natural axis of pelvic excavation.

In **1747** French obstetrician Andre Levret, published "Observations sur les causes et accidents de plusieurs accouchements laborieux" (Observations on the Causes and Accidents of Several difficult Deliveries), in which he described his modification of the instrument to follow the *curvature* of the maternal pelvis, this "pelvic curve" allowing a grip on a fetal head *still high* in the pelvic excavation, which could assist in more difficult cases.



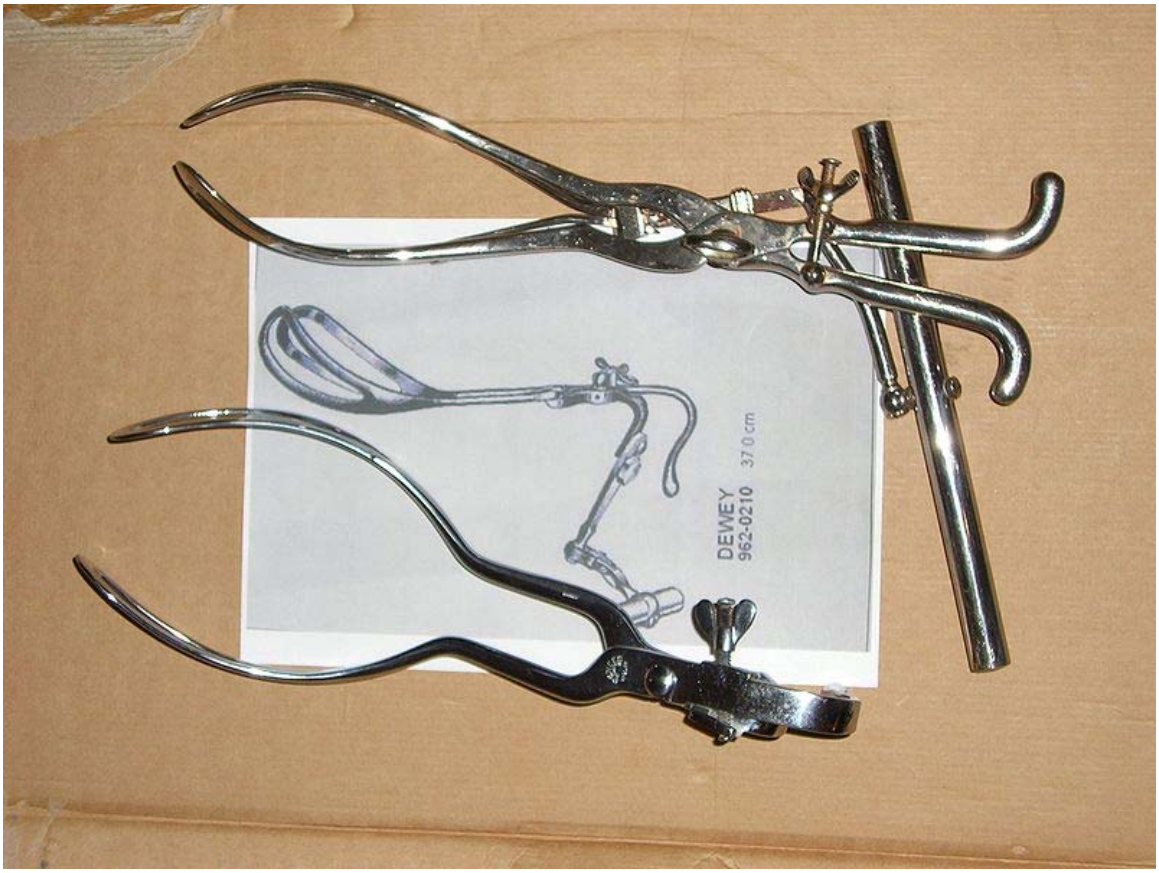
First illustration of Levret's pelvic curve - 1747

This improvement was published in 1751 in England by William Smellie in the book " A Treatise on the theory and practice of midwifery." After this fundamental improvement, the forceps would become a common obstetrical instrument for more than two centuries.



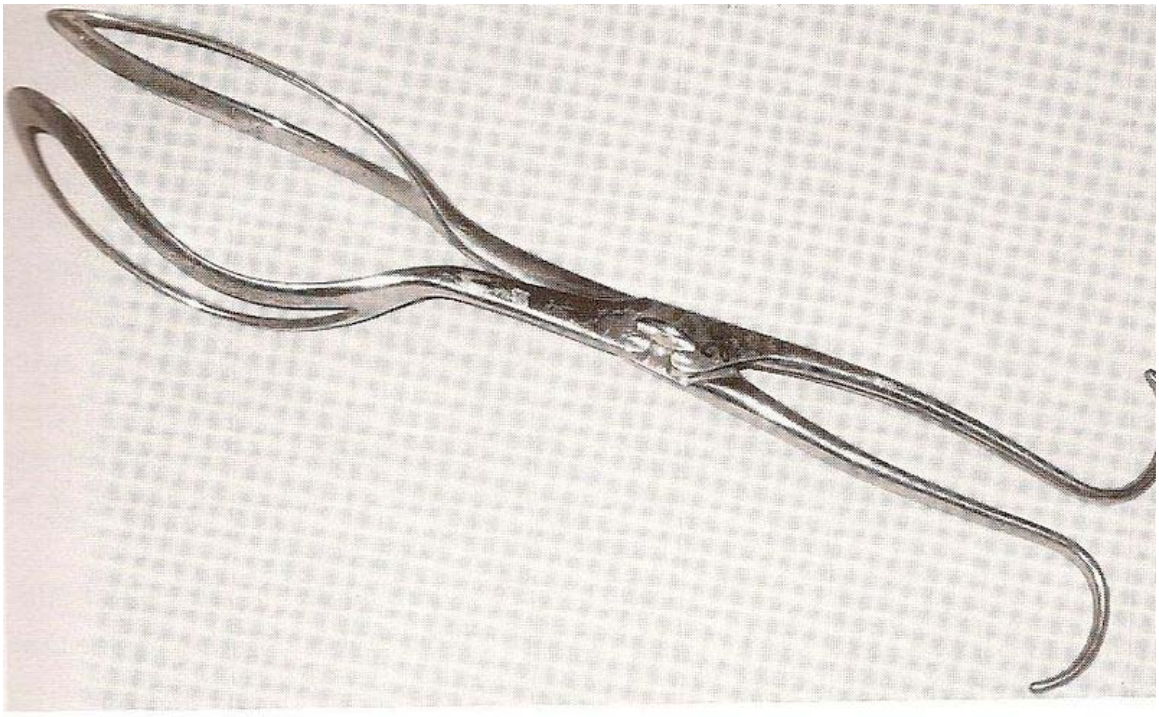
French forceps, Levret-Baudelocque type (1760-1860) with perforator and hook at the end of the handles

The last improvement of the instrument was added in **1877** by a French obstetrician, **Stephan Tarnier** in "descriptions of two new forceps." This instrument featured a *traction system* misaligned with the instrument itself, sometimes called the "third curvature of the forceps". This particularly ingenious traction system, allowed the forceps to exercise traction on the head of the child following *the axis of the maternal pelvic excavation*, which had never been possible before.



Tarnier forceps with tractor handle (1877) and USA Dewey model (1900)

Tarnier's idea was to "split" mechanically the grabbing of the fetal head (between the forceps blades) on which the operator does not intervene after their correct positioning, from a mechanical accessory set on the forceps itself, the "tractor" on which the operator exercises traction needed to pull down the fetal head in the correct axis of the pelvic excavation. Tarnier forceps (and its multiple derivatives under other names) remained the most widely used system in the world until the development of the cesarean section.

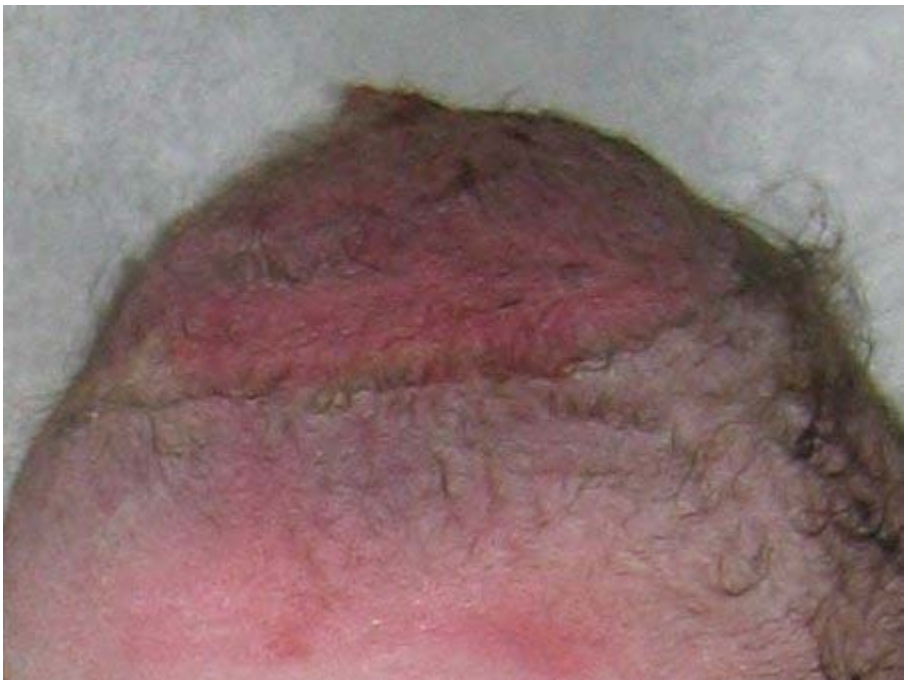


Hodge "Eclectic" forceps - USA (1833)

Elliott forceps with "pressure regulating" screw at the end of handles - USA (1860)

Forceps had a profound influence on obstetrics as it allowed for the speedy delivery of the baby in cases of difficult or obstructed labor. Over the course of the 19th Century, many practitioners attempted to redesign the forceps, so much so that the Royal College of Obstetrics and Gynecologist collection has several hundred examples.In the last decades, however, with the ability to perform a cesarean section relatively safely, and the introduction of the ventouse or vacuum extractor, the use of forceps and training in the technique of its use has sharply declined.

Ventouse



A baby's scalp showing the effects of a vacuum extraction (chignon). The effects were gone a week later.

Ventouse is a vacuum device used to assist the delivery of a baby when labour has not progressed adequately. It is an alternative to a forceps delivery and caesarean section. It is not usually used when the baby is in the breech position or for premature births. This technique is also called **vacuum-assisted vaginal delivery** or **vacuum extraction** (VE). The use of VE is generally very safe, but can rarely have negative effects on both the mother and the child.

Technique

The woman is placed in the lithotomy position and assists throughout the process by pushing. A suction cup is placed onto the head of the baby and the suction draws the skin from the scalp into the cup. Proper placement is critical to keep the head flexed, thus the cup is placed on the flexion point, about 3 cm anterior from the occipital (posterior) fontanelle. Ventouse devices have handles to allow for traction. When the head is fully out, the device is detached, allowing the woman to complete the delivery of her child.

In general, to allow for a proper use of the ventouse, the cervix has to be fully dilated, the head engaged in the birth canal, and the head position known. If the ventouse attempt fails, it may be necessary to deliver the infant by forceps or caesarean section.

Indications for use of vacuum

There are three generally accepted indications to use a ventouse to aid delivery:

- Prolonged pushing in the second stage of labor or maternal exhaustion
- Fetal emergency in the second stage of labor, generally indicated by changes in the fetal heart-rate
- Maternal illness where "bearing down" or pushing efforts would be risky (e.g. cardiac conditions, blood pressure)

Comparisons to other forms of assisted delivery

Positive aspects

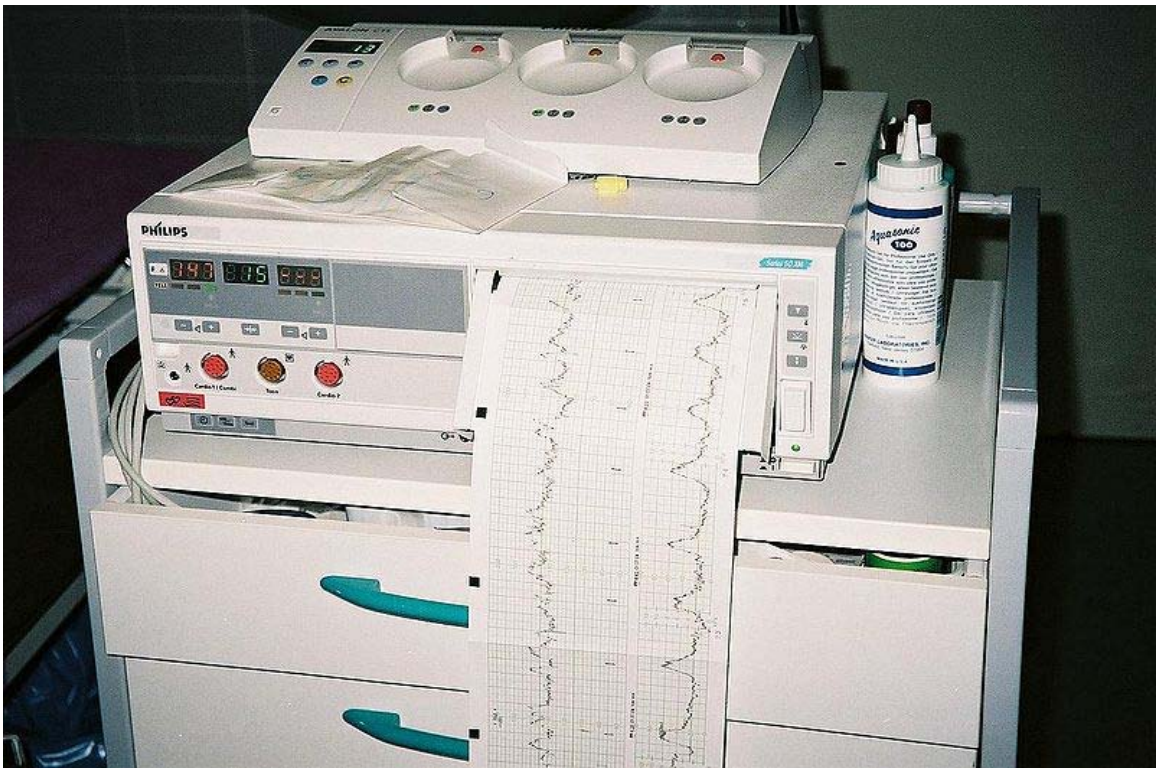
- An episiotomy is not usually required and there is little internal bruising.
- The mother still takes an active role in the birth.
- No special anesthesia required.
- The force applied to the baby can be less than that of a forceps delivery, leaving no marking on the face.
- There is less potential for maternal trauma compared to forceps and cesarean section.

Negative aspects

- The baby may be left with a temporary lump on its head, known as a chignon.
- A possible cephalohematoma formation, or subgaleal hemorrhage.

Chapter 5

Cardiotocography

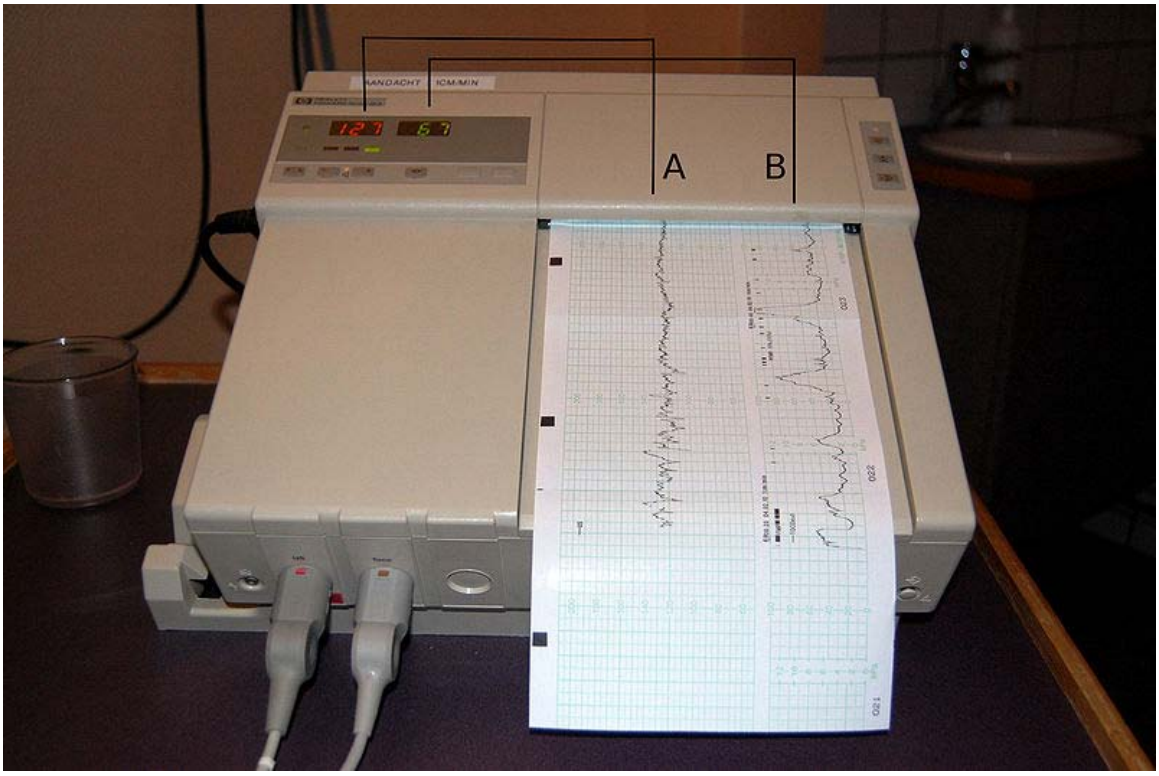


A cardiotocograph recording fetal heart rate and uterine contractions

In medicine (obstetrics), **cardiotocography** (**CTG**) is a technical means of recording (-*graphy*) the fetal heartbeat (*cardio*-) and the uterine contractions (-*toco*-) during pregnancy, typically in the third trimester. The machine used to perform the monitoring is called a **cardiotocograph**, more commonly known as an **electronic fetal monitor** (**EFM**).

The invasive fetal monitoring was invented by Doctors Orvan Hess and Edward Hon. A refined (antepartal, non-invasive, beat-to-beat) version (cardiotocograph) was later developed for Hewlett Packard by Dr. Konrad Hammacher.

Method



Schematic explanation of cardiotocography: heart rate (A) is calculated from fetal heart motion determined by ultrasound, and uterine contractions are measured by a pressure transducer (B). These numbers are represented on a time scale with the help of a running piece of paper, producing a graphical representation.

Simultaneous recordings are performed by two separate transducers, one for the measurement of the fetal heart rate and a second one for the uterine contractions. Each of the transducers may be either external or internal.

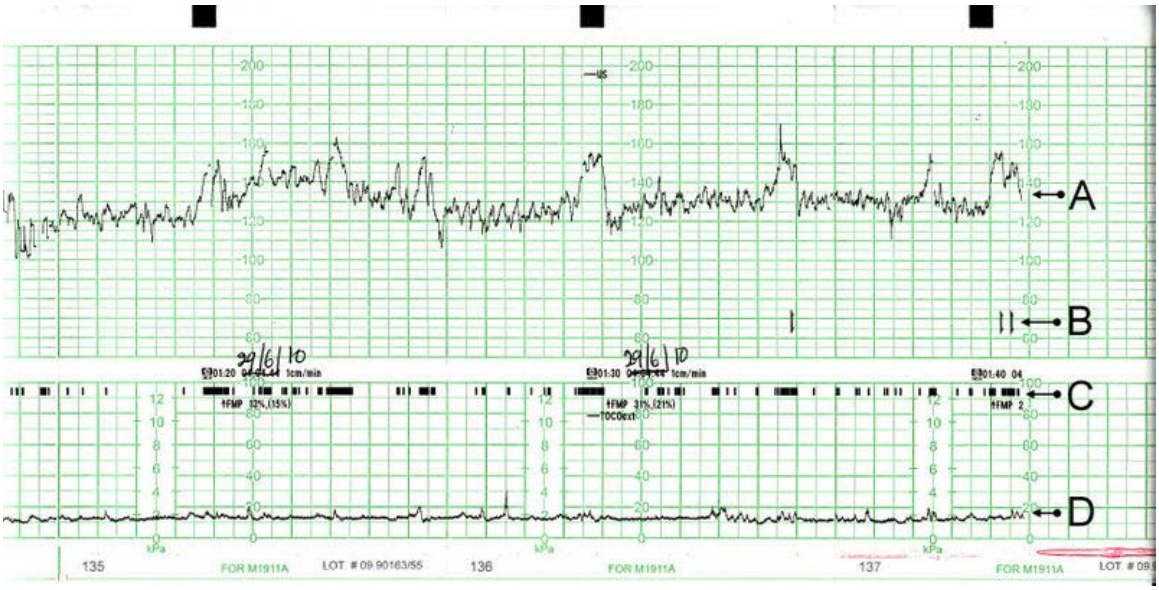
External measurement means taping or strapping the two sensors to the abdominal wall. The *heart* ultrasonic sensor, similar to a Doppler fetal monitor, detects motion of the fetal heart. The pressure-sensitive *contraction* transducer, called a tocodynamometer (toco), measures the tension of the maternal abdominal wall - an indirect measure of the intrauterine pressure.

Internal measurement requires a certain degree of cervical dilatation, as it involves inserting a pressure catheter into the uterine cavity, as well as attaching a *scalp electrode* to the child's head to adequately measure the electric activity of the fetal heart. Internal

measurement is more precise, and might be preferable when a complicated childbirth is expected.

A typical CTG reading is printed on paper and/or stored on a computer for later reference. Use of CTG and a computer network allows continual remote surveillance: a single nurse, midwife, or physician can watch the CTG traces of multiple patients simultaneously, via a computer station.

Interpretation



A typical CTG output for a woman not in labour. A: Fetal heartbeat; B: Indicator showing movements felt by mother (caused by pressing a button); C: Fetal movement; D: Uterine contractions

In the US, the Eunice Kennedy Shriver National Institute of Child Health and Human Development sponsored a workshop to develop a standardized nomenclature for use in interpreting intrapartum fetal heart rate and uterine contraction patterns. This nomenclature has been adopted by the Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN), the American College of Obstetricians and Gynecologists (ACOG), and the Society for Maternal-Fetal Medicine.

The Royal College of Obstetricians and Gynaecologists and the Society of Obstetricians and Gynaecologists of Canada have also published consensus statements on standardized nomenclature for fetal heart rate patterns.

Interpretation of a CTG tracing requires both qualitative and quantitative description of:

- Uterine activity (contractions)
- Baseline fetal heart rate

- Baseline FHR variability
- Presence of accelerations
- Periodic or episodic decelerations
- Changes or trends of FHR patterns over time.

Uterine Activity

There are several factors used in assessing uterine activity.

- Frequency- the amount of time between the start of one contraction to the start of the next contraction.
- Duration- the amount of time from the start of a contraction to the end of the same contraction.
- Intensity- a measure of how strong a contraction is. With external monitoring, this necessitates the use of palpation to determine relative strength. With an IUPC, this is determined by assessing actual pressures as graphed on the paper.
- Resting Tone- a measure of how relaxed the uterus is between contractions. With external monitoring, this necessitates the use of palpation to determine relative strength. With an IUPC, this is determined by assessing actual pressures as graphed on the paper
- Interval- the amount of time between the end of one contraction to the beginning of the next contraction.

The NICHD nomenclature defines uterine activity by quantifying the number of contractions present in a 10-minute window, averaged over 30 minutes. Uterine activity may be defined as:

- **Normal-** less than or equal to 5 contractions in 10 minutes, averaged over a 30-minute window
- **Tachysystole-** more than 5 contractions in 10 minutes, averaged over a 30-minute window

Baseline Fetal Heart Rate

The NICHD nomenclature defines baseline fetal heart rate as: The baseline FHR is determined by approximating the mean FHR rounded to increments of 5 beats per minute (bpm) during a 10-minute window, excluding accelerations and decelerations and periods of marked FHR variability (greater than 25 bpm). There must be at least 2 minutes of identifiable baseline segments (not necessarily contiguous) in any 10-minute window, or the baseline for that period is indeterminate. In such cases, it may be necessary to refer to the previous 10-minute window for determination of the baseline. Abnormal baseline is termed *bradycardia* when the baseline FHR is less than 110 bpm; it is termed *tachycardia* when the baseline FHR is greater than160 bpm.

Baseline FHR Variability

The NICHD nomenclature defines baseline FHR variability as: Baseline FHR variability is determined in a 10- minute window, excluding accelerations and decelerations. Baseline FHR variability is defined as fluctuations in the baseline FHR that are irregular in amplitude and frequency. The fluctuations are visually quantitated as the amplitude of the peak- to-trough in bpm. Using this definition, the baseline FHR variability is categorized by the quantitated amplitude as:

- **Absent-** undetectable
- **Minimal-** greater than undetectable, but less than or equal to 5 bpm
- **Moderate-** 6 bpm - 25 bpm
- **Marked-** greater than 25 bpm

Accelerations

The NICHD nomenclature defines an acceleration as a visually apparent abrupt increase in FHR. An abrupt increase is defined as an increase from the onset of acceleration to the peak in less than or equal to 30 seconds. To be called an acceleration, the peak must be greater than or equal to 15 bpm, and the acceleration must last greater than or equal to 15 seconds from the onset to return. A *prolonged acceleration* is greater than or equal to 2 minutes but less than 10 minutes in duration. An acceleration lasting greater than or equal to 10 minutes is defined as a baseline change. Before 32 weeks of gestation, accelerations are defined as having a peak greater than or equal to 10 bpm and a duration of greater than or equal to 10 seconds.

Periodic or episodic decelerations

Periodic refers to decelerations that are associated with contractions; episodic refers to those not associated with contractions. There are four types of decelerations as defined by the NICHD nomenclature.

- **Early Deceleration:** Visually apparent, usually symmetrical, gradual decrease and return of the FHR associated with a uterine contraction. A gradual FHR decrease is defined as one from the onset to the FHR nadir of greater than or equal to 30 seconds. The decrease in FHR is calculated from the onset to the nadir of the deceleration. The nadir of the deceleration occurs at the same time as the peak of the contraction. In most cases the onset, nadir, and recovery of the deceleration are coincident with the beginning, peak, and ending of the contraction, respectively
- **Late Deceleration:** Visually apparent usually symmetrical gradual decrease and return of the FHR associated with a uterine contraction. A gradual FHR decrease is defined as from the onset to the FHR nadir of greater than or equal to 30 seconds. The decrease in FHR is calculated from the onset to the nadir of the deceleration. The deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction. In most cases, the onset,

nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively.

- **Variable Deceleration:** Visually apparent abrupt decrease in FHR. An abrupt FHR decrease is defined as from the onset of the deceleration to the beginning of the FHR nadir of less than 30 seconds. The decrease in FHR is calculated from the onset to the nadir of the deceleration. The decrease in FHR is greater than or equal to 15 beats per minute, lasting greater than or equal to 15 seconds, and less than 2 minutes in duration. When variable decelerations are associated with uterine contractions, their onset, depth, and duration commonly vary with successive uterine contractions.
- **Prolonged Deceleration:** A prolonged deceleration is present when there is a visually apparent decrease in FHR from the baseline that is greater than or equal to 15 bpm, lasting greater than or equal to 2 minutes, but less than 10 minutes. A deceleration that lasts greater than or equal to 10 minutes is a baseline change

Additionally decelerations can be *recurrent* or *intermittent* based on their frequency (more or less than 50% of the time) within a 20 min window.

FHR Pattern Classification

The NICHD workgroup proposed terminology of a three-tiered system to replace the older undefined terms "reassuring" and "nonreassuring".

- **Category I (Normal)**: Tracings with all these findings present are strongly predictive of normal fetal acid-base status at the time of observation and the fetus can be followed in a standard manner:
  - Baseline rate 110-160 bpm,
  - Moderate variability,
  - Absence of late, or variable decelerations,
  - Early decelerations and accelerations may or may not be present.

- **Category II (Indeterminate)**:Tracing is not predictive of abnormal fetal acid-base status, but evaluation and continued surveillance and reevaluations are indicated.

- **Category III (Abnormal)**: Tracing is predictive of abnormal fetal acid-base status at the time of observation; this requires prompt evaluation and management:
  - Absence of baseline variability with recurrent late or variable decelerations or bradycardia; or
  - Sinusoidal fetal heart rate.

Effect on management

A Cochrane Collaboration review has shown that use of cardiotocography reduces the rate of seizures in the newborn, but there is no clear benefit in the prevention of cerebral

palsy, perinatal death and other complications of labour. In contrast, labour monitored by CTG is slightly more likely to result in instrumental delivery (forceps or vacuum extraction) or Cesarean section. The false-positive rate of cardiotocography for cerebral palsy is given as high as 99%, meaning that only 1-2 of one hundred babies with non-reassuring patterns will develop cerebral palsy. The introduction of additional methods of intrapartum assessment has given mixed results.

When introduced, this practice was expected to reduce the incidence of fetal demise in labor and make for a reduction in cerebral palsy (CP). Its use became almost universal for hospital births in the U.S. In recent years there has been some controversy as to the utility of the cardiotocograph in low-risk pregnancies, and the related belief that over-reliance on the test has led to increased misdiagnoses of fetal distress and hence increased (and possibly unnecessary) cesarean deliveries.

Manufacturer

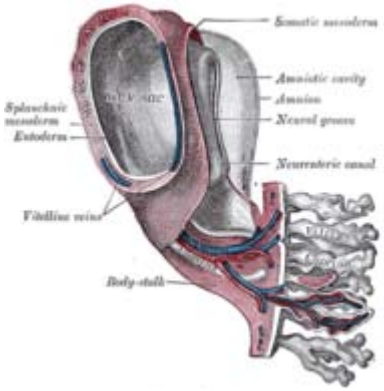
The popular manufacturers are GE(corometrics),Philips, Huntleigh(Sonicaid),Analogic, Toitu and Sunray.

Chapter 6

Chorionic Villus Sampling and Amniocentesis

Chorionic villus sampling

Intervention:
Chorionic villus sampling



Model of human embryo 1.3 mm. long. (Villi of chorion labeled at lower right.)

ICD-10 code:	16603-00
ICD-9 code:	75.33
MeSH	D015193
Other codes:	

Chorionic villus sampling (CVS) is a form of prenatal diagnosis to determine chromosomal or genetic disorders in the fetus. It entails getting a sample of the chorionic villus (placental tissue) and testing it. CVS usually takes place 10–12 weeks after the last period, earlier than amniocentesis (which is carried out as early as 14–16 weeks). It is the preferred technique before 15 weeks.

CVS was tested for the first time by Italian biologist Giuseppe Simoni, scientific director of Biocell Center, in 1983

Use as early as 8 weeks in special circumstances has been described.

It can be performed in a transcervical or transabdominal manner.

Indications

Possible reasons for having a CVS can include:

- Abnormal first trimester screen results
- Increased nuchal translucency or other abnormal ultrasound findings
- Family history of a chromosomal abnormality or other genetic disorder
- Parents are known carriers for a genetic disorder

- Previously, maternal age above 35 has been an idication for CVS. Note that maternal age alone is now rarely a reason to undergo dianostic test like CVS given it's higher risk. High maternal age is associated with icrease risk of Down's syndrome and at age 35, risk is 1:400.. Screening test are usually carried out first before deciding if CVS should be done.

Risks

Studies show that the risk of miscarriage following CVS is comparable to the rate following amniocentesis – between 0.5% and 4.6%. Apart from a risk of miscarriage, there is a risk of infection and amniotic fluid leakage. The resulting amniotic fluid leak can develop into a condition known as oligohydramnios which is low amniotic fluid level. If the resulting oligohydramnios is not treated and the amniotic fluid continues to leak it can result in the baby developing hypoplastic lungs (underdeveloped lungs). Additionally, there is a risk of CVS causing digit-reduction defects in the fetus if performed before 10 weeks (0.07%-0.10%).

It is important after having a CVS that the OB/GYN follow the patient closely to ensure the patient does not develop infection.

Limitations

A small percentage (1-2%) of pregnancies will have confined placental mosaicism, where some but not all of the placental cells tested in the CVS will be abnormal, even though the pregnancy is unaffected. Cells from the mother can be mixed with the placental cells obtained from the CVS procedure. Occasionally if these maternal cells are not completely separated from the placental sample, this can lead to discrepancies with the results. This phenomenon is called Maternal Cell Contamination (MCC). CVS cannot detect all birth

defects. It is used for testing chromosomal abnormalities or other specific genetic disorders only if there is family history or other reason to test.

Amniocentesis

	Intervention: Amniocentesis
ICD-10 code:	
ICD-9 code:	75.1
MeSH	D000649
Other codes:	

Amniocentesis (also referred to as **amniotic fluid test or AFT**), is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fetal infections, in which a small amount of amniotic fluid, which contains fetal tissues, is extracted from the amnion or amniotic sac surrounding a developing fetus, and the fetal DNA is examined for genetic abnormalities.

Procedure

Before the start of the procedure, a local anesthetic can be given to the mother in order to relieve the pain felt during the insertion of the needle used to withdraw the fluid. After the local is in effect, a needle is usually inserted through the mother's abdominal wall, then through the wall of the uterus, and finally into the amniotic sac. With the aid of ultrasound-guidance, a physician punctures the sac in an area away from the fetus and extracts approximately 20 ml of amniotic fluid. After the amniotic fluid is extracted, the fetal cells are separated from the sample. The cells are grown in a culture medium, then fixed and stained. Under a microscope the chromosomes are examined for abnormalities. The most common abnormalities detected are Down syndrome (trisomy 21), Edwards syndrome (trisomy 18), and Turner syndrome (monosomy X). In regard to the fetus, the puncture heals and the amniotic sac replenishes the liquid over the next 24–48 hours.

Indications and results

Early in pregnancy, used for diagnosis of chromosomal and other fetal problems such as:

- Down syndrome (trisomy 21)
- Trisomy 13
- Trisomy 18
- Fragile X

- Rare, inherited metabolic disorders
- Neural tube defects (anencephaly and spina bifida) by alpha-fetoprotein levels.

Later on, it also can be used to detect problems such as:

- Infection
- Rh incompatibility
- Prediction of lung maturity
- Decompression of polyhydramnios

An emerging indication for amniocentesis is in the management of preterm rupture of membranes where measurement of certain amniotic fluid inflammatory markers may be helpful. If amniotic fluid IL-6, a marker of inflammation, is elevated, the fetus is at high risk and delivery should be considered.

Risks and drawbacks

Amniocentesis is performed between the 15th-20th week of pregnancy; performing this test early can lead to injury to the baby's limbs. Most people do the test during the 18th week of pregnancy. The term "early amniocentesis" is sometimes used to describe use of the process between weeks 11 and 13. Approximately 6 percent of pregnant women take or consider taking the amniocentesis test.

Although the procedure is routine, and almost 70% of women who undergo the test report little to no discomfort, possible complications include infection of the amniotic sac from the needle, and failure of the puncture to heal properly, which can result in leakage or infection. Serious complications can result in miscarriage. Other possible complications include preterm labor and delivery, respiratory distress, postural deformities, fetal trauma and alloimmunisation of the mother (rhesus disease). Studies from the 1970s originally estimated the risk of amniocentesis-related miscarriage at around 1 in 200 (0.5%). A more recent study (2006) has indicated this may actually be much lower, perhaps as low as 1 in 1,600 (0.06%). In contrast, the risk of miscarriage from chorionic villus sampling (CVS) is believed to be approximately 1 in 100, although CVS may be done up to four weeks earlier, and may be preferable if the possibility of genetic defects is thought to be higher.

Amniotic fluid embolism has been described as a possible risk.

Amniotic Leak Detector (ALD) is an in vitro self-test panty liner that is intended to detect probable leaking amniotic fluid and identify the cause of wetness during pregnancy.

Early detection of amniotic leak can help to prevent complications, premature birth, identify a possible membrane rupture and confirm the waters have broken.

Amniocentesis and stem cells

Recent studies have discovered that amniotic fluid can be a rich source of multipotent mesenchymal, hematopoietic, neural, epithelial, and endothelial stem cells.

A potential benefit of using amniotic stem cells over those obtained from embryos is that they side-step ethical concerns among pro-life activists by obtaining pluripotent lines of undifferentiated cells without harm to a fetus or destruction of an embryo.

Artificial heart valves, working tracheas, as well as muscle, fat, bone, heart, neural and liver cells have all been engineered through use of amniotic stem cells. Tissues obtained from amniotic cell lines show promise for patients suffering from congenital diseases/malformations of the heart, liver, lungs, kidneys, and cerebral tissue.

Chapter 7

Triple Test and Percutaneous Umbilical Cord Blood Sampling

Triple test

The **triple test**, also called **triple screen**, the Kettering test or the Bart's test, is an investigation performed during pregnancy in the second trimester to classify a patient as either high-risk or low-risk for chromosomal abnormalities (and neural tube defects).

The term "multiple-marker screening test" is sometimes used instead. This term can encompass the "double test" and "quadruple test" (described below).

The Triple test measures serum levels of AFP, estriol, and beta-hCG, with a 70% sensitivity and 5% false-positive rate. It is complemented in some regions of the United States, as the *Quad test* (81% sensitivity and 5% false-positive rate by adding inhibin A to the panel) and other prenatal diagnosis techniques, although it remains widely used in Canada and other countries. A positive test means having a high risk of chromosomal abnormalities (and neural tube defects), and such patients are then referred for more sensitive and specific procedures to receive a definitive diagnosis, mostly invasive procedures like amniocentesis. The Triple test can be understood as an early predecessor to a long line of subsequent technological improvements. In some American states, such as Missouri, Medicaid reimburses only for the Triple test and not other potentially more accurate screening tests, whereas California offers Quad tests to all pregnant women.

Conditions screened

The most common abnormality the test can screen is trisomy 21 (Down syndrome). In addition to Down syndrome, the triple and quadruple tests screen for fetal trisomy 18 also known as Edward's syndrome, open neural tube defects, and may also detect an increased

risk of Turner syndrome, triploidy, trisomy 16 mosaicism, fetal death, Smith-Lemli-Opitz syndrome, and steroid sulfatase deficiency.

Values measured

The triple test measures the following three levels in the maternal serum:

- alpha-fetoprotein (AFP)
- human chorionic gonadotropin (hCG)
- unconjugated estriol (UE_3)

Interpretation

The levels may indicate increased risk for certain conditions:

AFP	UE_3	hCG	Associated conditions
low	low	high	Down Syndrome
low	low	low	trisomy 18 (Edward's syndrome)
high	n/a	n/a	neural tube defects like spina bifida associated with increase levels of acetylcholinesterase in aminonic fluid, or omphalocele, or gastroschisis, or multiple gestation like twins or triplets

An estimated risk is calculated and adjusted for the expectant mother's age; if she's diabetic; if she's having twins or other multiples, and the gestational age of the fetus. Weight and ethnicity may also be used in adjustments. Many of these factors affect the levels of the substances being measured and the interpretation of the results.

The test is for screening, not for diagnosis, and does not have nearly the same predictive power of amniocentesis or chorionic villus sampling. The screening test carries a much lower risk to the fetus, however, and in conjunction with the age-related risk of the patient it is useful to help determine the need for more invasive tests.

Variations

If only two of the hormones above are tested for, then the test is called a double test. A quad test tests an additional hormone, inhibin. Furthermore, the triple test may be combined with an ultrasound measurement of nuchal translucency.

Double test

Only AFP and hCG are measured. However, the maternal age, weight, ethnicity etc. are still included. A double test is almost as effective as a triple test, because unconjugated estriol, the omitted hormone, is, in practice, not detected at a higher rate in people who have it than in people without.

Quadruple test

A test of levels of dimeric inhibin A (DIA) is sometimes added to the other three tests, under the name "quadruple test." Other names used include "quad test", "quad screen", or "tetra screen." Inhibin A (DIA) will be found high in cases of Trisomy 21 and low in cases of Trisomy 18.

Percutaneous umbilical cord blood sampling

Percutaneous umbilical cord blood sampling (PUBS), also called **cordocentesis**, is a diagnostic genetic test that examines blood from the fetal umbilical cord to detect fetal abnormalities. PUBS provides a means of rapid chromosome analysis and is useful when information cannot be obtained through amniocentesis, CVS, or ultrasound (or if the results of these tests were inconclusive). This test carries a significant risk of complication and is typically reserved for pregnancies determined to be at high risk for genetic defect.

Procedure

PUBS is similar to amniocentesis, but instead of sampling the amniotic fluid which surrounds the fetus, PUBS examines fetal blood. An advanced imaging ultrasound determines the location for needle insertion into the placenta, and the needle is guided through the mother's abdomen and uterine wall into the fetal vein of the umbilical cord, where a fetal blood sample is removed. The sample can then be sent for chromosomal analysis. The entire process lasts 45 minutes to an hour. Because the fetal vein is fragile early in pregnancy, PUBS is performed no earlier than 17 weeks into pregnancy.

PUBS testing has a turnaround time of about 72 hours and can detect chromosomal abnormalities, blood disorder, some metabolic disorders, infections, and some causes of structural problems. PUBS has largely replaced fetoscopy, which has a much higher rate of miscarriage.

It has been used with mothers with immune thrombocytopenic purpura.

Risks

Miscarriage is the primary risk associated with PUBS and occurs in 1-2% of procedures. Additional possible complications are similar to those for amniocentesis and include blood loss at the puncture site, infection, and premature rupture of membranes. During the procedure, the mother may feel discomfort similar to a menstrual cramp.

Chapter 8

Apt Test and Kleihauer-Betke Test

Apt test

The **Apt test** is a medical test used to differentiate fetal or neonatal blood from maternal blood.

History

The test was developed by Leonard Apt, an American pediatric ophthalmologist. The test was originally used to identify the source of bloody stools in newborn infants. It has been modified to distinguish fetal from maternal hemoglobin in blood samples from any source.

Uses

The Apt test is most commonly used in cases of vaginal bleeding late during pregnancy (antepartum haemorrhage) to determine if the bleeding is from the mother or the fetus.

- A positive test would indicate that blood is of fetal origin, and could be due to vasa previa.
- A negative test indicates that the blood is of maternal origin.

In practice, the Apt test may not be done when there is suspicion of vasa previa, because the time to fetal collapse with bleeding from vasa previa is often very short.

The Apt test can also be used to detect the presence of fetal blood in the maternal circulation in cases of suspected fetal-maternal hemorrhage. Since the test is only a qualitative determination of the presence of fetal hemoglobin in maternal blood, the quantitative Kleihauer-Betke test is more commonly used.

Finally, the Apt test can be used after birth (postpartum hemorrhage) if the newborn has bloody vomiting, bloody stool, or active bleeding from the nasogastric tube. A positive apt test would mean that the blood is either due to gastrointestinal or pulmonary bleeding from the neonate. A negative Apt test would indicate that the blood is of maternal origin, suggesting that the neonate swallowed or aspirated maternal blood, either during delivery or during breastfeeding (e.g., from breast fissures).

Theory

The test is based on differences between maternal and fetal hemoglobin. Maternal blood contains adult hemoglobin composed of two alpha and two beta subunits. Fetal blood contains fetal hemoglobin composed of two alpha and two gamma subunits. This difference in composition gives the different types of hemoglobin different chemical properties. Fetal hemoglobin is resistant to alkali (basic) denaturation, whereas adult hemoglobin is susceptible to such denaturation. Therefore, exposing the blood specimen to sodium hydroxide (NaOH) will denature the adult but not the fetal hemoglobin. The fetal hemoglobin will appear as a pinkish color under the microscope while the adult hemoglobin will appear as a yellow-brownish color.

Practice

The blood is mixed with a small amount of tap water to cause hemolysis. The sample is next centrifuged for several minutes. The pink hemoglobin-containing supernatant is then mixed with 1 mL of 1% NaOH for each 5 mL of supernatant. The color of the fluid is assessed after 2 minutes. Fetal hemoglobin will stay pink and adult hemoglobin will turn yellow-brown since adult hemoglobin will convert to hematin which has a hydroxide ligand.

Kleihauer-Betke test

The **Kleihauer-Betke ("KB") test**, **Kleihauer-Betke ("KB") stain** or **Kleihauer test**, is a blood test used to measure the amount of fetal hemoglobin transferred from a fetus to a mother's bloodstream. It is usually performed on Rhesus-negative mothers to determine the required dose of Rho(D) immune globulin (RhIg) to inhibit formation of Rh antibodies in the mother and prevent Rh disease in future Rh-positive children.

Test details

The KB test is the standard method of detecting fetal-maternal hemorrhage (FMH). It takes advantage of the differential resistance of fetal hemoglobin to acid. A standard blood smear is prepared from the mother's blood, and exposed to an acid bath. This

removes adult hemoglobin, but not fetal hemoglobin, from the red blood cells. Subsequent staining makes fetal cells (containing fetal hemoglobin) appear rose-pink in color, while adult red blood cells are only seen as 'ghosts'. A large number of cells (over 5000) are counted under the microscope and a ratio of fetal to maternal cells generated.

In those with positive tests, follow up testing at a postpartum check should be done to rule out the possibility of a false positive. This could be caused by a process in the mother which causes persistent elevation of fetal hemoglobin, e.g. sickle cell trait.

Comparison with other more expensive or technologically advanced methods such as flow cytometry has shown that the KB stain, like the more advanced methods, is sensitive in its detection of FMH. Background counting errors can result in estimates of as much as 5 ml fetal blood loss when there actually is no such blood loss, but standard methods available in most laboratories admit an extremely low probability of the return of a false positive when more severe FMH has taken place.

Uses

Fetal-maternal hemorrhage severity estimation

To determine if a positive test for FMH should be considered as the likely cause of fetal death, the percent of total fetal blood volume lost should be calculated, making appropriate adjustments based on the following known relationships:

-
  - the size of a fetal red blood cell is 1.22 times that of an adult red blood cell;
  - the KB stain is known to have a mean success rate of 92% in detecting fetal red blood cells;
  - in a woman at or near term in her pregnancy, the mean volume of maternal red blood cells is approximately 1800 ml;
  - the mean fetal hematocrit is 50%; and
  - at stillbirth, the mean fetal blood volume is $150\frac{ml}{kg}$

These constraints can then be applied to yield the formula

$$PFB = \frac{(3200)(FC)}{(FW)(MC)}$$

where

-
  - *PFB* is the percentage of fetal blood lost;

- *FC* is the observed number of fetal red blood cells;
- *MC* is the observed number of maternal red blood cells (N.B. we have that $MC = TC - FC$, where *TC* is the total observed number of red blood cells, both maternal and fetal);
- *FW* is the stillbirth weight of the fetus in kilograms.

Stillbirth resolution

Suppose that a KB stain is performed and $TC = 5000$ total red blood cells are observed, $FC = 200$ of which are found to be fetal red blood cells. Suppose further that the stillbirth weight of the fetus under consideration is $FW = 2.0kg$. Then we would conclude that the total percentage of fetal blood lost is approximately

$$PFB = \frac{(3200)(FC)}{(FW)(MC)} = \frac{(3200)(200)}{(2.0)(4800)} = \frac{200}{3} = 66.667$$

to five significant digits. We would hence conclude that the fetus under consideration lost 66.667% (two thirds) of its blood via FMH. Generally, stillbirth is highly probable for any value of $PFB \geq 20$, particularly if the fetus abruptly loses this much blood; in this example, we would hence be likely to suspect FMH as the cause of the stillbirth. It is important to note, however, that such a diagnosis is still not completely conclusive; fetuses losing large quantities of blood over long periods of time are able to compensate for this slower blood loss; since the KB stain tells us nothing with regard to the level of acuity of FMH. This means that it is not possible to entirely correlate a positive KB stain and high *PFB* with a stillbirth, though in many cases, given other information, such as known hereditary complications of pregnancy, extremely high positive correlation coefficients $r \approx +1.000$between FMH and stillbirth have been observed.

Fetal red blood cell detection problems

Since fetal and maternal blood cells have the same life expectancy in the maternal bloodstream, it is possible to obtain informative results from a KB stain for a fair period of time after a stillbirth. However, if the mother and fetus are ABO incompatible, it is more crucial to quickly perform the KB stain following a stillbirth, as the fetal red blood cells will be eliminated from the maternal bloodstream very quickly, causing the KB stain to underestimate the degree of FMH, if any.

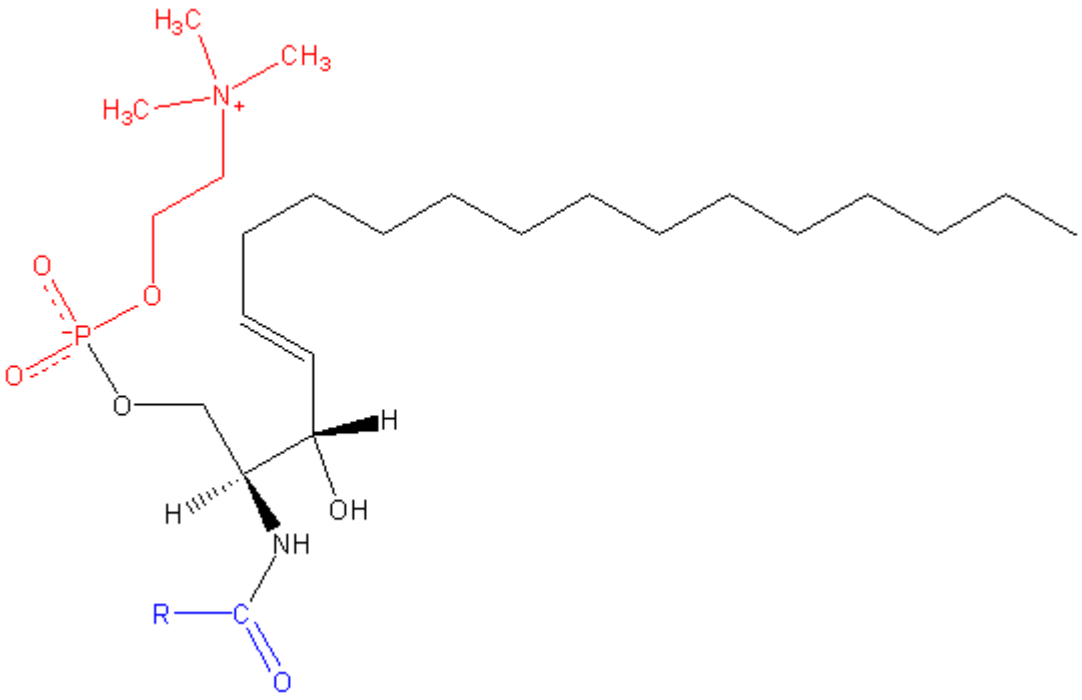
Lots of concern has been raised in the literature concerning false positives when sampling is done after delivery. In general this is not a problem. Delivery does result in higher frequency of detection of micro-hemorrhages but this should not confound interpretation of FMH as a possible cause of stillbirth. It is not necessary to draw the sample before induction, onset of labor, delivery, placental delivery etc. despite what some published literature purports. However, if caesarean section is to be used, failure to draw the sample prior to that will result in a 2% false positive rate.

Finally, anything which causes persistence of fetal hemoglobin in maternal blood cells will make interpretation much trickier. Certain hemoglobinopathies, the most common of which is sickle cell trait, do this. Overall, somewhere around 1-3% of the time this could result in false interpretation.

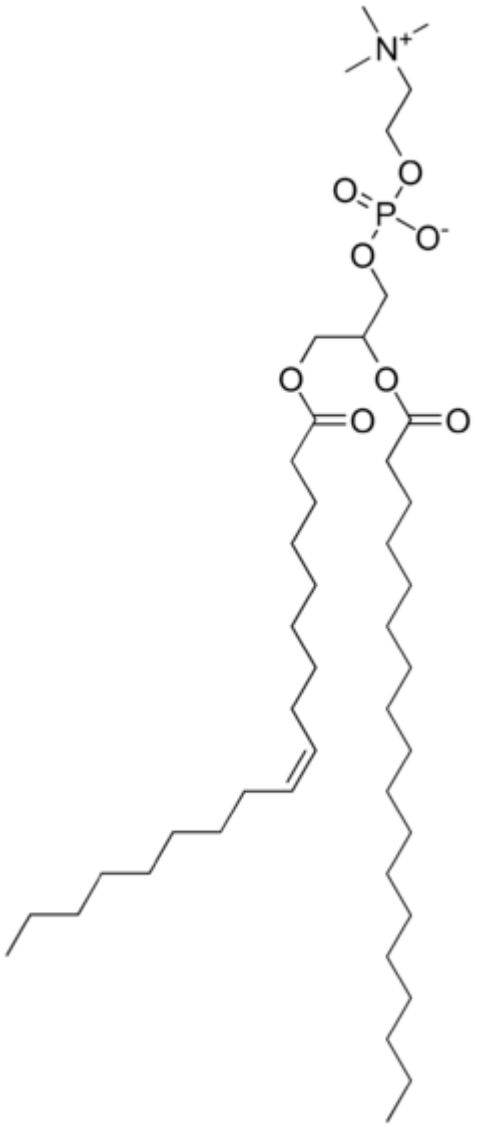
Chapter 9

Lecithin-Sphingomyelin Ratio and Fetal Fibronectin

Lecithin-sphingomyelin ratio



Sphingomyelin



Phosphatidylcholine, a type of phospholipid in lecithin.

The **lecithin-sphingomyelin ratio** is a test of fetal amniotic fluid to assess for fetal lung immaturity. Lungs require surfactant, a soap-like substance, to lower the surface pressure of the alveoli in the lungs. This is especially important for premature babies trying to expand their lungs after birth. Surfactant is a mixture of lipids, proteins, and glycoproteins, lecithin and sphingomyelin being two of them. Lecithin makes the surfactant mixture more effective.

Evaluation

As the lungs mature and become better able to produce surfactant, the ratio of lecithin to sphingomyelin increases in the amniotic fluid. As such, if a sample of amniotic fluid has a higher ratio, it indicates that there is more surfactant in the lungs and the baby will have less difficulty breathing at birth. An L/S ratio of 2 or more indicates a relatively low risk of infant respiratory distress syndrome, and an L/S ratio of less than 1.5 is associated with a high risk of infant respiratory distress syndrome.

If preterm delivery is necessary (as evaluated by a biophysical profile or other tests) and the L/S ratio is low, the mother may need to receive steroids to hasten the fetus' surfactant production.

Procedure

An amniotic fluid sample is collected via amniocentesis and the sample is spun down in a centrifuge at 1000 rpm for 3 to 5 minutes. Thin layer chromatography (TLC) is performed on the supernatant, which separates out the components. Lecithin and sphingomyelin are relatively easy to identify on TLC and the predictive value of the test is good.

Fetal fibronectin

Fetal fibronectin (fFN) is a protein produced by fetal cells and a type of fibronectin. fFN is found at the interface of the chorion and the decidua (between the fetal sack and the uterine lining).

It can be thought of as an adhesive or "biological glue" that binds the fetal sac to the uterine lining.

Diagnostic test

Fetal fibronectin "leaks" into the vagina if a preterm delivery is likely to occur and can be measured in a diagnostic test. It is an excellent biological marker of premature (preterm) delivery (a delivery before 37 weeks of gestation).

When the fFN test is positive, it is an inconclusive result. A positive result can indicate that a woman will go into preterm labor soon, but she may not go into labor for weeks. When the fFN test is negative, the result is a better predictor. A negative result means that there is little possibility of preterm labour within the next 7 to 10 days, and the test can be repeated weekly for women who remain at high risk. A negative fetal fibronectin test gives a more than 95% likelihood of remaining undelivered for the next 2 weeks. A systematic review of the medical literature found that fetal fibronectin is a good predictor

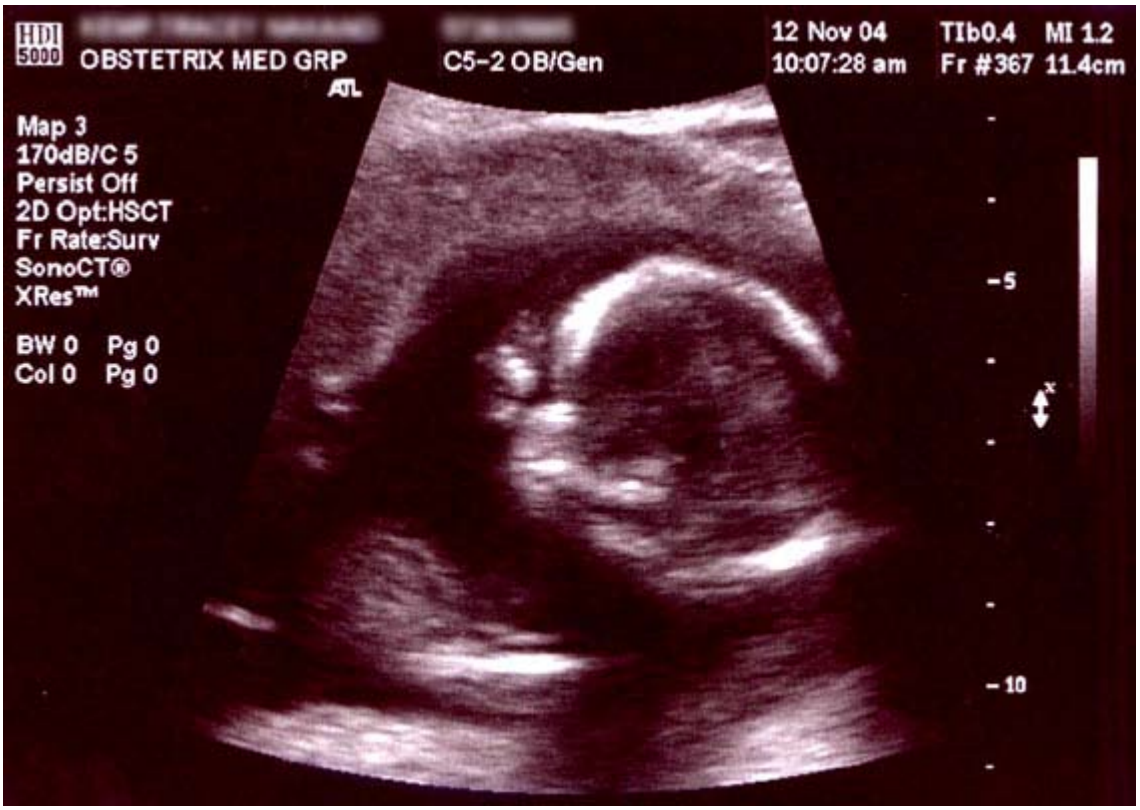
of spontaneous preterm birth before cervical dilation. The test may be run on patients between 22 and 35 weeks gestation.

The test is easily performed and is usually painless. A specimen is collected from the patient using a vaginal swab. The swab is placed in a transport tube and sent to a laboratory for testing. Most labs can easily produce a result in less than one hour.

A false positive fetal fibronectin result can occur if the test is performed after digital examination of the cervix or after having had intercourse. It is important that the swab be taken before a digital vaginal exam is performed.

Chapter 10

Obstetric Ultrasonography



Obstetric sonogram of a baby at 16 weeks. The bright white circle center-right is the head, which faces to the left. Features include the forehead at 10 o'clock, the left ear toward the center at 7 o'clock and the right hand covering the eyes at 9:00.

Obstetric sonography (ultrasonography) is the application of medical ultrasonography to obstetrics, in which sonography is used to visualize the embryo or foetus in its mother's uterus (womb). The procedure is often a standard part of prenatal care, as it yields a variety of information regarding the health of the mother and of the fetus, as well as regarding the progress of the pregnancy.

Types

Traditional obstetric sonograms are done by placing a transducer (a device that converts one type of energy into another) on the abdomen of the pregnant woman. One variant, a *transvaginal sonography,* is done with a probe placed in the woman's vagina. Transvaginal scans usually provide clearer pictures during early pregnancy and in obese women. Also used is *Doppler sonography* which detects the heartbeat of the fetus. Doppler sonography can be used to evaluate the pulsations in the fetal heart and bloods vessels for signs of abnormalities.

Early pregnancy

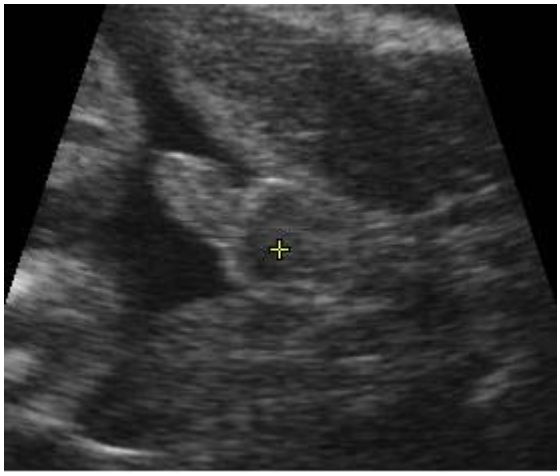
The gestational sac can sometimes be visualized as early as four and a half weeks of gestation (approximately two and a half weeks after ovulation) and the yolk sac at about five weeks gestation. The embryo can be observed and measured by about five and a half weeks. The heartbeat may be seen as early as 6 weeks, and is usually visible by 7 weeks gestation.

Dating and growth monitoring

Gestational age is usually determined by the date of the woman's last menstrual period, and assuming ovulation occurred on day fourteen of the menstrual cycle. Sometimes a woman may be uncertain of the date of her last menstrual period, or there may be reason to suspect ovulation occurred significantly earlier or later than the fourteenth day of her cycle. Ultrasound scans offer an alternative method of estimating gestational age. The most accurate measurement for dating is the crown-rump length of the fetus, which can be done between 7 and 13 weeks of gestation. After 13 weeks gestation, the fetal age may be estimated by the biparietal diameter (the transverse diameter of the head), the head circumference, the length of the femur (the longest bone in the body), and the many more fetal parameters that have been measured and correlated with age over the last 30 years. Dating is more accurate when done earlier in the pregnancy; if a later scan gives a different estimate of gestational age, the estimated age is not normally changed but rather it is assumed the fetus is not growing at the expected rate.

Not useful for dating, the abdominal circumference of the fetus may also be measured. This gives an estimate of the weight and size of the fetus and is important when doing serial ultrasounds to monitor fetal growth.

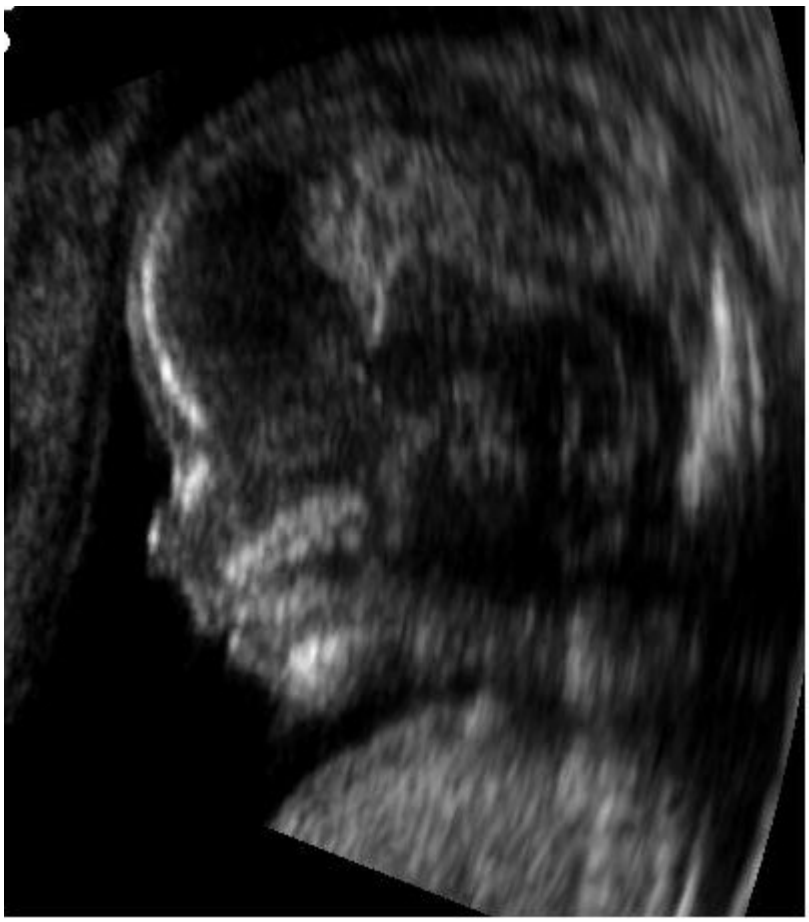
Fetal sex determination



Sonogram of male baby, with scrotum and penis in center of image

The sex of the baby can usually be determined by ultrasound at any time after 16 weeks, often at the dating scan around 20 weeks into the pregnancy depending upon the quality of the sonographic machine and skill of the operator. This is also the best time to have an ultrasound done as most infants are the same size at this stage of development. Depending on the skill of the sonographer, ultrasound may suffer from a high rate of false negatives and false positives. This means care has to be taken in interpreting the accuracy of the scan.

Ultrasonography of the cervix



Baby at 14 weeks (profile)

Obstetric sonography has become useful in the assessment of the cervix in women at risk for premature birth. A short cervix preterm is undesirable: At 24 weeks gestation a cervix length of less than 25 mm defines a risk group for preterm birth, further, the shorter the cervix the greater the risk. It also has been helpful to use ultrasonography in women with preterm contractions, as those whose cervix length exceed 30 mm are unlikely to deliver within the next week.

Abnormality screening

In some countries, routine pregnancy sonographic scans are performed to detect developmental defects before birth. This includes checking the status of the limbs and vital organs, as well as (sometimes) specific tests for abnormalities. Some abnormalities detected by ultrasound can be addressed by medical treatment in utero or by perinatal care, though indications of other abnormalities can lead to a decision regarding abortion.

Perhaps the most common such test uses a measurement of the nuchal translucency thickness ("NT-test", or "Nuchal Scan"). Although 91% of fetuses affected by Down syndrome exhibit this defect, 5% of fetuses flagged by the test do not have Down syndrome.

Ultrasound may also detect fetal organ anomaly. Usually scans for this type of detection are done around 18 to 20 weeks of gestational age.

History

Scottish physician Ian Donald was one of the pioneers of medical use of ultrasound. His article "Investigation of Abdominal Masses by Pulsed Ultrasound" was published in *The Lancet* in 1958. Donald was Regius Professor of Midwifery at the University of Glasgow.

In 1962, after about two years of work, Joseph Holmes, William Wright, and Ralph Meyerdirk developed the first compound contact B-mode scanner. Their work had been supported by U.S. Public Health Services and the University of Colorado. Wright and Meyerdirk left the university to form Physionic Engineering Inc., which launched the first commercial hand-held articulated arm compound contact B-mode scanner in 1963. This was the start of the most popular design in the history of ultrasound scanners.

Obstetric ultrasound has played a significant role in the development of diagnostic ultrasound technology in general. Much of the technological advances in diagnostic ultrasound technology are due to the drive to create better obstetric ultrasound equipment. Acuson Corporation's pioneering work on the development of Coherent Image Formation helped shape the development of diagnostic ultrasound equipment as a whole.

Safety issues

Current evidence indicates that diagnostic ultrasound is safe for the unborn child, unlike radiographs, which employ ionizing radiation. However, no randomized controlled trials have been undertaken to test the safety of the technology, and thus ultrasound procedures are generally not done repeatedly unless medically indicated.

A 2006 study on mice exposed to ultrasound showed neurological changes in the exposed fetuses. Some of the rodent brain cells failed to migrate to their proper position and remained scattered in incorrect parts of the brain.

It has been shown that Low Intensity Pulsed Ultrasound does have a localized effect on growth in human beings. The 1985 FDA-allowed maximum power of 180 milliwatts per square cm is well under the levels used in therapeutic ultrasound, but still higher than the 30-80 milliwatts per square cm range of the Statison V veterinary LIPUS device. LIPUS has been shown to affect tissue growth in as little as 20 minutes of time with repeated daily applications. Adding to the similarity, LIPUS and medical ultrasound both operate in the 1 to 10MHz range.

While the benefits of medical ultrasound probably outweigh any risks, vanity uses such as making 3D ultrasound movies without a doctor's order present an obviously unnecessary, but unknown risk to a developing fetus. The FDA discourages its use for non-medical purposes such as fetal keepsake videos and photos, even though it is the same technology used in hospitals. The demand for keepsake ultrasound products in medical environments has prompted commercial solutions such as self-serve software that allows the patient to create a "keepsake" from the ultrasound imagery recorded during a medical ultrasound procedure.

Conversion of the 3D image files into standard CAD/CAM file formats allows the reconstruction of fetal and other images in a variety of materials including a 3d laser etched images in a crystal glass block or a solid cameo effect using a 3D printer.

Chapter 11

Nuchal Scan and Leopold's Maneuvers

Nuchal scan

A **nuchal scan** is a sonographic prenatal screening scan (ultrasound) to help identify higher risks of Down syndrome in a fetus, particularly for older women who have higher risks of such pregnancies. High thickness measurements are also associated with congenital heart defect. The scan is carried out at 11–13.6 weeks pregnancy and assesses the amount of fluid behind the neck of the fetus - also known as the nuchal fold or 'the **nuchal translucency'**. Fetuses at risk of Down tend to have a higher amount of fluid around the neck. The scan may also help confirm both the accuracy of the pregnancy dates and the fetal viability. Its high definition imaging may also detect other less common chromosomal abnormalities.

Indication

All women, whatever their age, have a small risk of delivering a baby with a physical or Intellectual disability. The nuchal scan helps doctors and midwives to estimate the risk of the fetus having Down syndrome or other defects more accurately than by maternal age alone.

Down Syndrome

The most common genetic disorder is Down syndrome (trisomy 21). The risk rises with maternal age from 1 in 1400 pregnancies below age 25, to 1 in 350 at age 35, to 1 in 100 at age 40.

The only way to be sure whether the fetus has a chromosomal abnormality is by having an invasive test such as an amniocentesis or chorionic villus sampling, but such tests

carry a risk of causing a miscarriage estimated variously as 1% or 0.06%. Based on maternal age, some countries offer invasive testing to women over 35; others to the oldest 5% of pregnant women. Most women, especially those with a low risk of having a Down-affected child, may wish to avoid the risk to the fetus and the discomfort of invasive testing.

Blood testing is also used to look for abnormal levels of fetal protein or hormones. The results of all three factors may indicate a higher risk. If this is the case, the woman may be advised to have invasive tests.

Screening for Down syndrome by a combination of maternal age and thickness of nuchal translucency in the fetus at 11–14 weeks of gestation was introduced in the 1990s. This method identifies about 75% of affected fetuses while screening about 5% of pregnancies. Natural fetal loss after positive diagnosis at 12 weeks is about 30%.

Other chromosomal defects

Other chromosomal defects that cause a thicker nuchal translucency are

- Turner syndrome
- Trisomy 18
- Trisomy 13
- Triploidy

Other defects with normal karyotype

In fetuses with a normal number of chromosomes, a thicker nuchal translucency is associated with other fetal defects and genetic syndromes.

Procedure

Nuchal scan is performed between 11 and 14 weeks of gestation, because the accuracy is best in this period. The scan is obtained with the fetus in sagittal section and a neutral position of the fetal head (neither hyperflexed nor extended, either of which can influence the nuchal translucency thickness). The fetal image is enlarged to fill 75% of the screen, and the maximum thickness is measured, from leading edge to leading edge. It is important to distinguish the nuchal lucency from the underlying amnionic membrane.

Normal thickness depends on the crown-rump length (CRL) of the fetus. Among those fetuses whose nuchal translucency exceeds the normal values, there is a relatively high risk of significant abnormality.

Accuracy

Between 65 and 85% of trisomic fetuses will have a large nuchal thickness. Further, other, non-trisomic abnormalities may also demonstrate an enlarged nuchal transparency. This leaves the measurement of nuchal transparency as a potentially useful 1st trimester screening tool. Abnormal findings allow for early careful evaluation of chromosomes and possible structural defects on a targeted basis.

At 12 weeks of gestational age, an "average" nuchal thickness of 2.18mm has been observed, however, up to 13% of chromosomally normal fetuses present with a nuchal lucency of greater than 2.5mm, and thus for even greater accuracy of predicting risks, the outcome of the nuchal scan may be combined with the results of simultaneous maternal blood tests. In pregnancies affected by Down syndrome there is a tendency for the levels of human chorionic gonadotropin (hCG) to be increased and pregnancy-associated plasma protein A (PAPP-A) to be decreased.

The advantage of nuchal scanning over the previous use of just biochemical blood profiling, is mainly the reduction in false positive rates.

Nuchal scanning alone detects 62% of all Down Syndrome with a false positive rate of 5.0%, the combination with blood testing gives corresponding values of 73% and 4.7%. In another study values of 79.6% and 2.7% for the combined screening were then improved with the addition of second trimester ultrasound scanning to 89.7% and 4.2% respectively. A further study reported detection of 88% for trisomy 21 (Down syndrome) and 75% for trisomy 18 (Edwards syndrome), with a 3.3% false-positive rate. Finally, using the additional ultrasound feature of an absent nasal bone can further increase detection rates for Down syndrome to more than 95%.

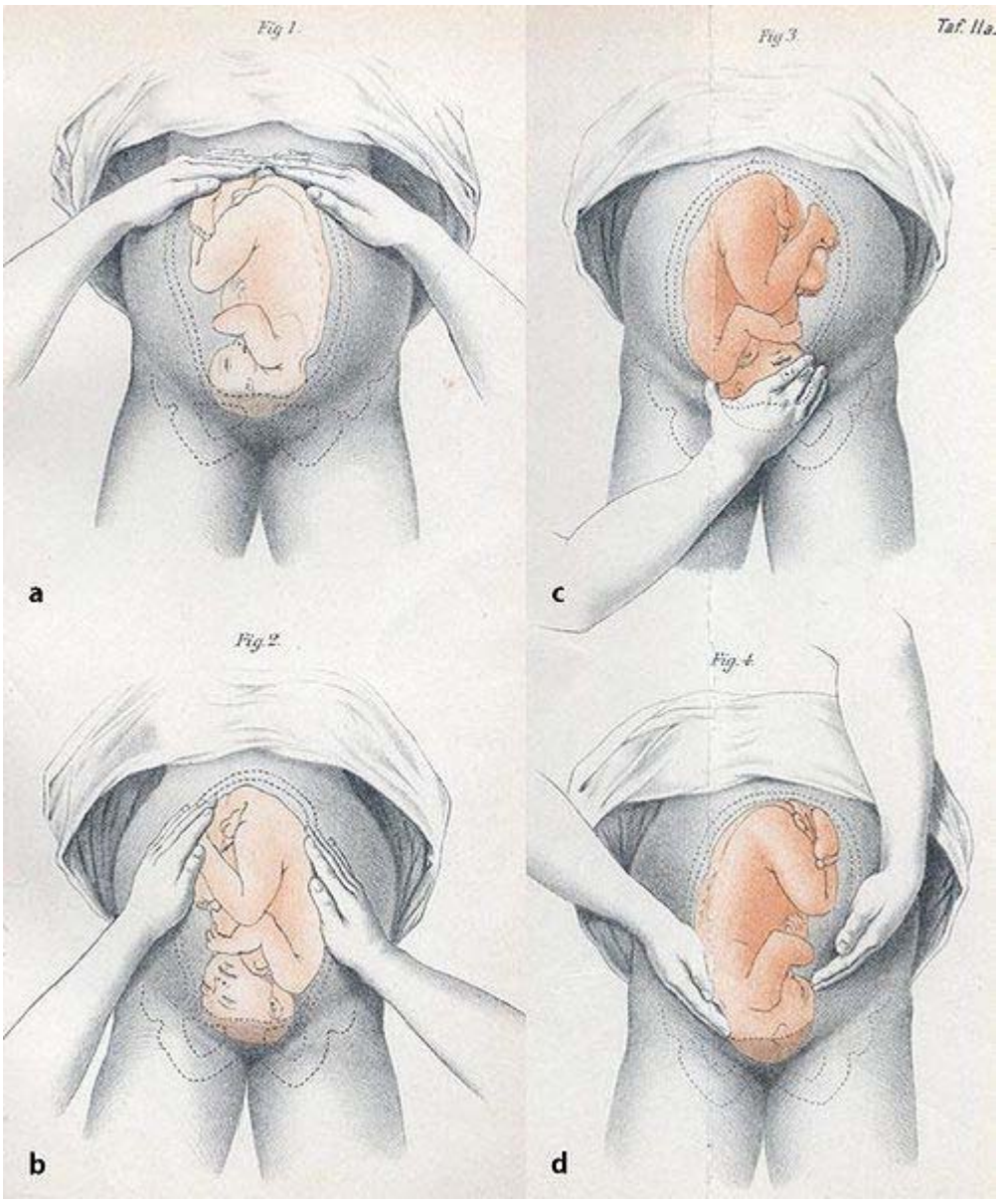
When screening is positive, amniocentesis testing is required to confirm the presence of a genetic abnormality. However this procedure carries a small risk of miscarriage so prior screening with low false positive rates are needed to minimize the chance of miscarrying.

Development of nuchal translucency

The translucent area measured (the nuchal translucency) is only useful to measure between 11 and 14 weeks of gestation, when the fetal lymphatic system is developing and the peripheral resistance of the placenta is high. After 14 weeks the lymphatic system is likely to have developed sufficiently to drain away any excess fluid, and changes to the placental circulation will result in a drop in peripheral resistance. So after this time any abnormalities causing fluid accumulation may seem to correct themselves and can thus go undetected by nuchal scanning.

The buildup in fluid is due to a blockage of fluid in the developing fetal lymphatic system. Progressive increase in the width of the translucent area during the 11 to 14 week measurement period is thus indicative of congenital lymphedema.

Leopold's maneuvers



Leopold's Maneuvers

In obstetrics, **Leopold's Maneuvers** are a common and systematic way to determine the position of a fetus inside the woman's uterus; they are named after the gynecologist Christian Gerhard Leopold. They are also used to estimate term fetal weight.

The maneuvers consist of four distinct actions, each helping to determine the position of the fetus. The maneuvers are important because they help determine the position and presentation of the fetus, which in conjunction with correct assessment of the shape of the

maternal pelvis can indicate whether the delivery is going to be complicated, or whether a Cesarean section is necessary.

The examiner's skill and practice in performing the maneuvers are the primary factor in whether the fetal lie is correctly ascertained, and so the maneuvers are not truly diagnostic. Actual position can only be determined by ultrasound performed by a competent technician or physician.

Performing the maneuvers

Leopold's Maneuvers are difficult to perform on obese women and women who have hydramnios. The palpation can sometimes be uncomfortable for the woman if care is not taken to ensure she is relaxed and adequately positioned. To aid in this, the health care provider should first ensure that the woman has recently emptied her bladder. If she has not, she may need to have a straight urinary catheter inserted to empy it if she is unable to micturate herself. The woman should lie on her back with her shoulders raised slightly on a pillow and her knees drawn up a little. Her abdomen should be uncovered, and most women appreciate it if the individual performing the maneuver warms their hands prior to palpation.

First maneuver: Fundal Grip

While facing the woman, palpate the woman's upper abdomen with both hands. A professional can often determine the size, consistency, shape, and mobility of the form that is felt. The fetal head is hard, firm, round, and moves independently of the trunk while the buttocks feel softer, are symmetric, and the shoulders and limbs have small bony processes; unlike the head, they move with the trunk.

Second maneuver

After the upper abdomen has been palpated and the form that is found is identified, the individual performing the maneuver attempts to determine the location of the fetal back. Still facing the woman, the health care provider palpates the abdomen with gentle but also deep pressure using the palm of the hands. First the right hand remains steady on one side of the abdomen while the left hand explores the right side of the woman's uterus. This is then repeated using the opposite side and hands. The fetal back will feel firm and smooth while fetal extremities (arms, legs, etc.) should feel like small irregularities and protrusions. The fetal back, once determined, should connect with the form found in the upper abdomen and also a mass in the maternal inlet, lower abdomen.

Third maneuver: Pawlick's Grip

In the third maneuver the health care provider attempts to determine what fetal part is lying above the inlet, or lower abdomen. The individual performing the maneuver first grasps the lower portion of the abdomen just above the pubic symphysis with the thumb

and fingers of the right hand. This maneuver should yield the opposite information and validate the findings of the first maneuver. If the woman enters labor, this is the part which will most likely come first in a vaginal birth. If it is the head and is not actively engaged in the birthing process, it may be gently pushed back and forth. The Pawlick's Grip, although still used by some obstetricians, is not recommended as it is more uncomfortable for the woman. Instead, a two-handed approach is favored by placing the fingers of both hands laterally on either side of the presenting part.

Fourth maneuver: Pelvic Grip

The last maneuver requires that the health care provider face the woman's feet, as he or she will attempt to locate the fetus' brow. The fingers of both hands are moved gently down the sides of the uterus toward the pubis. The side where there is resistance to the descent of the fingers toward the pubis is greatest is where the brow is located. If the head of the fetus is well-flexed, it should be on the opposite side from the fetal back. If the fetal head is extended though, the occiput is instead felt and is located on the same side as the back.

Cautions

Leopold's maneuvers are intended to be performed by health care professionals, as they have received the training and instruction in how to perform them. That said, as long as care taken not to roughly or excessively disturb the fetus, there is no real reason it cannot be performed at home as an informational exercise. It is important to note that all findings are not truly diagnostic, and as such ultrasound is required to conclusively determine the fetal position.

Chapter 12

Labor Induction, EXIT Procedure and Caesarean Delivery on Maternal Request

Labor induction

Labor induction is a method of artificially or prematurely stimulating childbirth in a woman.

Indications

Common suggested reasons for induction include:

- The baby is believed to be getting too big.
- Postdate pregnancy, i.e. if the pregnancy has gone past the 42 week mark.
- Intrauterine fetal growth retardation (IUGR).
- There are health risks to the woman in continuing the pregnancy (e.g. she has pre-eclampsia).
- Premature rupture of the membranes (PROM); this is when the membranes have ruptured, but labor does not start within a specific amount of time.
- Premature termination of the pregnancy (abortion).
- Scheduling concerns.
- Fetal death in utero.
- Twin pregnancy continuing beyond 38 weeks.

Methods of induction

Methods of inducing labor include medication and processes.

If an induction causes complications during labor, a Caesarean section is almost always conducted. An induction is most likely to result in successful vaginal delivery when a woman is close to or in the early stages of labor. Signs of impending labor may include softening of the cervix, dilation and increasing frequency or intensity of contractions. The

Bishop score may be used to assess the advisability of induction, and is based on such factors.

Medication

- Intravaginal, endocervical or extra-amniotic administration of prostaglandin, such as dinoprostone or misoprostol. In the few controlled trials that have been done, extra-amniotic administration appears to be more efficient than intravaginal or endocervical administration of prostaglandins in labor induction, with no differential effects on other outcome measures.
- Intravenous administration of synthetic oxytocin preparations, such as Pitocin.
- Natural Induction - Many midwives or other holistic providers practice "natural" induction, which may include use of herbs, castor oil or other medically unconventional agents to stimulate or advance a stalled labor.
- Use of mifepristone has been described.
- Relaxin has been investigated, but is not currently commonly used.

Processes

- "Membrane sweep", also known as membrane stripping, or "stretch and sweep" in Australia and the UK - during an internal examination, the midwife moves her finger around the cervix to stimulate and/or separate the membranes around the baby from the cervix. This causes a release of prostaglandins which can help to kick-start labor.
- Artificial rupture of the membranes (AROM or ARM) ("breaking the waters")

When to induce

Until recently, the most common practice has been to induce labor by the end of the 42nd week of gestation. This practice is still very common. Recent studies have shown an increasing risk of infant mortality for births in 41st and particularly 42nd week of gestation, as well as a higher risk of injury to the mother and child . The recommended date for induction of labor has therefore been moved to the end of the 41st week of gestation in many countries including Sweden and Canada.

Criticisms of induction

- Induced labor tends to be more intense and painful for the woman. This can lead to the increased use of analgesics and other pain-relieving pharmaceuticals. These interventions have been said to lead to an increased likelihood of caesarean section delivery for the baby. However, studies into this matter indicate that induction has no effect on the rates of caesarean section. Two more recent studies have shown that induction may increase the risk of caesarean section if performed before the 40th week of gestation, but it has no effect or actually lowers the risk if performed after the 40th week.

Elective induction

In 1999, Intermountain Healthcare, in Salt Lake City, Utah, noticed a striking trend that was part of a larger U.S. phenomenon. Women and their doctors were more frequently choosing to induce labor and increasingly, those inductions were happening at 37 or 38 weeks gestational age. Clinicians were concerned that early inductions might have negative health consequences for babies and moms.

Intermountain data showed that women who deliver before babies reach 39 weeks gestational age tend to have longer and more complicated deliveries, an increased proportion of which lead to more C-sections. Also found were an increase in the number of newborns with medical complications in the group delivered before 39 weeks.

This led to efforts to implement guidelines to reduce elective inductions before 39 weeks—the ideal gestational period. In 1999, approximately 28 percent of all inductions at Intermountain's hospitals occurred before 39 weeks. In 2011, that percentage is under 2 percent. And with the significant drop in early elective inductions, Intermountain has also seen a drop in the average length of labor, fewer C-sections, and a reduction in certain newborn complications in electively induced patients. Following Intermountain's guidelines continues to benefit new babies and their moms. It has also saved patients tens of millions each year.

Patients should talk to their providers to understand the benefits of not inducing labor before babies reach 39 weeks gestational age.

- Some feel that doctors show increasing propensity toward induction simply for personal convenience or to relieve load on hospital facilities. "[Induction] enables doctors to practice daylight obstetrics," says Dr. Marsden Wagner, a neonatologist who served for 15 years as a director of women's and children's health in industrialized countries for the World Health Organization. "It means that as a doctor, I can come in at 9 a.m., give you the pill, and by 6 p.m. I've delivered a baby and I'm home having dinner." A growing number of pregnant women are opting to have induced labor, according to a 12-year study of women in Illinois that was published in the September 2008 issue of the journal Medical Care. The researchers say that the consequences are not clear, but some believe that elective inductions will be done for convenience reasons.

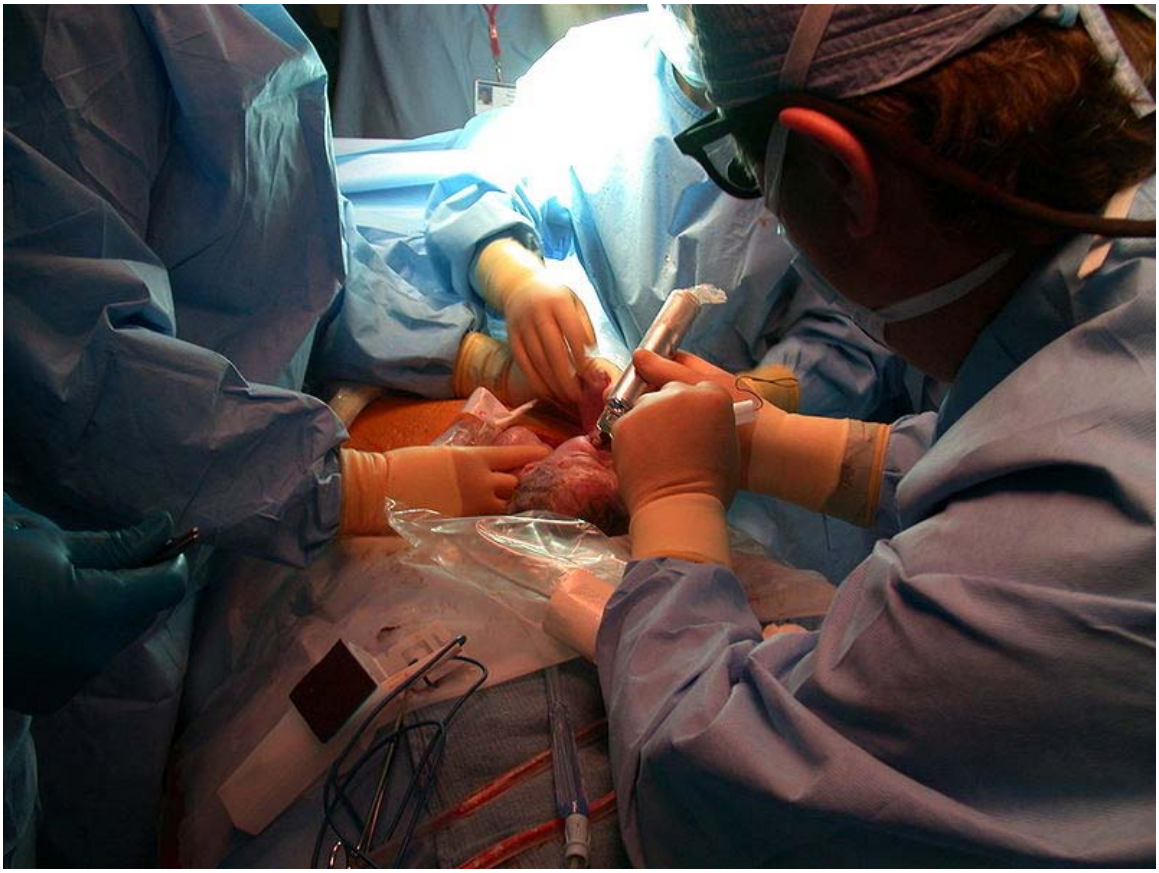
EXIT procedure

The **EXIT procedure**, or **ex utero intrapartum treatment procedure**, is a specialized surgical delivery procedure used to deliver babies who have airway compression. Causes of airway compression in newborn babies result from a number of rare congenital disorders, including bronchopulmonary sequestration, congenital cystic adenomatoid malformation, mouth or neck tumor such as teratoma, and lung or pleural tumor such as pleuropulmonary blastoma. Airway compression discovered at birth is a medical emergency. In many cases, however, the airway compression is discovered during prenatal ultrasound exams, permitting time to plan a safe delivery using the EXIT procedure or other means.

Process

The EXIT is an extension of a standard classical Caesarean section, where an opening is made on the midline of the anesthetized mother's abdomen and uterus. Then comes the EXIT: the baby is partially delivered through the opening but remains attached by its umbilical cord to the placenta, while a pediatric otolaryngologist-head & neck surgeon establishes an airway so the fetus can breathe. Once the EXIT is complete, the umbilical cord is cut and clamped, and the infant is fully delivered. Then the remainder of the C-section proceeds.

The ex utero intrapartum treatment (EXIT) procedure was originally developed to reverse temporary tracheal occlusion in patients who had undergone fetal surgery for severe congenital diaphragmatic hernia (CDH). In a select group of fetuses with CDH, tracheal occlusion is used to obstruct the normal flow of fetal lung fluid and to stimulate lung expansion and growth. With the airway obstructed, airway management at birth is critical. The solution was to arrange delivery in such a way that the occlusion could be removed and the airway secured while the baby remained on placental support. If the uterus was kept relaxed and the utero-placental blood flow kept intact, the fetus could remain on a maternal 'heart-lung machine' while the airway was secured. While the technique of tracheal occlusion remains under study in clinical trials, EXIT procedures have been shown to be useful for management of other causes of fetal airway obstruction.



EXIT procedure: With only the baby's head and shoulders delivered, a pediatric surgeon establishes access to the airway, while the baby continues to receive oxygen through the umbilical cord.

Challenges

The EXIT is much more complex than a standard C-section, as it requires careful coordination between the mother's physicians and the specialists operating on the newborn baby. The difficulty lies in preserving enough blood flow through the umbilical cord, protecting the placenta, and avoiding contractions of the uterus so that there is sufficient time to establish the airway. Also, the umbilical cord should not be manipulated, but should be kept in warmed fluids to avoid physiological occlusion.

Caesarean delivery on maternal request

Caesarean delivery on maternal request (CDMR) is a medically unnecessary caesarean section, where the conduct of a childbirth via a caesarean section (CS, or c-section) is requested by the pregnant patient. While it is a form of an elective caesarean section, the absence of a medical indication is its distinguishing mark.

Background

Over the last century, delivery by CS has become increasingly safer. The indications for delivery by CS therefore could become "softer", and the move to perform CS on request can be viewed as an extension of this development. Until recently an elective caesarean section was done on the basis of some medical grounds; the CDMR situation, however, makes the mother's preference the determining factor for the delivery mode.

An elective caesarean will be agreed in advance. An elective caesarean can be suggested by either the mother or her obstetrician, often as a result of a change in the medical status of the mother or baby. The term is used by the press and on the web in a number of different ways, but any caesarian section which is not an emergency is classified as elective. The mother in essence has agreed to it but may not have chosen it.

The popular media suggest that many women are opting for cesareans in the belief that it is a practical solution. The ethical view that a woman has the right to make decisions regarding her body has empowered women to make a choice regarding the method of her childbirth. Furthermore, with women living longer, concern about damage to the pelvic floor organs by vaginal delivery adds an additional dimension to the issue. Such damage could lead to a relaxation in the ligaments that hold the pelvic organs in place; urinary incontinence can become a consequence.

Prevalence

The movement for CDMR may have started in Brazil. It has been estimated that possibly 4-18% of all CSs are done on maternal request; however, estimates are difficult to come by. The global nature of the CDMR phenomenon was underlined by a study that showed that in southeast China about 20% of women chose this mode of delivery.

Controversy

A meeting of experts sponsored by the NIH in March, 2006 attempted to address the medical issues and found "insuffient evidence to evaluate fully the benefits and risks" of CDMR versus vaginal delivery, and thus was not able to come to a consensus about the general advisability of a cesarean delivery by demand. The available evidence suggests certain differences as follows:

Proponents for CDMR will point out that it facilitates the birth process by performing it at a scheduled time under controlled circumstances, with typically less bleeding, and less risk of trauma to the baby. Furthermore, there is some evidence that urinary stress incontinence as a long-term result of damage to the pelvic floor is increased after vaginal birth. Opponents to CS feel that it is not natural, that the costs are higher, infection rates are higher, hospitalization longer, and rates for breastfeeding decrease. Also, once a CS has been done, subsequent deliveries will likely be also by CS, each time at a somewhat

higher risk. Further, babies born after a vaginal delivery tend to be at a lower risk for the infant respiratory distress syndrome.

Subsequent to the NIH report a large review from the USA of almost 6 million births was published that suggested that neonatal mortality is significantly higher (1.77 vs. 0.62 per 1,000 live births) in babies born by CS. The authors propose that the compression of the fetal lungs during the birthing process may be one of the factors that is beneficial for subsequent survival; this effect is missing when the baby is delivered by CS. A study published in the February 13, 2007 issue of the *Canadian Medical Association Journal* found that women that have "planned" cesareans had an overall rate of severe complications more than three times that of women that planned vaginal deliveries.

Chapter 13

Hysterectomy

	Intervention: Hysterectomy
ICD-10 code:	
ICD-9 code:	68.9
MeSH	D007044
Other codes:	

A **hysterectomy** (from Greek ὑστέρα *hystera* "womb" and εκτομία *ektomia* "a cutting out of") is the surgical removal of the uterus, usually performed by a gynecologist. Hysterectomy may be total (removing the body, fundus, and cervix of the uterus; often called "complete") or partial (removal of the uterine body while leaving the cervix intact; also called "supracervical"). It is the most commonly performed gynecological surgical procedure. In 2003, over 600,000 hysterectomies were performed in the United States alone, of which over 90% were performed for benign conditions. Such rates being highest in the industrialized world has led to the major controversy that hysterectomies are being largely performed for unwarranted and unnecessary reasons.

Removal of the uterus renders the patient unable to bear children (as does removal of ovaries and fallopian tubes), and changes the hormonal levels of the female considerably, so the surgery is normally recommended for only a few specific circumstances:

- Certain types of reproductive system cancers (uterine, cervical, ovarian) or tumors
- Severe and intractable endometriosis (growth of the uterine lining outside the uterine cavity) and/or adenomyosis (a form of endometriosis, where the uterine lining has grown into and sometimes through the uterine wall musculature) after pharmaceutical or other surgical options have been exhausted
- Postpartum to remove either a severe case of placenta praevia (a placenta that has either formed over or inside the birth canal) or placenta percreta (a placenta that has grown into and through the wall of the uterus to attach itself to other organs), as well as a last resort in case of excessive postpartum bleeding
- For trans men, as part of their gender transition

- For severe developmental disabilities

Although hysterectomy is frequently performed for fibroids (benign tumor-like growths inside the uterus itself made up of muscle and connective tissue), conservative options in treatment are available by doctors who are trained and skilled at alternatives. It is well documented in medical literature that myomectomy, surgical removal of fibroids with reconstruction of the uterus, has been performed for over a century.

The uterus is a hormone-responsive reproductive sex organ, and the ovaries produce the majority of estrogen and progesterone that is available in genetic females of reproductive age.

Some women's health education groups such as the Hysterectomy Educational Resources and Services (HERS) Foundation seek to inform the public about the many consequences and alternatives to hysterectomy, and the important functions that the female organs have all throughout a woman's life.

Incidence

Canada

In Canada, the number of hysterectomies between 2008 and 2009 was almost 47,000. The national rate in for the same timeline was 338 per 100,000 population, down from 484 per 100,000 in 1997. The reasons for hysterectomies differed depending on whether the woman was living in an urban or rural location. Urban women most common reason was due to uterine fibroids and rural women had hysterectomies mostly for menstrual disorders.

United States

According to the National Center for Health Statistics, of the 617,000 hysterectomies performed in 2004, 73% also involved the surgical removal of the ovaries. In the United States, 1/3 of women can be expected to have a hysterectomy by age 60. There are currently an estimated 22 million people in the United States who have undergone this procedure. An average of 622,000 hysterectomies a year have been performed for the past decade.

United Kingdom

In the UK, one in 5 women is likely to have a hysterectomy by age 60, and ovaries are removed in about 20% of hysterectomies.

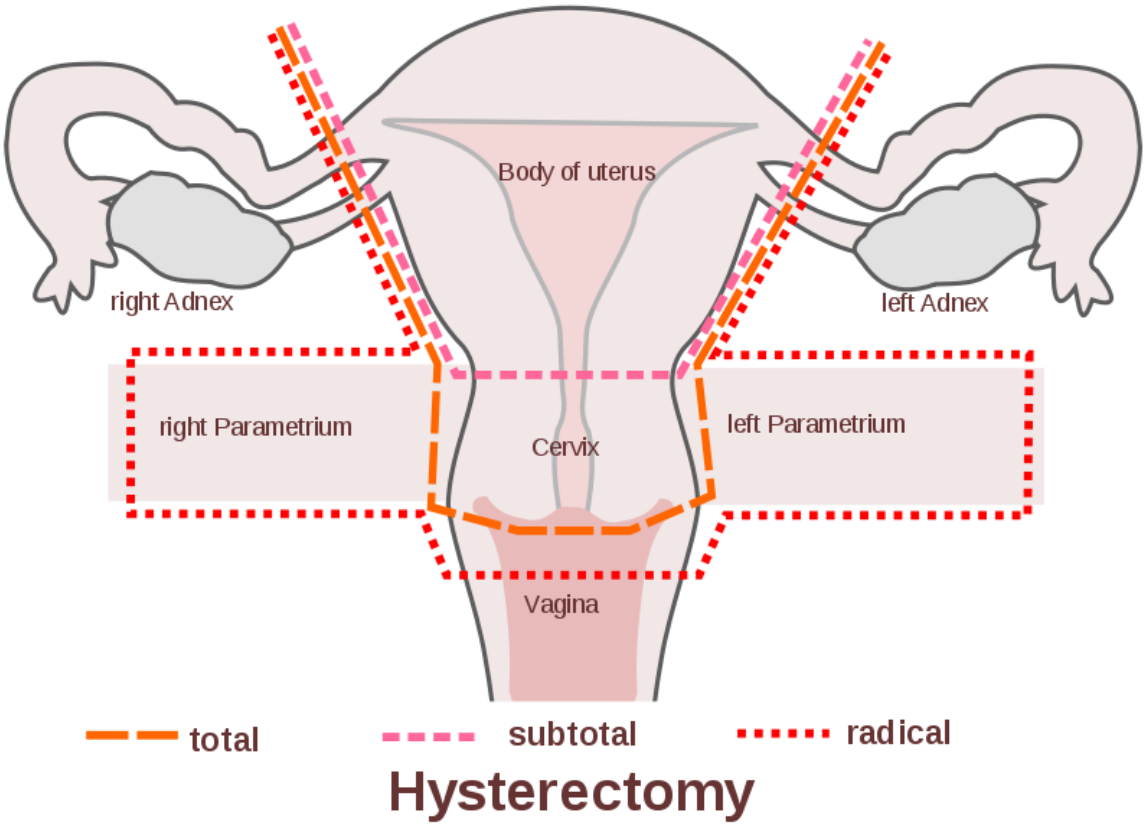
Indications

Hysterectomy is usually performed for problems with the uterus itself or problems with the entire female reproductive complex. Some of the conditions treated by hysterectomy include uterine fibroids (myomas), endometriosis (growth of tissue resembling the uterine lining tissue outside of the uterine cavity), adenomyosis (a more severe form of endometriosis, where the uterine lining has grown into and sometimes through the uterine wall), several forms of vaginal prolapse, heavy or abnormal menstrual bleeding, and at least three forms of cancer (uterine, advanced cervical, ovarian). Hysterectomy is also a surgical last resort in uncontrollable postpartum obstetrical haemorrhage.

Uterine fibroids, although a benign disease, may cause heavy menstrual flow and discomfort to some of those with the condition. Many alternative treatments are available: pharmaceutical options (the use of NSAIDs or opiates for the pain and hormones to suppress the menstrual cycle); myomectomy (removal of uterine fibroids while leaving the uterus intact); uterine artery embolization, high intensity focused ultrasound or watchful waiting. In mild cases, no treatment is necessary. If the fibroids are inside the lining of the uterus (submucosal), and are smaller than 4 cm, hysteroscopic removal is an option. A submucosal fibroid larger than 4 cm, and fibroids located in other parts of the uterus, can be removed with a laparotomic myomectomy, where a horizontal incision is made above the pubic bone for better access to the uterus.

Hysterectomy is sometimes performed as a prophylactic treatment for those with either a strong family history of reproductive system cancers (especially breast cancer in conjunction with BRCA1 or BRCA2 mutation) or as part of their recovery from such cancers. With the availability of new medications such as raloxifene, aromatase inhibitors, and more recent prophylactic strategies for high risk BRCA mutations, there are now alternatives available to either reduce or eliminate altogether the necessity of performing a hysterectomy as part of prophylaxis treatment for BRCA mutations.

Types of hysterectomy



Schematic drawing of types of hysterectomy

Hysterectomy in the literal sense of the word means merely removal of the uterus, however other organs such as ovaries, fallopian tubes and the cervix are very frequently removed as part of the surgery.

- Radical hysterectomy : complete removal of the uterus, cervix, upper vagina, and parametrium. Indicated for cancer. Lymph nodes, ovaries and fallopian tubes are also usually removed in this situation.
- Total hysterectomy : Complete removal of the uterus and cervix.
- Subtotal hysterectomy : removal of the uterus, leaving the cervix in situ.

Many women want to retain the cervix believing that it may affect sexual satisfaction after hysterectomy. It has been postulated that removing the cervix causes excessive neurologic and anatomic disruption, thus leading to vaginal shortening, vaginal vault prolapse, and vaginal cuff granulations. These issues were addressed in a systematic review of total versus supracervical hysterectomy for benign gynecological conditions, which reported the following findings:

- There was no difference in the rates of incontinence, constipation or measures of sexual function.
- Length of surgery and amount of blood lost during surgery were significantly reduced during supracervical hysterectomy compared to total hysterectomy, but there was no difference in post-operative transfusion rates.
- Febrile morbidity was less likely and ongoing cyclic vaginal bleeding one year after surgery was more likely after supracervical hysterectomy.
- There was no difference in the rates of other complications, recovery from surgery, or readmission rates.

In the short-term, randomized trials have shown that cervical preservation or removal does not affect the rate of subsequent pelvic organ prolapse. However, no trials to date have addressed the risk of pelvic organ prolapse many years after surgery, which may differ after total versus supracervical hysterectomy. It is obvious that supracervical hysterectomy does not eliminate the possibility of having cervical cancer since the cervix itself is left intact. Those who have undergone this procedure must still have regular Pap smears to check for cervical dysplasia or cancer.

Technique

Hysterectomy can be performed in different ways. The oldest known technique is abdominal incision. Subsequently the vaginal (performing the hysterectomy through the vaginal canal) and later laparoscopic vaginal (with additional instruments inserted through a small hole, frequently close to the navel) techniques were developed.

Most hysterectomies in the United States are done via laparotomy (abdominal incision, not to be confused with laparoscopy). A transverse (Pfannenstiel) incision is made through the abdominal wall, usually above the pubic bone, as close to the upper hair line of the individual's lower pelvis as possible, similar to the incision made for a caesarean section. This technique allows doctors the greatest access to the reproductive structures and is normally done for removal of the entire reproductive complex. The recovery time for an open hysterectomy is 4–6 weeks and sometimes longer due to the need to cut through the abdominal wall. Historically, the biggest problem with this technique were infections, but infection rates are well-controlled and not a major concern in modern medical practice. An open hysterectomy provides the most effective way to explore the abdominal cavity and perform complicated surgeries. Before the refinement of the vaginal and laparoscopic vaginal techniques it was also the only possibility to achieve subtotal hysterectomy, meanwhile any of the techniques can be used for subtotal hysterectomy.

Vaginal hysterectomy is performed entirely through the vaginal canal and has clear advantages over abdominal surgery such as less complications, shorter hospital stays and shorter healing time. Abdominal hysterectomy, the most common method, is used in cases such as after caesarean delivery, when the indication is cancer, when complications are expected or surgical exploration is required. The average vaginal-to-abdominal hysterectomy quotient (VAQ) in US residency programs is 0.50.

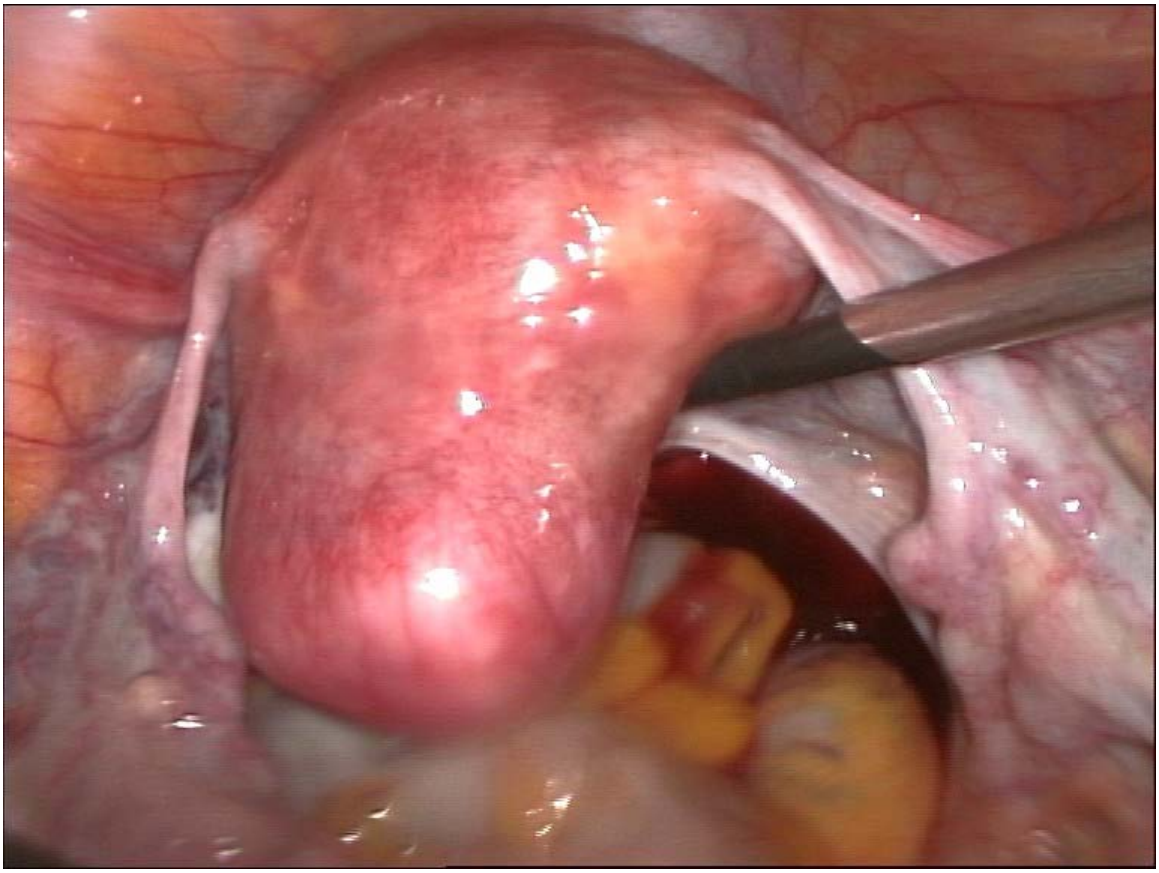
With the development of the laparoscopic techniques in the 1970-1980s, the "laparoscopic-assisted vaginal hysterectomy" (LAVH) has gained great popularity among gynecologists because compared with the abdominal procedure it is less invasive and the post-operative recovery is much faster. It also allows better exploration and slightly more complicated surgeries then the vaginal procedure. LAVH begins with laparoscopy and is completed such that the final removal of the uterus (with or without removal of the ovaries) is via the vaginal canal. Thus, LAVH is also a total hysterectomy, the cervix must be removed with the uterus. Total laparoscopic hysterectomy (TLH) is more advanced than an LAVH and does not require a double-setup, laparoscopic and vaginal. In OBGYN residency programs, the average laparoscopy-to-laparotomy quotient (LPQ) is 0.55.

The "laparoscopic-assisted supracervical hysterectomy" (LASH) was later developed to remove the uterus without removing the cervix using a morcellator which cuts the uterus into small pieces that can be removed from the abdominal cavity via the laparoscopic ports.

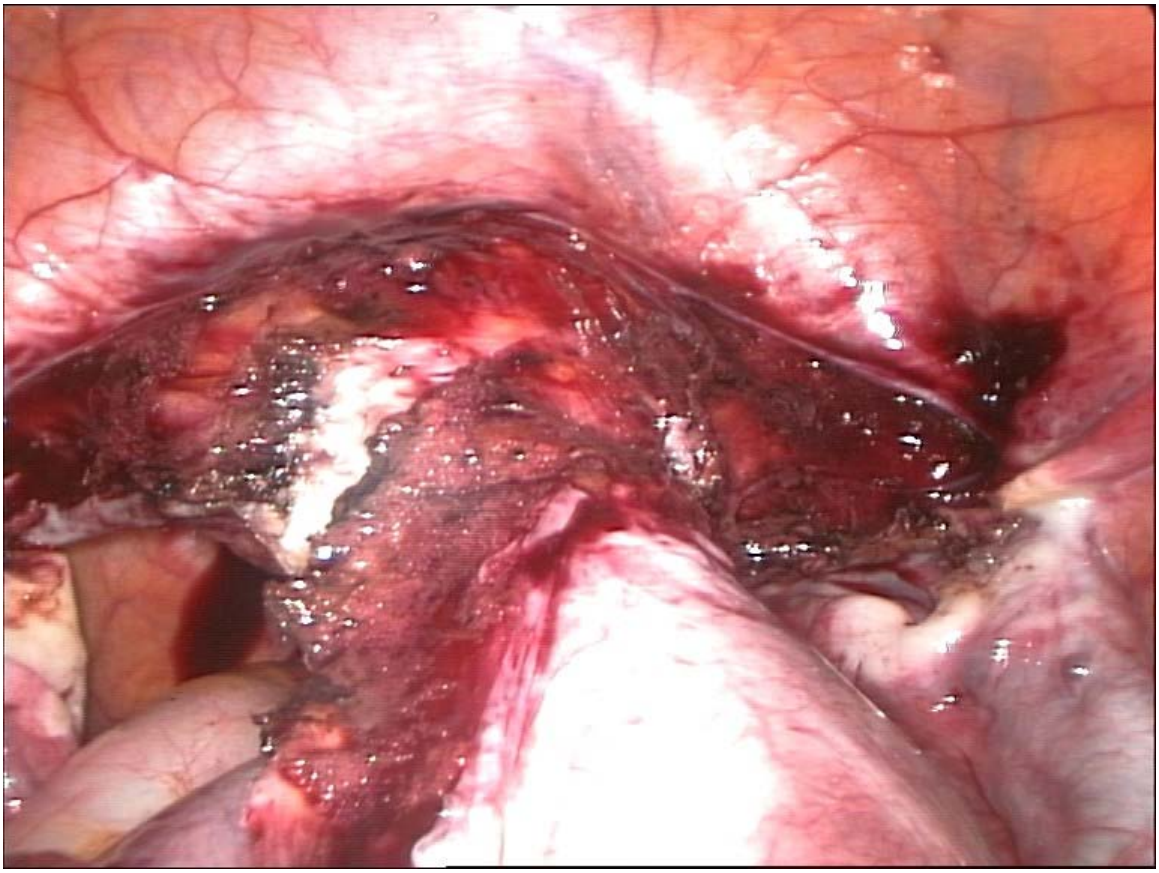
Total laparoscopic hysterectomy (TLH) is performed solely through the laparoscopes in the abdomen, starting at the top of the uterus. The entire uterus is disconnected from its attachments using long thin instruments through the "ports". Then all tissue to be removed is passed through the small abdominal incisions.

Supracervical (subtotal) laparoscopic hysterectomy (LSH) is performed similar to the total laparoscopic surgery but the uterus is amputated between the cervix and fundus.

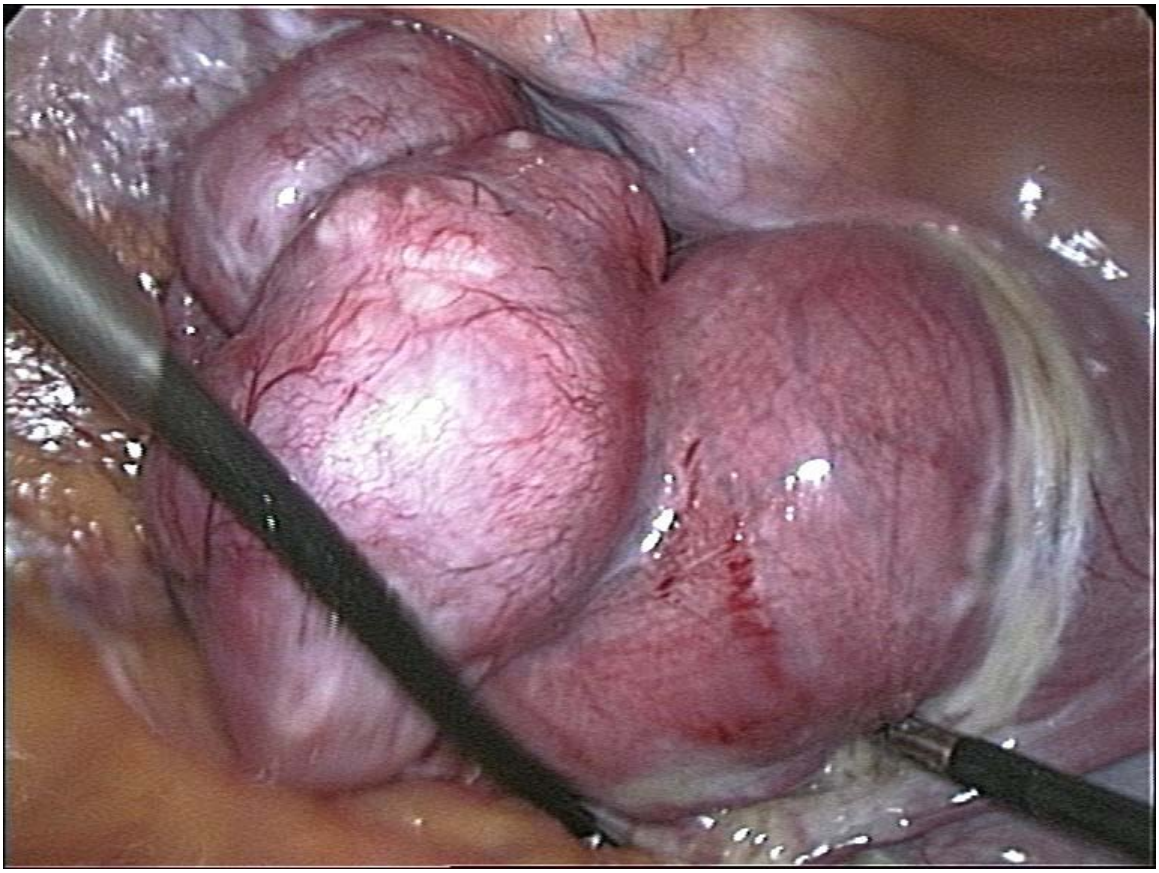
"Robotic hysterectomy" is a variant of laparoscopic surgery using special remotely controlled instruments that allow the surgeon finer control as well as three-dimensional magnified vision.



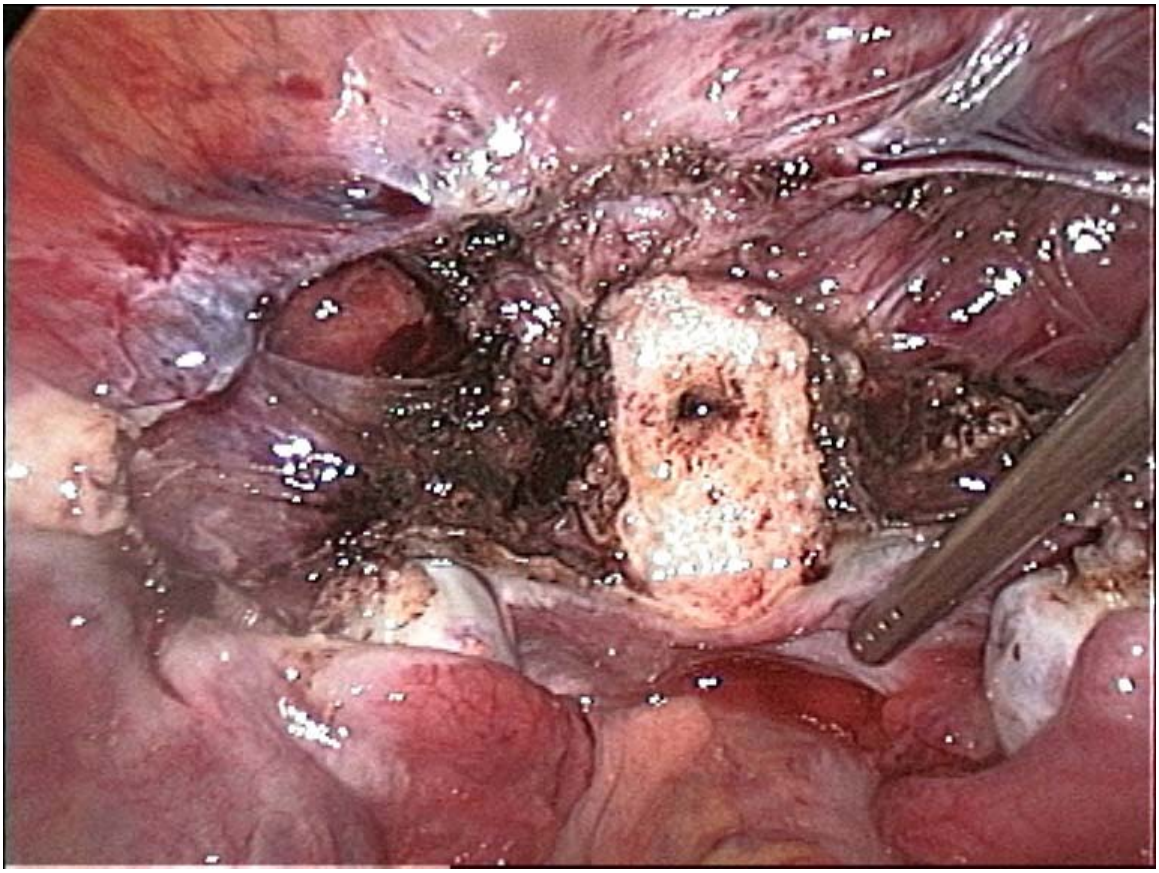
uterus before hysterectomy



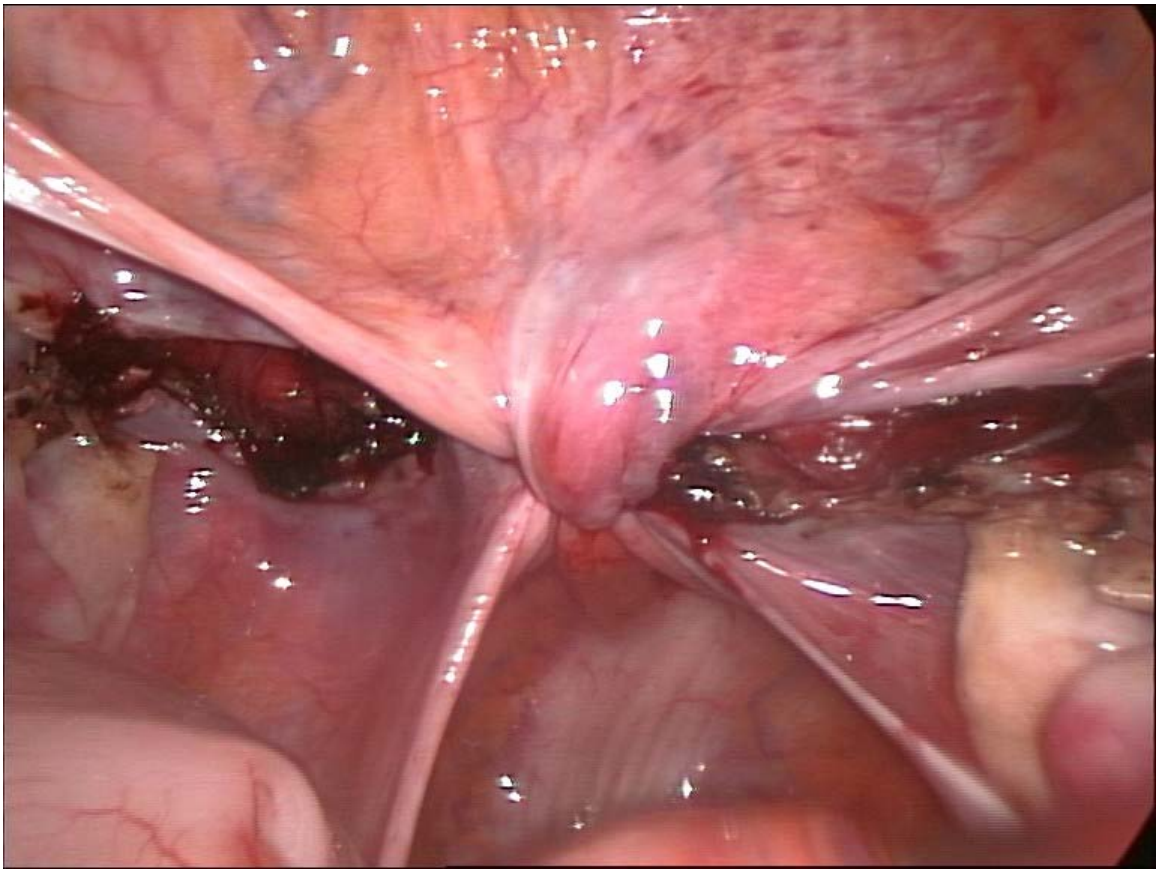
laparoscopical hysterectomy



transvaginal extraction of the uterus in total laparoscopical hysterectomy



cervical stump (white) after removement of the uterine corpus at laparoscopic supracervical hysterectomy



end of an laparoscopical hysterectomy

Comparison of techniques

The abdominal technique is very often applied in difficult circumstances or when complications are expected. Given this circumstances the complication rate and time required for surgery compares very favorably with other techniques, however time required for healing is much longer.

Vaginal hysterectomy was shown to be superior to LAVH and some types of laparoscopic surgery (sufficient data was not available for all types of laparoscopic surgery), causing fewer short- and long-term complications, more favorable effect on sexual experience with shorter recovery times and fewer costs. It is however not possible or very difficult to perform some more complicated surgeries using this technique.

A recent Cochrane review recommends vaginal hysterectomy over other variants where possible. Laparoscopic surgery offers certain advantages when vaginal surgery is not possible but has also the disadvantage of significantly longer time required for the surgery.

In direct comparison of abdominal (laparotomic) and laparoscopic techniques laparoscopic surgery causes longer operation time and substantially higher rate of major complications while offering much quicker healing.

Vaginal hysterectomy is the only available option that is feasible without total anaesthesia or in outpatient settings (although so far recommended only in exceptional cases).

Time required for completion of surgery in the eVAL trial is reported as following:

- abdominal 55.2 minutes average, range 19-155
- vaginal 46.6 minutes average, range 14-168
- laproscopic (all variants) 82.5 minutes average, range 10-325 (combined data from both trial arms)

Large multifibroid uteri and subtotal hysterectomies did previously require abdominal incision but with the use of in situ morcellation they can be sometimes also performed using laparoscopic or vaginal techniques. Even impacted fibroid uteri with severe adhesions, oblitered cul-de-sac and no motion whatsoever on pelvic exam can be removed laparoscopically by experienced laparoscopic surgeons. An advanced laparoscopist can replace the majority of inpatient total abdominal hysterectomies performed for benign indications with outpatient total laparoscopic hysterectomy.

Non-robotic laparoscopic hysterectomy has a higher likelihood a requiring a large incision and conversion to open technique than robotic hysterectomy. In addition blood loss and duration of hospital stay were lower when using robotic technique when compared to non-robotic laparoscopic hysterectomy.

The other techniques are not long enough in use to allow a general assessment, it appears that laparoscopic subtotal hysterectomy(LSH) is a promising technique.

Benefits

Hysterectomy is usually performed for serious conditions and is highly effective in curing those conditions.

The Maine Women Health Study of 1994 followed for 12 months time approximately 800 women with similar gynecological problems (pelvic pain, urinary incontinence due to uterine prolapse, severe endometriosis, excessive menstrual bleeding, large fibroids, painful intercourse), around half of whom had a hysterectomy and half of whom did not. The study found that a substantial number of those who had a hysterectomy had marked improvement in their symptoms following hysterectomy, as well as significant improvement in their overall physical and mental health one year out from their surgery. The study concluded that for those who have intractable gynecological problems that had not responded to non-surgical intervention, hysterectomy may be beneficial to their

overall health and wellness. Somewhat surprisingly, ovarian cancer risk after hysterectomy appears to be substantially lowered even when the ovaries are preserved.

Risks and side effects

Hysterectomy has like any other surgery certain risks and side effects.

Mortality and surgical risks

Short term mortality (within 40 days of surgery) is usually reported in the range of 1-6 cases per 1000 when performed for benign causes. Risks for surgical complications are presence of fibroids, younger age (vascular pelvis with higher bleeding risk and larger uterus), dysfunctional uterine bleeding and parity.

The mortality rate is several times higher when performed in patients that are pregnant, have cancer or other complications.

Long term effect on all case mortality is relatively small. Women under the age of 45 years have a significantly increased long term mortality that is believed to be caused by the hormonal side effects of hysterectomy and prophylactic oophorectomy.

Approximately 35% of women after hysterectomy undergo another related surgery within 2 years.

Reconvalescence

Hospital stay is 3 to 5 days or more for the abdominal procedure and between 2 to 3 days for vaginal or laparoscopically assisted vaginal procedures.

Time for full recovery is very long and independent on the procedure that was used. Depending on the definition of "full recovery" 6 to 12 months have been reported. Serious limitations in everyday activities are expected for a minimum of 4 months.

Unintended oophorectomy and premature ovarian failure

Removal of one or both ovaries is performed in a substantial number of hysterectomies that were intended to be ovariesparing.

The average onset age of menopause in those who underwent hysterectomy is 3.7 years earlier than average even when the ovaries are preserved. This has been suggested to be due to the disruption of blood supply to the ovaries after a hysterectomy or due to missing endocrine feedback of the uterus. The function of the remaining ovaries is significantly affected in about 40% women, some of them even require hormone replacement treatment. Surprisingly, a similar and only slightly weaker effect has been also observed for endometrial ablation which is often considered as an alternative to hysterectomy.

Substantial number of women develop benign ovarian cysts after hysterectomy.

Premature menopause and its effects

Estrogen levels fall sharply when the ovaries are removed, removing the protective effects of estrogen on the cardiovascular and skeletal systems. This condition is often referred to as "surgical menopause", although it is substantially different from a naturally occurring menopausal state; the former is a sudden hormonal shock to the body that causes rapid onset of menopausal symptoms such as hot flashes, while the latter is a gradually occurring decrease of hormonal levels over a period of years with uterus intact and ovaries able to produce hormones even after the cessation of menstrual periods.

When only the uterus is removed there is a three times greater risk of cardiovascular disease. If the ovaries are removed the risk is seven times greater. Several studies have found that osteoporosis (decrease in bone density) and increased risk of bone fractures are associated with hysterectomies. This has been attributed to the modulatory effect of estrogen on calcium metabolism and the drop in serum estrogen levels after menopause can cause excessive loss of calcium leading to bone wasting.

Hysterectomies have also been linked with higher rates of heart disease and weakened bones. Those who have undergone a hysterectomy with both ovaries removed typically have reduced testosterone levels as compared to those left intact. Reduced levels of testosterone in women is predictive of height loss, which may occur as a result of reduced bone density, while increased testosterone levels in women are associated with a greater sense of sexual desire.

Oophorectomy before the age of 45 is associated with a fivefold mortality from neurologic and mental disorders.

Urinary incontinence and vaginal prolapse

Urinary incontinence and vaginal prolapse are well known adverse effects that develop with high frequency very long time after the surgery. Typically those complications develop 10–20 years after the surgery. For this reason exact numbers are not known and risk factors poorly understood, it is also unknown if the choice surgical technique has any effect. It has been assessed that the risk for urinary incontinence is approximately doubled within 20 years after hysterectomy. One long term study found a 2.4 fold increased risk for surgery to correct urinary stress incontinence following hysterectomy

The risk for vaginal prolapse depends on factors such as number of vaginal deliveries, the difficulty of those deliveries, and the type of labor the individual does.

Effects on social life and sexuality

Some women find their natural lubrication during sexual arousal is also reduced or eliminated. Those who experience uterine orgasm will not experience it if the uterus is

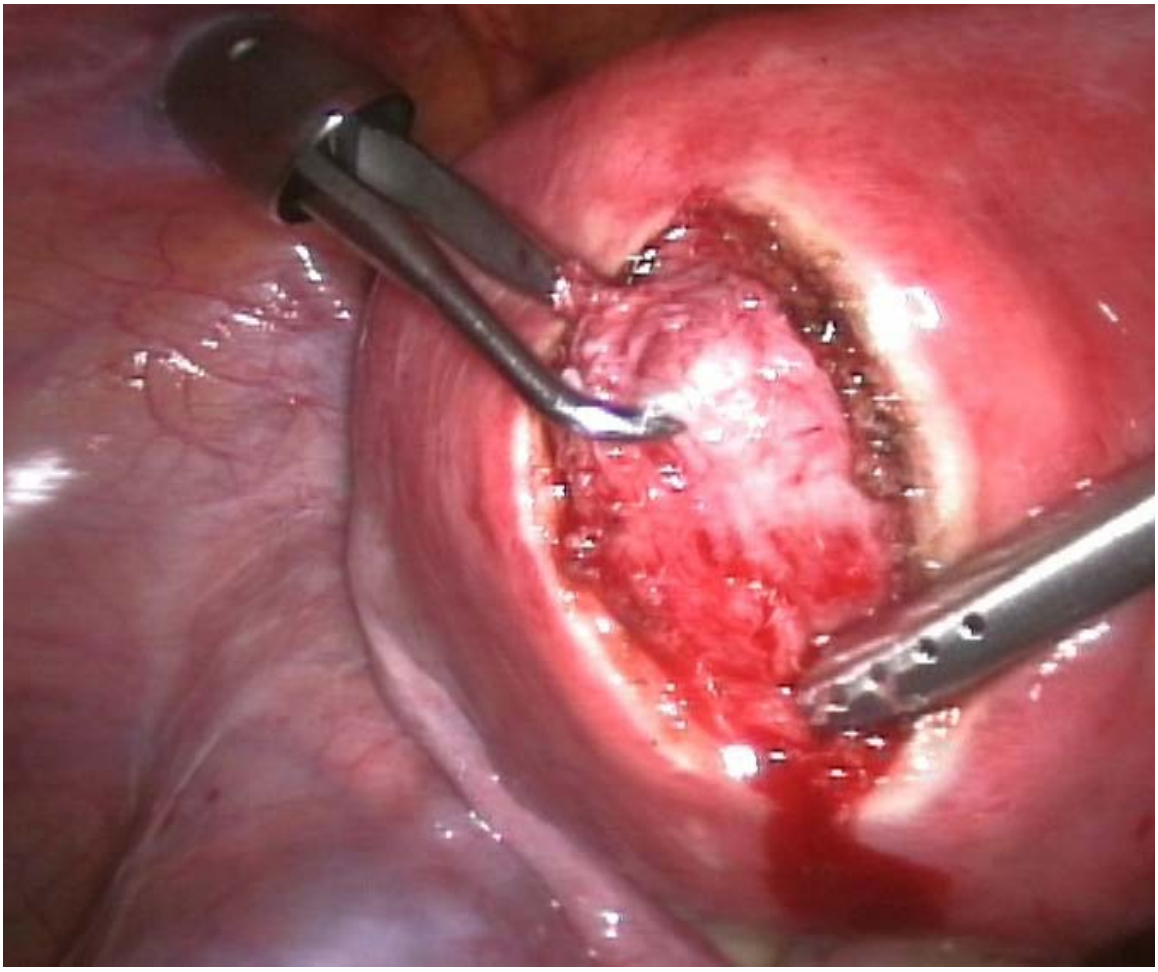
removed. The vagina is shortened and made into a closed pocket and there is a loss of support to the bladder and bowel.

Other rare problems

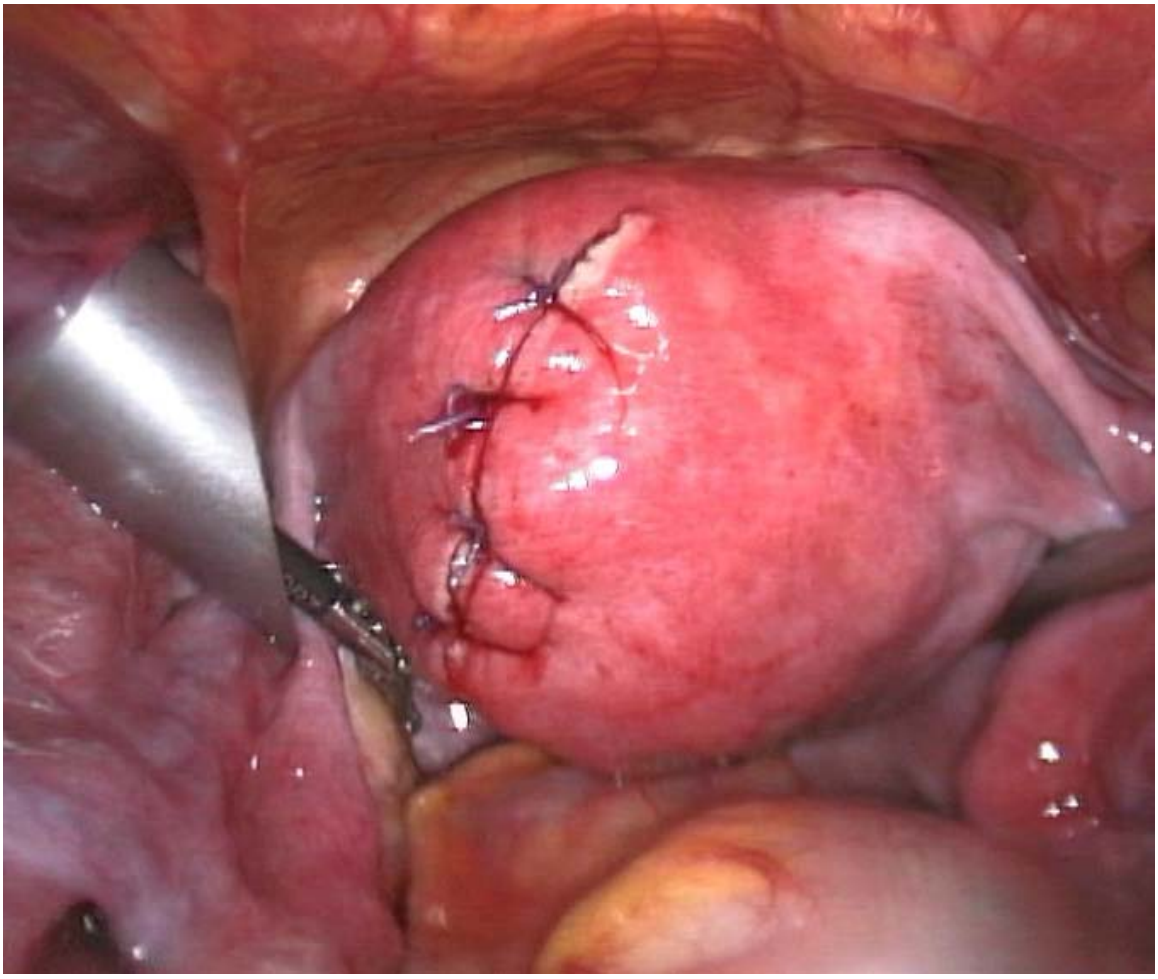
Hysterectomy may cause an increased risk of the relatively rare renal cell carcinoma. Hormonal effects or injury of the ureter were considered as possible explanations.

Removal of the uterus without removing the ovaries can produce a situation that on rare occasions can result in ectopic pregnancy due to an undetected fertilization that had yet to descend into the uterus before surgery. Two cases have been identified and profiled in an issue of the *Blackwell Journal of Obstetrics and Gynecology*; over 20 other cases have been discussed in additional medical literature.

Alternatives



Myomectomy



Sutured uterus wound after myomectomy

Depending on the problem there are alternatives to hysterectomy :

Heavy bleeding

Dysfunctional uterine bleeding (DUB) may be treated with endometrial ablation, which is an outpatient procedure in which the lining of the uterus is destroyed with heat, mechanically or by radio frequency ablation. Endometrial ablation will greatly reduce or entirely eliminate monthly bleeding in ninety percent of patients with DUB. It is not effective for patients with very thick uterine lining or uterine fibroids.

Menorrhagia (heavy or abnormal menstrual bleeding) may also be treated with the less invasive endometrial ablation.

Uterine fibroids

Uterine fibroids may be removed and the uterus reconstructed in a procedure called "myomectomy." A myomectomy may be performed through an open incision, laparoscopically or through the vagina (hysterescopy).

Uterine artery embolization is a minimally invasive procedure for treatment of uterine fibroids. Under local anesthesia a catheter is introduced into the femoral artery at the groin and advanced under radiographic control into the uterine arterty. A mass of microspheres or polyvinyl alcohol (PVA) material (an embolus) is injected into the uterine arteries in order to block the flow of blood through those vessels. The restriction in blood supply usually results in in significant reduction of fibroids and improvement of heavy bleeding tendency. The 2006 Cochrane review comparing hysterectomy and UAE did not find any major advantage for either procedure. The subsequently finished HOPEFUL study found substantially fewer serious adverse effects for UAE with lesser overall cost and comparable satisfaction. In this study 86% UAE treated women and 70% hysterectomy treated women recommend their treatment to a friend.

Uterine fibroids can be treated also with a non-invasive procedure called Magnetic Resonance guided Focused Ultrasound (MRgFUS). This procedure involves no cutting or general anesthesia and the uterus remains intact.

Prolapse

Prolapse may also be corrected surgically without removal of the uterus.

As part of transitioning from female-to-male

Hysterectomies with bilateral salpingo-oophorectomy are often performed either prior to or as a part of sex reassignment surgery for trans men. Some in the FTM community prefer to have this operation along with hormone replacement therapy in the early stages of their gender transition to avoid complications from heavy testosterone use while still having female-hormone-producing organs in place (e.g. uterine cancer and hormonally induced coronary artery disease) or to remove as many sources of female sex hormones as possible in order to better "pass" during the real life experience portion of their transition. Just as many, however, prefer to wait until they have full "bottom surgery" (removal of female sexual organs and construction of male-appearing external anatomy) to avoid undergoing multiple separate operations.