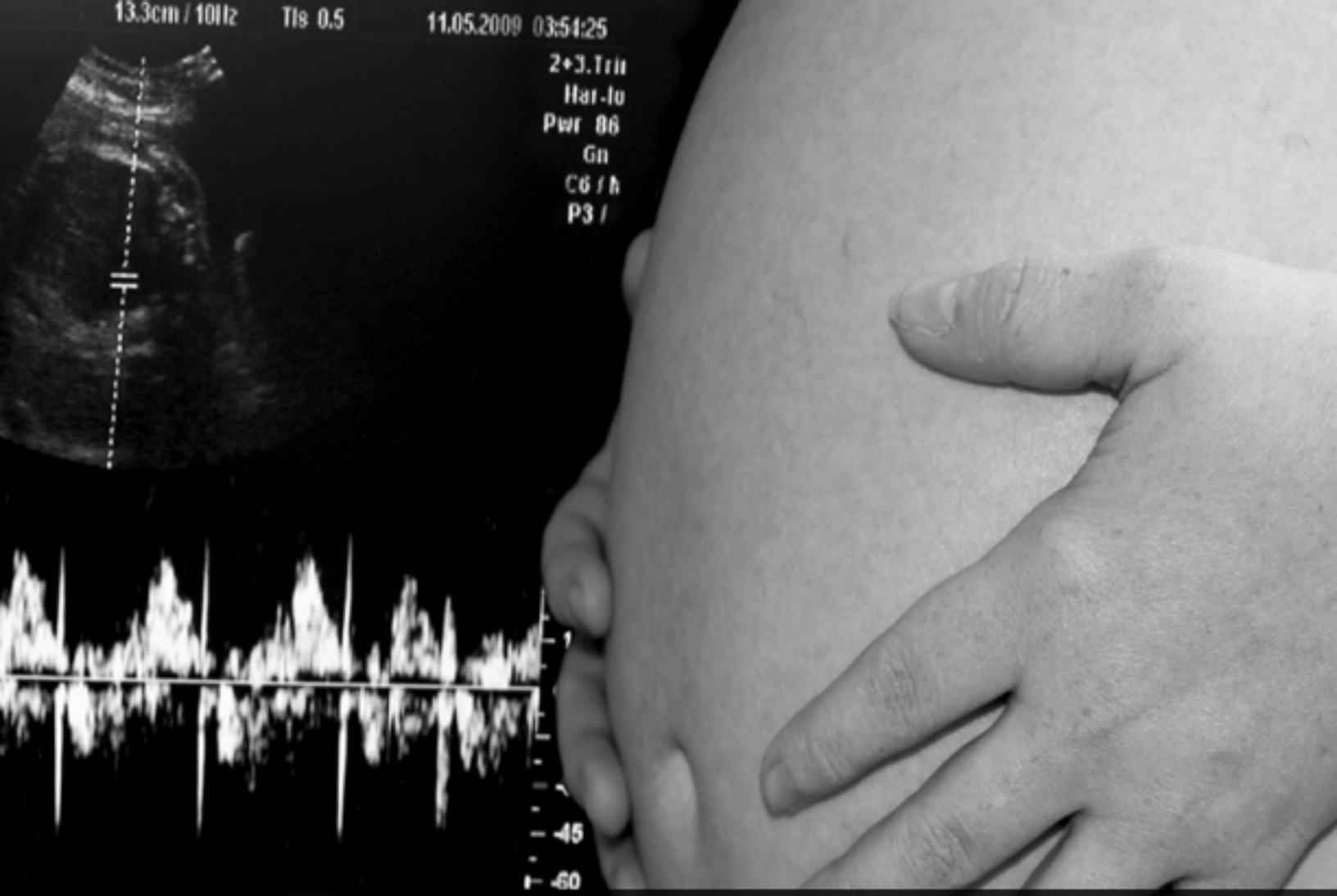

Obstetrics and Obstetrical Procedures

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Chapter 1

Obstetrics

Obstetrician	
Occupation	
Names	Doctor, consultant, medical specialist
Type	Specialty
Activity sectors	Medicine and surgery
Description	
Education required	Medical training and specialised postgraduate training
Fields of employment	Hospitals, clinics

Obstetrics (from the Latin *obstare*, "to stand by") is the surgical specialty dealing with the care of women and their children during pregnancy (prenatal period), childbirth and the postnatal period. Midwifery is the non-surgical equivalent. Veterinary obstetrics is the same concept for veterinary medicine. Almost all modern obstetricians are also gynaecologists.

Prenatal care

Prenatal care is important in screening for various complications of pregnancy. This includes routine office visits with physical exams and routine lab tests:

3D ultrasound of 3-inch (76 mm) fetus (about 14 weeks gestational age)

Fetus at 17 weeks

Fetus at 20 weeks

First trimester

- Complete blood count (CBC)
- Blood type
- General antibody screen (indirect Coombs test) for HDN
    - Rh D negative antenatal patients should receive RhoGam at 28 weeks to prevent Rh disease.
- Rapid plasma reagent (RPR) which screens for syphilis
- Rubella antibody screen
- Hepatitis B surface antigen
- Gonorrhea and Chlamydia culture
- PPD for tuberculosis
- Pap smear
- Urinalysis and culture
- HIV screen
- Group B Streptococcus screen – will receive IV penicillin or ampicillin (it is much cheaper and has a wider coverage)if positive (if mother is allergic, alternative therapies include IV clindamycin or IV vancomycin)

genetic screening for downs syndrome (trisomy 21) and trisomy 18 the national standard in the United States is rapidly evolving away from the AFP-Quad screen for downs syndrome- done typically in the second trimester at 16–18 weeks. The newer integrated screen (formerly called F.A.S.T.E.R for First And Second Trimester Early Results) can be done at 10 plus weeks to 13 plus weeks with an ultrasound of the fetal neck (thick skin is bad) and two chemicals (analytes) Papp-a and bhcg (pregnancy hormone level itself). It gives an accurate risk profile very early. There is a second blood screen at 15 to 20 weeks which refines the risk more accurately. The cost is higher than an "AFP-quad" screen due

to the ultrasound and second blood test but it is quoted to have a 93% pick up rate as opposed to 88% for the standard AFP/QS. This is an evolving standard of care in the United States.

Second trimester

- MSAFP/quad. screen (four simultaneous blood tests) (maternal serum alpha-fetoprotein; inhibin; estriol; bhcg or free bhcg) - elevations, low numbers or odd patterns correlate with neural tube defect risk and increased risks of trisomy 18 or trisomy 21
- Ultrasound either abdominal or trannsvaginal to assess cervix, placenta, fluid and baby
- Amniocentesis is the national standard for women over 35 or who reach 35 by mid pregnancy or who are at increased risk by family history or prior birth history

Third trimester

- Hematocrit (if low, mother will receive iron supplementation)
- Glucose loading test (GLT) - screens for gestational diabetes; if > 140 mg/dL, a glucose tolerance test (GTT) is administered; a fasting glucose > 105 mg/dL suggests gestational diabetes.

Most doctors do a sugar load in a drink form of 50 grams of glucose in cola, lime or orange and draw blood an hour later (plus or minus 5 minutes) ; the standard modified criteria have been lowered to 135 since the late 1980s

Antenatal record

On the first visit to her obstetrician or midwife, the pregnant woman is asked to carry out the antenatal record, which constitutes a medical history and physical examination. On subsequent visits, the gestational age (GA) is rechecked with each visit.

Symphysis-fundal height (SFH; in cm) should equal gestational age after 20 weeks of gestation, and the fetal growth should be plotted on a curve during the antenatal visits. The fetus is palpated by the midwife or obstetrician using Leopold maneuver to determine the position of the baby. Blood pressure should also be monitored, and may be up to 140/90 in normal pregnancies. High blood pressure indicates hypertension and possibly pre-eclampsia, if severe swelling (edema) and spilled protein in the urine are also present.

Fetal screening is also used to help assess the viability of the fetus, as well as congenital problems. Genetic counseling is often offered for families who may be at an increased risk to have a child with a genetic condition. Amniocentesis at around the 20th week is sometimes done for women 35 or older to check for Down's Syndrome and other chromosome abnormalities in the fetus.

Even earlier than amniocentesis is performed, the mother may undergo the triple test, nuchal screening, nasal bone, alpha-fetoprotein screening and Chorionic villus sampling, also to check for disorders such as Down Syndrome. Amniocentesis is a prenatal genetic screening of the fetus, which involves inserting a needle through the mother's abdominal wall and uterine wall, to extract fetal DNA from the amniotic fluid. There is a risk of miscarriage and fetal injury with amniocentesis because it involves penetrating the uterus with the baby still in utero.

Imaging

A dating scan at 12 weeks

Imaging is another important way to monitor a pregnancy. The mother and fetus are also usually imaged in the first trimester of pregnancy. This is done to predict problems with the mother; confirm that a pregnancy is present inside the uterus; estimate the gestational age; determine the number of fetuses and placentae; evaluate for an ectopic pregnancy and first trimester bleeding; and assess for early signs of anomalies.

X-rays and computerized tomography (CT) are not used, especially in the first trimester, due to the ionizing radiation, which has teratogenic effects on the fetus. No effects of magnetic resonance imaging (MRI) on the fetus have been demonstrated, but this technique is too expensive for routine observation. Instead, ultrasound is the imaging

method of choice in the first trimester and throughout the pregnancy, because it emits no radiation, is portable, and allows for realtime imaging.

Ultrasound imaging may be done at any time throughout the pregnancy, but usually happens at the 12th week (dating scan) and the 20th week (detailed scan).

A normal gestation would reveal a gestational sac, yolk sac, and fetal pole. The gestational age can be assessed by evaluating the mean gestational sac diameter (MGD) before week 6, and the crown-rump length after week 6. Multiple gestation is evaluated by the number of placentae and amniotic sacs present.

Complications and emergencies

The main emergencies include:

- Ectopic pregnancy is when an embryo implants in the Fallopian tube or (rarely) on the ovary or inside the peritoneal cavity. This may cause massive internal bleeding.
- Pre-eclampsia is a disease which is defined by a combination of signs and symptoms that are related to maternal hypertension. The cause is unknown, and markers are being sought to predict its development from the earlist stages of pregnancy. Some unknown factors cause vascular damage in the endothelium, causing hypertension. If severe, it progresses to *eclampsia*, where a convulsions occur, which can be fatal. Preeclamptic patients with the HELLP syndrome show liver failure and Disseminated intravascular coagulation (DIC).
- Placental abruption where the patient can bleed to death if not managed appropriately.
- Fetal distress where the fetus is getting compromised in the uterine environment.
- Shoulder dystocia where one of the fetus' shoulders becomes stuck during vaginal birth, especially in macrosomic babies of diabetic mothers.
- Uterine rupture can occur during obstructed labor and endangered fetal and maternal life.
- Prolapsed cord refers to the prolapse of the fetal cord during labor with the risk of fetal suffocation.
- Obstetrical hemorrhage may be due to a number of factors such as placenta previa, uterine rupture of tears, uterine atony, retained placenta or placental fragments, or bleeding disorders.
- Puerperal sepsis is a progressed infection of the uterus during or after labor.

Fetal assessments

Ultrasound is routinely used for dating the gestational age of a pregnancy from the size of the fetus, the most accurate dating being in first trimester before the growth of the fetus has been significantly influenced by other factors. Ultrasound is also used for detecting congenital anomalies (or other fetal anomalies) and determining the biophysical profiles (BPP), which are generally easier to detect in the second trimester when the fetal

structures are larger and more developed. Specialised ultrasound equipment can also evaluate the blood flow velocity in the umbilical cord, looking to detect a decrease/absence/reversal or diastolic blood flow in the umbilical artery.

Other tools used for assessment include:

- Fetal karyotype can be used for the screening of genetic diseases. This can be obtained via amniocentesis or chorionic villus sampling (CVS)
- Fetal hematocrit for the assessment of fetal anemia, Rh isoimmunization, or hydrops can be determined by percutaneous umbilical blood sampling (PUBS) which is done by placing a needle through the abdomen into the uterus and taking a portion of the umbilical cord.
- Fetal lung maturity is associated with how much surfactant the fetus is producing. Reduced production of surfactant indicates decreased lung maturity and is a high risk factor for infant respiratory distress syndrome. Typically a lecithin:sphingomyelin ratio greater than 1.5 is associated with increased lung maturity.
- Nonstress test (NST) for fetal heart rate
- Oxytocin challenge test

Childbirth

Induction

Induction is a method of artificially or prematurely stimulating labour in a woman. Reasons to induce can include pre-eclampsia, placental malfunction, intrauterine growth retardation, and other various general medical conditions, such as renal disease. Induction may occur any time after 34 weeks of gestation if the risk to the fetus or mother is greater than the risk of delivering a premature fetus regardless of lung maturity.

Induction may be achieved via several methods:

- Pessary of *Prostin* cream, prostaglandin E_2
- Intravaginal or oral administration of misoprostol
- Cervical insertion of a 30-mL Foley catheter
- Rupturing the amniotic membranes
- Intravenous infusion of synthetic oxytocin (Pitocin or Syntocinon)

Labor

During labor itself, the obstetrician/doctor/intern/medical student under supervision may be called on to do a number of tasks. These tasks can include:

- Monitor the progress of labor, by reviewing the nursing chart, performing vaginal examination, and assessing the trace produced by a fetal monitoring device (the cardiotocograph)

- Accelerate the progress of labor by infusion of the hormone oxytocin
- Provide pain relief, either by nitrous oxide, opiates, or by epidural anesthesia done by anaesthestists, an anesthesiologist, or a nurse anesthetist.
- Surgically assisting labor, by forceps or the Ventouse (a suction cap applied to the fetus' head)
- Caesarean section, if there is an associated risk with vaginal delivery, as such fetal or maternal compromise supported by evidence and literature. Caesarean section can either be elective, that is, arranged before labor, or decided during labor as an alternative to hours of waiting. True "emergency" Cesarean sections include abruptio placenta, and are more common in multigravid patients, or patients attempting a Vaginal Birth After Caeserean section (VBAC).

Postnatal

A woman in the Western world who is delivering in a hospital may leave the hospital as soon as she is medically stable and chooses to leave, which can be as early as a few hours postpartum, though the average for spontaneous vaginal delivery (SVD) is 1–2 days, and the average caesarean section postnatal stay is 3–4 days. During this time the mother is monitored for bleeding, bowel and bladder function, and baby care. The infant's health is also monitored.

Post-Natal Care

• Care provided to the mother following parturition. Certain things must be kept in mind as the physician proceeds with the post-natal care.

1. General Condition of the patient.
2. Check for Vital Signs (Pulse, Blood Pressure, Temperature, Respiratory Rate, (Pain) at times)
3. Palor?
4. Edema?
5. Dehydration?
6. Fundus (height following parturition, and the feel of the fundus) (Per Abdominal Examination)
7. If an Episiotomy or a C-Section was performed, check for the dressing. Intact, pus, oozing, haematomas?
8. Lochia (colour, amount, odour)?
9. Bladder (keep the patient catheterized for 12 hours following local anaesthesia and 24-48 hours after general anaesthesia) ? (check for bladder function)
10. Bowel Movements?
11. Follow up with the neonate to check if they’re healthy.

Salary

The salary of a obstetrician varies by country. In the United States, the salary ranges from $200,000 to $339,738.

Country	Annual salary (US$)
United Kingdom	187,771
United Arab Emirates	231,809
United States	236,411

Chapter 2

Prenatal Care

A doctor performs a prenatal exam

Prenatal care refers to the medical and nursing care recommended for women before and during pregnancy. The aim of good prenatal care is to detect any potential problems early, to prevent them if possible (through recommendations on adequate nutrition, exercise, vitamin intake etc), and to direct the woman to appropriate specialists, hospitals, etc. if necessary. The availability of routine prenatal care has played a part in reducing maternal death rates and miscarriages as well as birth defects, low birth weight, and other preventable infant problems. Animal studies indicate that mothers' (and possibly fathers') diet, vitamin intake, and glucose levels *prior* to ovulation and conception have long-term effects on fetal growth and adolescent and adult disease.

While availability of prenatal care has considerable personal health and social benefits, socioeconomic problems prevent its universal adoption in many developed as well as developing nations.

One prenatal practice is for the expecting mother to consume vitamins with at least 400 mcg of folic acid to help prevent neural tube defects.

Prenatal care generally consists of:

- monthly visits during the first two trimesters (from week 1–28)
- biweekly from 28 to week 36 of pregnancy
- weekly after week 36 (delivery at week 38–40)
- Assessment of parental needs and family dynamic

Physical examination

Physical examinations generally consist of:

- Collection of (mother's) medical history
- Checking (mother's) blood pressure
- (Mother's) height and weight
- Pelvic exam
- Doppler fetal heart rate monitoring
- (Mother's) blood and urine tests
- Discussion with caregiver

Ultrasound

Obstetric ultrasounds are most commonly performed during the second trimester at approximately week 20. Ultrasounds are considered relatively safe and have been used for over 35 years for monitoring pregnancy.

Among other things, ultrasounds are used to:

- Diagnose pregnancy (uncommon)
- Check for multiple fetuse
- Assess possible risks to the mother (e.g., miscarriage, blighted ovum, ectopic pregnancy, or a molar pregnancy condition)
- Check for fetal malformation (e.g., club foot, spina bifida, cleft palate, clenched fists)
- Determine if an intrauterine growth retardation condition exists
- Note the development of fetal body parts (e.g., heart, brain, liver, stomach, skull, other bones)
- Check the amniotic fluid and umbilical cord for possible problems
- Determine due date (based on measurements and relative developmental progress)

Generally an ultrasound is ordered whenever an abnormality is suspected or along a schedule similar to the following:

- 7 weeks — confirm pregnancy, ensure that it's neither molar or ectopic, determine due date
- 13–14 weeks (some areas) — evaluate the possibility of Down Syndrome
- 18–20 weeks

- 34 weeks (some areas) — evaluate size, verify placental position

Prenatal Care and Race in the USA

Many health professionals consider prenatal care a nearly essential practice for pregnant women; however, there are wide gaps in the American population regarding who has access to these services and who actually utilizes these services. For example, African-American expectant mothers are 2.8 times as likely as non-Hispanic white mothers to begin their prenatal care in the third trimester, or to receive no prenatal care during the entirety of the pregnancy. Similarly, Hispanic expectant mothers are 2.5 times as likely as non-Hispanic white mothers to begin their prenatal care in the third trimester, or to receive no prenatal care at all. The following factors impact a woman's likelihood of acquiring prenatal care:

- *Health Insurance:* 13% of women who become pregnant every year in the United States are uninsured, resulting in severely limited access to prenatal care. According to Children's Defense Fund's website, "Almost one in every four pregnant Black women and more than one in three pregnant Latina women is uninsured, compared with one in nearly seven pregnant White women. Without coverage, Black and Latina mothers are less likely to access or afford prenatal care." Currently, pregnancy is considered a "pre-existing condition," making it much harder for uninsured pregnant women to actually be able to afford private health insurance.

- *Formal Education:* Oftentimes, Black and Hispanic pregnant women have fewer years of formal education, which sparks a large domino effect of consequences related to prenatal care. A lack of formal education results in less knowledge about pregnancy appropriate prenatal healthcare as a whole, fewer job opportunities, and a lower level of income throughout their adult life.

- *Trust & Comfort with Healthcare Industry:* Many minority women have limited experience with the healthcare industry on a whole, as compared to their Caucasian counterparts. Consequently, there is a lower level of trust with physicians, nurses, and the entire care regimen. Many women who are distrustful of biomedicine will decline certain prenatal tests, citing their own bodily knowledge as more trustworthy than their doctor's high-tech interpretations. Even worse, some minority women may opt to avoid the distress and discomfort of the medical industry and refuse prenatal care entirely.

- *Understanding of Prenatal Testing:* Many ethnic/racial minority mothers are referred to genetic counseling and prenatal testing centers after being declared "at-risk" for birth defects after initial screenings. However, few testing centers effectively communicate what occurs during the various tests, what the test is looking for, or what the various results could mean for the remainder of the pregnancy. Therefore, some mothers are quite uncomfortable with this lack of clearly-communicated information and are consequently hesitant to pursue

prenatal testing and counseling that health professionals would consider recommendable.

Consequences of Minorities' Limited Access to Prenatal Care

Without timely, thorough, and appropriate prenatal care, the racial minorities of the United States continue to face severe consequences for the birth outcome of both infant and mother.

- *Delivery Complications:* In one study, researchers found that all minority races experienced higher rates of complications such as: intrauterine growth restriction, preeclampsia, preterm premature rupture of membranes, gestational diabetes, placenta previa, and preterm birth.

- *Low Birth Weight:* Black infants are almost twice as likely to be born at a low birth weight as White babies. This birth complication is ranked as the most prevalent cause of death among African American infants, claiming 1780 lives in 2005.

- *Congenital Malformations:* Any genetic factor or prenatal event that adversely affects the development of the fetus in utero can result in a congenital malformation. Some commonly known congenital malformations are cleft palate, heart defects, and Down syndrome. As of 2005, congenital malformations are the leading cause of death among Hispanic infants, claiming 1373 lives.

- *Infant Mortality:* In the United States, the non-Hispanic white population experiences an infant mortality rate of 5.8 deaths per every 1000 live births. The African-American population's infant mortality rate is 2.3 times greater (13.6 deaths per 1000 live births).

- *Impact of Prenatal Care on Birth Outcomes:* When women utilize prenatal care appropriately, many of them increase their chances of having a successful birth outcome. For example, prenatal care includes discussions with physicians about what lifestyle changes should be made during pregnancy (such as tobacco or alcohol cessation); if these changes do not occur, the pregnancy is more likely to be problematic or result in an infant with a defect or prone to early mortality. Additionally, doctors can provide prescriptions for specific prenatal vitamins and supplements to ensure a healthy mother and infant. Finally, specific prenatal tests screen for genetic abnormalities, and expectant mothers can learn if their fetuses have any significant defects prior to delivery; in these situations, physicians and genetic counselors can help advise mothers about their options for continuing the pregnancy. While some poor birth outcomes cannot be entirely avoided through prenatal care, the pregnant woman can receive important information, advice, and guidance about her own individual situation, rather than being surprised in the delivery room with some unexpected news.

- *Pregnancy and Exercise:* Updated recommendations by the American College of Sports Medicine suggest at least 2-1/2 hours of moderate-intensity aerobic activity spread throughout the week for pregnant and postpartum women. Women who regularly engage in high-intensity or higher amounts of activity may continue under the counsel of their health care professional provided their condition remains unchanged.

Prenatal Care Improvements for Minorities

Although minorities continue to face decreased access to high-quality prenatal care, there are specific improvements the biomedical field can make to fix this disparity.

- *Connect physicians and patients on a cultural level:* For many minority patients, it is difficult to develop a long-standing and trusting relationship with healthcare providers of different cultural backgrounds, as each culture has its own priorities, values, and goals. In traditionally underserved communities with sizeable minority populations, healthcare providers should strive to offer physicians and nurses who match the racial background of the patients they are working to serve.

- *Improve all providers' cultural awareness and sensitivity:* If patients cannot be matched with healthcare providers culturally, then they should at least be able to visit a physician who is trained specifically to deal with cultural differences. This awareness and sensitivity can come in many forms, such as a familiarity with a foreign language, an understanding of how a specific ethnicity views mothers, or knowing how family networks play into the mothers' decision-making process. All of these options have the potential to improve doctor-patient relationships, and this sort of education can be implemented in medical training programs both in medical school settings and on-site training programs.

- *Community Outreach Programs:* Because hospitals and doctors' offices are unfamiliar and unwelcoming places for some individuals, the healthcare industry should establish a multifaceted community outreach program in large cities. These programs would train members of the minority population in basic health education; then these community health workers would help to facilitate connections between expectant mothers and local healthcare establishments. The community health workers could even continue their relationship throughout the duration of the pregnancy, serving as a patient liaison during the various tests, appointments, and conversations.

Chapter 3

Prenatal Diagnosis

Prenatal diagnosis or **prenatal screening** is testing for diseases or conditions in a fetus or embryo before it is born. The aim is to detect birth defects such as neural tube defects, Down syndrome, chromosome abnormalities, genetic diseases and other conditions, such as spina bifida, cleft palate, Tay Sachs disease, sickle cell anemia, thalassemia, cystic fibrosis, and fragile x syndrome. Screening can also be used for prenatal sex discernment. Common testing procedures include amniocentesis, ultrasonography including nuchal translucency ultrasound, serum marker testing, or genetic screening. In some cases, the tests are administered to determine if the fetus will be aborted, though physicians and patients also find it useful to diagnose high-risk pregnancies early so that delivery can be scheduled in a tertiary care hospital where the baby can receive appropriate care.

Fetal screening has also been done to determine characteristics generally not considered birth defects, and avail for e.g. sex selection. The rise of designer babies and parental selection for specific traits raises a host of bioethical and legal issues that will dominate reproductive rights debates in the 21st century.

Invasiveness

Diagnostic prenatal testing can be by invasive or non-invasive methods. An invasive method involves probes or needles being inserted into the uterus, e.g. amniocentesis, which can be done from about 14 weeks gestation, and usually up to about 20 weeks, and chorionic villus sampling, which can be done earlier (between 9.5 and 12.5 weeks gestation) but which may be slightly more risky to the fetus. However since chorionic villus sampling is performed earlier in the pregnancy than amniocentesis, typically during the first trimester, it can reasonably be expected that there will be a higher rate of miscarriage after chorionic villus sampling than after amniocentesis. Non-invasive techniques include examinations of the woman's womb through ultrasonography and maternal serum screens (i.e. Alpha-fetoprotein) and also genetic analysis on fetal cells isolated from maternal blood. Non-invasive genetic tests for Down Syndrome, Trisomy 18, and Trisomy 13 fetal DNA present in maternal blood are in development. If an elevated risk of chromosomal or genetic abnormality is indicated by a non-invasive screening test, a more invasive technique may be employed to gather more information. In the case of neural tube defects, a detailed ultrasound can non-invasively provide a definitive diagnosis.

A journal released at January 2011 stated that a new DNA blood test to detect Down syndrome can cut the need for invasive tests by up to 98 percent. The test is highly accurate in detecting whether a fetus carries an extra copy of chromosome 21, and it produces virtually no false negative result, but the test is expensive and does not eliminate the problem of false positives.

Fetal versus maternal

Some screening tests performed on the woman are intended to detect traits or characteristics of the fetus. Others detect conditions in the woman that may have an adverse effect on the fetus, or that threaten the pregnancy. For example, abnormally low levels of the serum marker PAPP-A have been shown to correspond to an increased risk of pre-eclampsia, in which the mother's high blood pressure can threaten the pregnancy, though many physicians find regular blood-pressure monitoring to be more reliable.

Reasons for prenatal diagnosis

There are three purposes of prenatal diagnosis: (1) to enable timely medical or surgical treatment of a condition before or after birth, (2) to give the parents the chance to abort a fetus with the diagnosed condition, and (3) to give parents the chance to "prepare" psychologically, socially, financially, and medically for a baby with a health problem or disability, or for the likelihood of a stillbirth.

Having this information in advance of the birth means that healthcare staff as well as parents can better prepare themselves for the delivery of a child with a health problem. For example, Down Syndrome is associated with cardiac defects that may need intervention immediately upon birth.

Many expectant parents would like to know the sex of their baby before birth. Methods include amniocentesis with karyotyping, and prenatal ultrasound. In some countries, health care providers are expected to withhold this information from parents, while in other countries they are expected to give this information.

Qualifying risk factors

Because of the miscarriage and fetal damage risks associated with amniocentesis and CVS procedures, many women prefer to first undergo screening so they can find out if the fetus' risk of birth defects is high enough to justify the risks of invasive testing. Since screening tests yield a risk score which represents the chance that the baby has the birth defect, the most common threshold for high-risk is 1:270. A risk score of 1:300 would therefore be considered low-risk by many physicians. However, the trade-off between risk of birth defect and risk of complications from invasive testing is relative and subjective; some parents may decide that even a 1:1000 risk of birth defects warrants an invasive test while others wouldn't opt for an invasive test even if they had a 1:10 risk score.

ACOG guidelines currently recommend that all pregnant women, regardless of age, be offered invasive testing to obtain a definitive diagnosis of certain birth defects. Therefore, most physicians offer diagnostic testing to all their patients, with or without prior screening and let the patient decide.

The following are some reasons why a patient might consider her risk of birth defects already to be high enough to warrant skipping screening and going straight for invasive testing.

- Women over the age of 35
- Women who have previously had premature babies or babies with a birth defect, especially heart or genetic problems
- Women who have high blood pressure, lupus, diabetes, asthma, or epilepsy
- Women who have family histories or ethnic backgrounds prone to genetic disorders, or whose partners have these
- Women who are pregnant with multiples (twins or more)
- Women who have previously had miscarriages

Methods of prenatal screening and diagnosis

There are multiple ways of classifying the methods available, including the invasiveness and the time performed.

Invasiveness	Test	Comments	Time
Non-invasive	Fetal Cells in Maternal Blood (FCMB)	Based on enrichment of fetal cells which circulate in maternal blood. Since fetal cells hold all the genetic information of the developing fetus they can be used to perform prenatal diagnosis.	First trimester
Non-invasive	Preimplantation Genetic Diagnosis (PGD)	During in vitro fertilization (IVF) procedures, it is possible to sample cells from human embryos prior the implantation. PGD is in itself non-invasive, but IVF usually involves invasive procedures such as transvaginal oocyte retrieval	prior to implantation
Non-invasive	External examination	Examination of the woman's uterus from outside the body.	First or second trimester
Non-invasive	Ultrasound detection	Commonly *dating scans* (sometimes known as *booking scans*) from 7 weeks to confirm pregnancy dates and look for twins. The specialised nuchal scan at 11–13 weeks may be	First or second trimester

		used to identify higher risks of Downs syndrome. Later *morphology scans* from 18 weeks may check for any abnormal development.	
Non-invasive	Fetal heartbeat	Listening to the fetal heartbeat	First or second trimester
Non-invasive	Non-stress test	Use of cardiotocography during the third trimester to monitor fetal wellbeing	Third trimester
Less invasive	Maternal serum screening (triple test)	Second trimester maternal serum screening (AFP screening, triple screen, quad screen, or penta screen) can check levels of alpha fetoprotein, β-hCG, inhibin-A, estriol, and h-hCG (hyperglycosolated hCG) in the woman's serum.	Second trimester
Less invasive	Transcervical retrieval of trophoblast cells	Cervical mucus aspiration, cervical swabbing, and cervical or intrauterine lavage can be used to retrieve trophoblast cells for diagnostic purposes, including prenatal genetic analysis. Success rates for retrieving fetal trophoblast cells vary from 40% to 90%. It can be used for fetal sex determination and identify aneuploidies. Antibody markers have proven useful to select trophoblast cells for genetic analysis and to demonstrate that the abundance of recoverable trophoblast cells diminishes in abnormal gestations, such as in ectopic pregnancy or anembryonic gestation.	First trimester
Less invasive	Maternal serum screening (triple test)	First trimester maternal serum screening can check levels of free β-hCG, PAPP-A, intact or beta hCG, inhibin-A, or h-hCG in the woman's serum, and combine these with the measurement of nuchal translucency (NT). Some institutions also look for the presence of a fetal nasalbone on the ultrasound.	First trimester

Less invasive	Detection of fetal blood cells in maternal blood	With this technique, it is technically possible to obtain a sample of fetal DNA using blood cells from the fetus that have made their way into the woman's bloodstream. Tests such as Baby Gender Mentor allegedly use this method to determine the sex of a fetus as early as six weeks into a pregnancy. Recent developments have also allowed such testing to be used to detect fetal aneuploidy. However, fetal blood cells in maternal blood are extremely rare and very fragile, making it very hard to handle and analyze them. Several companies continue to develop technologies that may someday offer a new way to screen or even diagnose chromosomal abnormalities.	
More invasive	Chorionic villus sampling	Involves getting a sample of the chorionic villus and testing it. This can be done earlier than amniocentesis, but may have a higher risk of miscarriage, estimated at 1%.	After 10 weeks
More invasive	Amniocentesis	This can be done once enough amniotic fluid has developed to sample. Cells from the fetus will be floating in this fluid, and can be separated and tested. Miscarriage risk of amniocentesis is commonly quoted as 0.5% (1:200). By amniocentesis is also possible to cryopreserve amniotic stem cells.	After 15 weeks
More invasive	Embryoscopy and fetoscopy	Though rarely done, these involve putting a probe into a women's uterus to observe (with a video camera), or to sample blood or tissue from the embryo or fetus.	
More invasive	Percutaneous umbilical cord blood sampling		

Advances in Prenatal Screening

Measurement of fetal proteins in maternal serum is a part of standard prenatal screening for fetal aneuploidy and neural tube defects. Computational predictive model shows that extensive and diverse feto-maternal protein trafficking occurs during pregnancy and can be readily detected non-invasively in maternal whole blood. This computational approach circumvented a major limitation, the abundance of maternal proteins interfering with the detection of fetal proteins, to fetal proteomic analysis of maternal blood. Entering fetal gene transcripts previously identified in maternal whole blood into a computational predictive model helped develop a comprehensive proteomic network of the term neonate. It also shows that the fetal proteins detected in pregnant woman's blood originate from a diverse group of tissues and organs from the developing fetus. Development proteomic networks dominate the functional characterization of the predicted proteins, illustrating the potential clinical application of this technology as a way to monitor normal and abnormal fetal development.

Typical screening sequence

California provides a useful guide to most of the currently available screening paradigms.

At early presentation of pregnancy at around 6 weeks, early dating ultrasound scan may be offered to help confirm the gestational age of the embryo and check whether a single or twin pregnancy, but such a scan is unable detect common abnormalities. Details of prenatal screening and testing options may be provided.

Around weeks 10-11, nuchal thickness scan (NT) may be offered which can be combined with blood tests for PAPP-A and beta-hCG, two serum markers that correlate with chromosomal abnormalities, in what is called the First Trimester Combined Test. The results of the blood test are them combined with the NT ultrasound measurements, maternal age, and gestational age of the fetus to yield a risk score for Down Syndrome, Trisomy 18, and Trisomy 13. First Trimester Combined Test has a sensitivity (i.e. detection rate for abnormalities) of 82-87% and a false-positive rate around 5%.

Alternatively, a second trimester Quad blood test may be taken (the triple test is widely considered obsolete but in some states, such as Missouri, where Medicaid only covers the Triple test, that's what the patient typically gets). With *integrated screening*, both a First Trimester Combined Test and a Triple/Quad test is performed, and a report is only produced after both tests have been analyzed. However patients may not wish to wait between these two sets of test. With *sequential screening*, a first report is produced after the first trimester sample has been submitted, and a final report after the second sample. With *contingent screening*, patients at very high or very low risks will get reports after the first trimester sample has been submitted. Only patients with *moderate risk* (risk score between 1:50 and 1:2000) will be asked to submit a second trimester sample, after which they will receive a report combining information from both serum samples and the NT measurement. The First Trimester Combined Test and the Triple/Quad test together have a sensitivity of 88-95% with a 5% false-positive rate for Down Syndrome, though they

can also be analyzed in such a way as to offer a 90% sensitivity with a 2% false-positive rate.

Finally for patients who do not receive an NT ultrasound in the 1st trimester may still receive a Serum Integrated test involving measuring PAPP-A serum levels in the 1st trimester and then doing a Quad test in the 2nd trimester. This offers an 85-88% sensitivity and 5% false-positive rate for Down Syndrome. Also, patient may skip 1st trimester screening entirely and receive only a 2nd trimester Quad test, with an 81% sensitivity for Down Syndrome and 5% false-positive rate.

Conditions typically tested for

Use of NT ultrasound will screen for Down Syndrome (Trisomy 21), Edwards Syndrome (Trisomy 18), and Patau Syndrome (Trisomy 13), whilst screens that only use serum markers will screen for Down Syndrome and Trisomy 18, but not Trisomy 13. Considering that Trisomy 13 is extremely rare, maybe 1:5000 pregnancies and 1:16000 births, this difference is probably not significant. The AFP marker, whether alone or as part of the Quad test, can identify 80% of spina bifida, 85% of abdominal wall defects, and 97% of anencephaly. Frequently women will receive a detailed 2nd trimester ultrasound in Weeks 18-20 (Morphology scan) regardless of her AFP level, which makes the AFP score unnecessary. Morphology ultrasound scans being undertaken on larger sized fetuses than in earlier scans, detect other structural abnormalities such as cardiac and renal tract abnormalities.

Rarer conditions also detected

In addition to the direct seeking of chromosomal abnormalities and spina bifida, the blood tests can suggest additional conditions:

- Very low estriol level (part of Quad test) can indicate a risk of Smith-Lemli-Opitz Syndrome (SLOS), an extremely rare (1:100,000) genetic disorder which can then only be confirmed with an amniocentesis. However with a 0.3% false-positive rate, 300 women would be told they are at high-risk of SLOS for every 1 affected pregnancy. Most physicians would agree that subjecting 300 women to an amniocentesis to diagnose 1 case of SLOS is not prudent.
- A low PAPP-A reading from a 1st Trimester serum test could also indicate a risk for pre-eclampsia, intrauterine growth restriction (IUGR), or early fetal demise (i.e. miscarriage). However, because PAPP-A only weakly correlates with these conditions and, in any case, there's little that one can do about them (except for pre-eclampsia, though that is better identified by other means), a PAPP-A test makes little sense except as a component of Down Syndrome screening.

Ethical and practical issues

Ethical issues of prenatal testing

- The option to continue or abort a pregnancy is the primary choice after most prenatal testing. Rarely, fetal intervention corrective procedures are possible.
- Are the risks of prenatal diagnosis, such as amniocentesis worth the potential benefit?
- Some fear that this may lead to being able to pick and choose what children parents would like to have. This could lead to choice in sex, physical characteristics, and personality in children. Some feel this type of eugenic abortion is already underway (for example, sex selection).
- Knowing about certain birth defects such as spina bifida and teratoma before birth may give the option of fetal surgery during pregnancy, or assure that the appropriate treatment and/or surgery be provided immediately after birth.
- Questions of the value of mentally or physically disabled people in society.
- How to ensure that information about testing options is given in a non-directive and supportive way.
- That parents are well informed if they have to consider abortion vs. continuing a pregnancy.

Will the result of the test affect treatment of the fetus?

In some genetic conditions, for instance cystic fibrosis, an abnormality can only be detected if DNA is obtained from the fetus. Usually an invasive method is needed to do this.

If a genetic disease is detected, there is often no treatment that can help the fetus until it is born. However in the US, there are prenatal surgeries for spina bifida foetus. Early diagnosis gives the parents time to research and discuss post-natal treatment and care, or in some cases, abortion. Genetic counselors are usually called upon to help families make informed decisions regarding results of prenatal diagnosis.

False positives and false negatives

Ultrasound of a fetus, which is considered a screening test, can sometimes miss subtle abnormalities. For example, studies show that a detailed 2nd trimester ultrasound, also called a level 2 ultrasound, can detect about 97% of neural tube defects such as spina bifida. Ultrasound results may also show "soft signs," such as an Echogenic intracardiac focus or a Choroid plexus cyst, which are usually normal, but can be associated with an increased risk for chromosome abnormalities.

Other screening tests, such as the Quad test, can also have false positives and false negatives. Even when the Quad results are positive (or, to be more precise, when the Quad test yields a score that shows at least a 1 in 270 risk of abnormality), usually the pregnancy is normal, but additional diagnostic tests are offered. In fact, consider that

Down Syndrome affects about 1:400 pregnancies; if you screened 4000 pregnancies with a Quad test, there would probably be 10 Down Syndrome pregnancies of which the Quad test, with its 80% sensitivity, would call 8 of them high-risk. The quad test would also tell 5% (~200) of the 3990 normal women that they are high-risk. Therefore, about 208 women would be told they are high-risk, but when they undergo an invasive test, only 8 (or 4% of the high risk pool) will be confirmed as positive and 200 (96%) will be told that their pregnancies are normal. Since amniocentesis has approximately a 0.5% chance of miscarriage, one of those 200 normal pregnancies might result in a miscarriage because of the invasive procedure. Meanwhile, of the 3792 women told they are low-risk by the Quad test, 2 of them will go on to deliver a baby with Down Syndrome. The Quad test is therefore said to have a 4% positive predictive value (PPV) because only 4% of women who are told they are "high-risk" by the screening test actually have an affected fetus. The other 96% of the women who are told they are "high-risk" needlessly worry until they get the results back from their invasive procedure and find out that their pregnancy is normal.

By comparison, in the same 4000 women, a screening test that has a 99% sensitivity and a 0.5% false positive rate would detect all 10 positives while telling 20 normal women that they are positive. Therefore, 30 women would undergo a confirmatory invasive procedure and 10 of them (33%) would be confirmed as positive and 20 would be told that they have a normal pregnancy. Of the 3970 women told by the screen that they are negative, none of the women would have an affected pregnancy. Therefore, such a screen would have a 33% positive predictive value. It's still unfortunate that 20 false-positive women have had to undergo an invasive procedure to find out they have a normal pregnancy, but it's still better than 200 false-positives with the Quad test.

The real-world false-positive rate for the Quad test (as well as 1st Trimester Combined, Integrated, etc.) is greater than 5%. 5% was the rate quoted in the large clinical studies that were done by the best researchers and physicians, where all the ultrasounds were done by well-trained sonographers and the gestational age of the fetus was calculated as closely as possible. In the real world, where calculating gestational age may be a less precise art, the formulas that generate a patient's risk score are not as accurate and the false-positive rate can be higher, even 10%.

Because of the low accuracy of conventional screening tests, 5-10% of women, often those who are older, will opt for an invasive test even if they received a low-risk score from the screening. A patient who received a 1:330 risk score, while technically low-risk (since the cutoff for high-risk is commonly quoted as 1:270), might be more likely to still opt for a confirmatory invasive test. On the other hand, a patient who receives a 1:1000 risk score is more likely to feel assuaged that her pregnancy is normal.

Both false positives and false negatives will have a large impact on a couple when they are told the result, or when the child is born. Diagnostic tests, such as amniocentesis, are considered to be very accurate for the defects they check for, though even these tests are not perfect, with a reported 0.2% error rate (often due to rare abnormalities such as

mosaic Down Syndrome where only some of the fetal/placental cells carry the genetic abnormality).

A higher maternal serum AFP level indicates a greater risk for anencephaly and open spina bifida. This screening is 80% and 90% sensitive for spina bifida and anencephaly, respectively.

Amniotic fluid acetylcholinesterase and AFP level are more sensitive and specific than AFP in predicting neural tube defects.

Many maternal-fetal specialists do not bother to even do an AFP test on their patients because they do a detail ultrasound on all of them in the 2nd trimester, which has a 97% detection rate for neural tube defects such as anencephaly and open spina bifida.

No prenatal test can detect *all* forms of birth defects and abnormalities.

Societal Pressures on Prenatal Testing Decisions

Amniocentesis has become the standard of care for prenatal care visits for women who are "at risk" or over a certain age. Most obstetricians (depending on the country) offer patients the AFP triple test, HIV test, and ultrasounds routinely. However, almost all women meet with a genetic counselor before deciding whether to have prenatal diagnosis. It is the role of the genetic counselor to accurately inform women of the risks and benefits of prenatal diagnosis. Genetic counselors are trained to be non-directive and to support the patient's decision. Some doctors do advise women to have certain prenatal tests and the patient's partner may also influence the woman's decision.

Informed consent and medical malpractice

Obstetricians have an ethical duty to properly inform patients of their options, specifically the availability of screening and diagnostic testing. Physicians have been successfully sued by women who gave birth to babies with abnormalities that could have been detected had they known about their screening options, though the plaintiff must also prove that she would have elected to terminate the pregnancy in the event of a positive finding. Also, physicians who fail to inform their patients of the risks of amniocentesis and CVS might be found guilty of negligence informed consent in the event that the patient sues after a procedure-related miscarriage or fetal damage.

There is a misconception that a physician only needs to do what other physicians typically do (i.e. standard of care). However, in the case of informed consent, the legal standard is more commonly defined as what a reasonable patient would elect to do if she is informed. So if a reasonable patient would want to be screened if only she is informed or if a reasonable patient would want to receive an amniocentesis if only she is informed of that option, then a physician is legally obligated to inform the patient of these options.

As newer, more accurate screening tests emerge, physicians may need to quickly get up to speed on the most recent data and start informing their patients of the existence of these tests. Failure to inform patients of the available of these more accurate screening tests might result in a wrongful birth or wrongful miscarriage lawsuit if the patient can demonstrate that she would have chosen the newer test, if she had known about it, to avoid the unfortunate outcome that resulted from receiving a conventional screening test or invasive procedure.

Chapter 4

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.

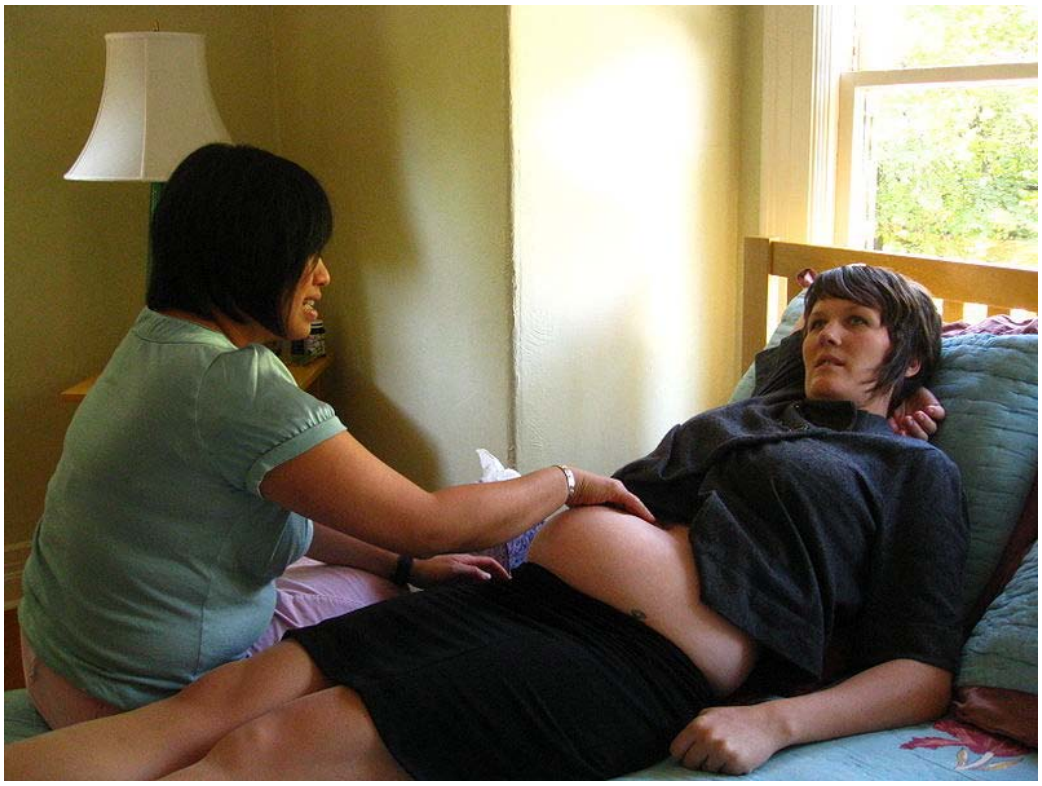
While the benefits of medical ultrasound probably outweigh any risks, vanity uses such as making 3D ultrasound movies without a doctor's order present an obviously

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 5

Midwifery



A midwife measures the height of the mother's fundus at about 26 weeks to determine the probable gestational age of the fetus.

Midwifery is a health care profession in which providers offer care to childbearing women during pregnancy, labour and birth, and during the postpartum period. They also care for the newborn and assist the mother with breastfeeding.

A practitioner of midwifery is known as a **midwife**, a term used in reference to both women and men, although the majority of midwives are female. In addition to providing care to women during pregnancy and birth, many midwives also provide primary care to women, well-woman care related to reproductive health, annual gynecological exams, family planning, and menopausal care.

Midwives are autonomous practitioners who are specialists in low-risk pregnancy, childbirth, and postpartum. They generally strive to help women to have a healthy pregnancy and natural birth experience. Midwives are trained to recognize and deal with deviations from the normal. Obstetricians, in contrast, are specialists in illness related to childbearing and in surgery. The two professions can be complementary, but often are at odds because obstetricians are taught to "actively manage" labor, while midwives are taught not to intervene unless necessary.

Midwives refer women to general practitioners or obstetricians when a pregnant woman requires care beyond the midwives' area of expertise. In many jurisdictions, these professions work together to provide care to childbearing women. In others, only the midwife is available to provide care. Midwives are trained to handle certain situations that may be described as normal variations or may be considered abnormal, including breech births, twin births and births where the baby is in a posterior position, using non-invasive techniques.

Definition

A woman giving birth on a birth chair, from a work by Eucharius Rößlin.

According to the International Confederation of Midwives (a definition that has also been adopted by the World Health Organization and the International Federation of Gynecology and Obstetrics):

A midwife is a person who, having been regularly admitted to a midwifery educational program that is duly recognized in the country in which it is located, has successfully completed the prescribed course of studies in midwifery and has acquired the requisite qualifications to be registered and/or legally licensed to practice midwifery.

The midwife is recognised as a responsible and accountable professional who works in partnership with women to give the necessary support, care and advice during pregnancy, labor and the postpartum period, to conduct births on the midwife's own responsibility and to provide care for the infant. This care includes preventive measures, the promotion of normal birth, the detection of complications in mother and child, accessing of medical or other appropriate assistance and the carrying out of emergency measures.

The midwife has an important task in health counseling and education, not only for the woman, but also within the family and community. This work should involve antenatal education and preparation for parenthood and may extend to women's health, sexual or reproductive health and childcare, and to gain the knowledge to counteract the lack of pain relivers and antiseptics.

A midwife may practice in any setting including in the home, the community, hospitals, clinics or health units.

Etymology

The term *midwife* is derived from Middle English: *mid* = "with" and Old English: *wif* = "woman".

Early historical perspective

In ancient Egypt, midwifery was a recognized female occupation, as attested by the Ebers papyrus which dates from 1900 to 1550 BCE. Five columns of this papyrus deal with obstetrics and gynecology, especially concerning the acceleration of parturition and the birth prognosis of the newborn. The Westcar papyrus, dated to 1700 BCE, includes instructions for calculating the expected date of confinement and describes different styles of birth chairs. Bas reliefs in the royal birth rooms at Luxor and other temples also attest to the heavy presence of midwifery in this culture.

Midwifery in Greco-Roman antiquity covered a wide range of women, including old women who continued folk medical traditions in the villages of the Roman Empire, trained midwives who garnered their knowledge from a variety of sources, and highly trained women who were considered female physicians. However, there were certain characteristics desired in a “good” midwife, as described by the physician Soranus of Ephesus in the 2nd century. He states in his work, *Gynecology*, that “a suitable person

will be literate, with her wits about her, possessed of a good memory, loving work, respectable and generally not unduly handicapped as regards her senses [i.e., sight, smell, hearing], sound of limb, robust, and, according to some people, endowed with long slim fingers and short nails at her fingertips." Soranus also recommends that the midwife be of sympathetic disposition (although she need not have borne a child herself) and that she keep her hands soft for the comfort of both mother and child. Pliny, another physician from this time, valued nobility and a quiet and inconspicuous disposition in a midwife. A woman who possessed this combination of physique, virtue, skill, and education must have been difficult to find in antiquity. Consequently, there appears to have been three "grades" of midwives present in ancient times. The first was technically proficient; the second may have read some of the texts on obstetrics and gynecology; but the third was highly trained and reasonably considered a medical specialist with a concentration in midwifery.

Midwives were known by many different titles in antiquity, ranging from *iatrinē* (Gr. nurse), *maia* (Gr., midwife), *obstetrix* (Lat., obstetrician), and *medica* (Lat., doctor) (. It appears as though midwifery was treated differently in the Eastern end of the Mediterranean basin as opposed to the West. In the East, some women advanced beyond the profession of midwife (*maia*) to that of gynaecologist (*iatros gynaikeios*, translated as *women's doctor*), for which formal training was required. Also, there were some gynecological tracts circulating in the medical and educated circles of the East that were written by women with Greek names, although these women were few in number. Based on these facts, it would appear that midwifery in the East was a respectable profession in which respectable women could earn their livelihoods and enough esteem to publish works read and cited by male physicians. In fact, a number of Roman legal provisions strongly suggest that midwives enjoyed status and remuneration comparable to that of male doctors. One example of such a midwife is Salpe of Lemnos, who wrote on women's diseases and was mentioned several times in the works of Pliny.

However, in the Roman West, our knowledge of practicing midwives comes mainly from funerary epitaphs. Two hypotheses are suggested by looking at a small sample of these epitaphs. The first is the midwifery was not a profession to which freeborn women of families that had enjoyed free status of several generations were attracted; therefore it seems that most midwives were of servile origin. Second, since most of these funeral epitaphs describe the women as freed, it can be proposed that midwives were generally valued enough, and earned enough income, to be able to gain their freedom. It is not known from these epitaphs how certain slave women were selected for training as midwives. Slave girls may have been apprenticed, and it is most likely that mothers taught their daughters.

The actual duties of the midwife in antiquity consisted mainly of assisting in the birthing process, although they may also have helped with other medical problems relating to women when needed. Often, the midwife would call for the assistance of a physician when a more difficult birth was anticipated. In many cases the midwife brought along two or three assistants. In antiquity, it was believed by both midwives and physicians that a normal delivery was made easier when a woman sat upright. Therefore, during

parturition, midwives brought a stool to the home where the delivery was to take place. In the seat of the birthstool was a crescent-shaped hole through which the baby would be delivered. The birthstool or chair often had armrests for the mother to grasp during the delivery. Most birthstools or chairs had backs which the patient could press against, but Soranus suggests that in some cases the chairs were backless and an assistant would stand behind the mother to support her. The midwife sat facing the mother, encouraging and supporting her through the birth, perhaps offering instruction on breathing and pushing, sometimes massaging her vaginal opening, and supporting her perineum during the delivery of the baby. The assistants may have helped by pushing downwards on the top of the mother's abdomen.

Finally, the midwife received the infant, placed it in pieces of cloth, cut the umbilical cord, and cleansed the baby. The child was sprinkled with “fine and powdery salt, or natron or aphronitre” to soak up the birth residue, rinsed, and then powdered and rinsed again. Next, the midwives cleared away any and all mucus present from the nose, mouth, ears, or anus. Midwives were encouraged by Soranus to put olive oil in the baby’s eyes to cleanse away any birth residue, and to place a piece of wool soaked in olive oil over the umbilical cord. After the delivery, the midwife made the initial call on whether or not an infant was healthy and fit to rear. She inspected the newborn for congenital deformities and testing its cry to hear whether or not it was robust and hearty. Ultimately, midwives made a determination about the chances for an infant’s survival and likely recommended that a newborn with any severe deformities be exposed.

A 2nd-century terracotta relief from the Ostian tomb of Scribonia Attice, wife of physician-surgeon M. Ulpius Amerimnus, details a childbirth scene. Scribonia was a midwife and the relief shows her in the midst of a delivery. A patient sits in the birthing chair, gripping the handles and the midwife’s assistant stands behind her providing support. Scribonia sits on a low stool in front of the woman, modestly looking away while also assisting the delivery by dilating and massaging the vagina, as encouraged by Soranus.

The services of a midwife were not inexpensive; this fact that suggests poorer women who could not afford the services of a professional midwife often had to make do with female relatives. Many wealthier families had their own midwives. However, the vast majority of women in the Greco-Roman world very likely received their maternity care from hired midwives. They may have been highly trained or only possessed a rudimentary knowledge of obstetrics. Also, many families had a choice of whether or not they wanted to employ a midwife who practiced the traditional folk medicine or the newer methods of professional parturition. Like a lot of other factors in antiquity, quality gynecological care often depended heavily on the socioeconomic status of the patient.

During the Christian era in Europe, midwives became important to the church due to their role in emergency baptisms, and found themselves regulated by Roman Catholic canon law. In Medieval times, childbirth was considered so deadly that the Christian Church told pregnant women to prepare their shrouds and confess their sins in case of death. The Church pointed to Genesis 3:16 as the basis for pain in childbirth, where Eve's

punishment for her role in disobeying God was that he would "multiply thy sorrows, and thy conceptions: in sorrow shalt thou bring forth children." A popular medieval saying was, "The better the witch; the better the midwife"; to guard against witchcraft, the Church required midwives to be licensed by a bishop and swear an oath not to use magic when assisting women through labour.

Later historical perspective

In the 18th century, a division between surgeons and midwives arose, as medical men began to assert that their modern scientific processes were better for mothers and infants than the folk-medical midwives.

At the outset of the 18th century in England, most babies were caught by a midwife, but by the onset of the 19th century, the majority of those babies born to persons of means had a surgeon involved. A number of excellent full-length studies of this historical shift have been written.

German social scientists Gunnar Heinsohn and Otto Steiger theorize that midwifery became a target of persecution and repression by public authorities because midwives not only possessed highly specialized knowledge and skills regarding assisting birth, but also regarding contraception and abortion. According to Heinsohn and Steiger's theory, the modern state persecuted the midwives as witches in an effort to repopulate the European continent which had suffered severe loss of manpower as a result of the bubonic plague (also known as the black death) which had swept over the continent in waves, starting in 1348.

They thus interpret the witch hunts as attacking midwifery and knowledge about birth control with a demographic goal in mind. Indeed, after the witch hunts, the number of children per mother rose sharply, giving rise to what has been called the "European population explosion" of modern times, producing an enormous youth bulge that enabled Europe to colonize large parts of the rest of the world.

While historians specializing in the history of the witch hunts have generally remained critical of this macroeconomic approach and continue to favor micro level perspectives and explanations, prominent historian of birth control John M. Riddle has expressed agreement.

United States

There are two main divisions of modern midwifery in the US: nurse-midwives and direct-entry midwives.

Nurse-midwives

Two Certified Nurse Midwives from Colorado pose with new mother and her son, born at Presbyterian-St. Lukes Medical Center in Denver.

Nurse-midwives were introduced in the United States in 1925 by Mary Breckinridge for use in the Frontier Nursing Service (FNS). Breckinridge chose the nurse-midwifery model used in England and Scotland because she expected these nurse-midwives on horseback to serve the health care needs of the families living in the remote hills of eastern Kentucky. This combination of nurse and midwife was very successful. The Metropolitan Life Insurance Company studied the first seven years of the service and reported a substantially lower maternal and infant mortality rate than for the rest of the country. The report concluded that if this type of care was available to other women in the U.S., thousands of lives would be saved, and suggested nurse-midwife training should be made available in the U.S. Breckinridge founded the Frontier School of Midwifery and Family Nursing in 1939, the first nurse-midwifery education program in the U.S.

The Frontier School is still educating nurse-midwives and has added distance learning to its methodology. In 1989 the program became the first distance option for nurses to become nurse-midwives without leaving their home communities. The students do their academic work on-line with the Frontier School of Midwifery and Family Nursing faculty members and they do their clinical practice with a nurse-midwife in their

community who is credentialed by Frontier as a clinical faculty member. This community based model has graduated over 1200 nurse-midwives.

In the United States, nurse-midwives are variably licensed depending on the state as advanced practice nurses, midwives or nurse-midwives. Certified Nurse-Midwives are educated in both nursing and midwifery and provide gynecological and midwifery care of relatively healthy women. In addition to licensing, many nurse-midwives have a master's degree in nursing, public health, or midwifery. Nurse-midwives practice in hospitals, medical clinics and private offices and may deliver babies in hospitals, birth centers and at home. They are able to prescribe medications in all 50 states. Nurse-midwives provide care to women from puberty through menopause. Nurse-midwives may work closely with obstetricians, who provide consultation and assistance to patients who develop complications. Often, women with high risk pregnancies can receive the benefits of midwifery care from a nurse-midwife in collaboration with a physician. Currently, 2% of nurse-midwives are men. The American College of Nurse-Midwives accredits nurse-midwifery/midwifery education programs and serves as the national professional society for the nation's certified nurse-midwives and certified midwives. Upon graduation from these programs, graduates sit for a certification exam administered by the American Midwifery Certification Board.

Direct-entry midwives

A direct-entry midwife is educated in the discipline of midwifery in a program or path that does not require prior education as a nurse. Direct-entry midwives learn midwifery through self-study, apprenticeship, a private midwifery school, or a college- or university-based program distinct from the discipline of nursing. A direct-entry midwife is trained to provide the Midwives Model of Care to healthy women and newborns throughout the childbearing cycle primarily in out-of-hospital settings.

Under the umbrella of "direct-entry midwife" are several types of midwives:

A **Certified Professional Midwife** (CPM) is a knowledgeable, skilled and professional independent midwifery practitioner who has met the standards for certification set by the North American Registry of Midwives (NARM) and is qualified to provide the midwives model of care. The CPM is the only US credential that requires knowledge about and experience in out-of-hospital settings. At present, there are approximately 900 CPMs practicing in the US.

A **Licensed Midwife** is a midwife who is licensed to practice in a particular state. Currently, licensure for direct-entry midwives is available in 24 states.

The term **"Lay Midwife"** has been used to designate an uncertified or unlicensed midwife who was educated through informal routes such as self-study or apprenticeship rather than through a formal program. This term does not necessarily mean a low level of education, just that the midwife either chose not to become certified or licensed, or there

was no certification available for her type of education (as was the fact before the Certified Professional Midwife (CPM) credential was available).

The American College of Nurse-Midwives (ACNM) also provides accreditation to non-nurse midwife programs, as well as colleges that graduate nurse-midwives. This credential, called the **Certified Midwife**, is currently recognized in only three states (New York, New Jersey, and Rhode Island). All CMs must pass the same certifying exam administered by the American Midwifery Certification Board for CNMs.

The North American Registry of Midwives (NARM) is a certification agency whose mission is to establish and administer certification for the credential "Certified Professional Midwife" (CPM). The CPM certification process validates entry-level knowledge, skills, and experience vital to responsible midwifery practice. This certification process encompasses multiple educational routes of entry including apprenticeship, self-study, private midwifery schools, college- and university-based midwifery programs, and nurse-midwifery. Created in 1987 by the Midwives' Alliance of North America (MANA), NARM is committed to identifying standards and practices that reflect the excellence and diversity of the independent midwifery community in order to set the standard for North American midwifery.

Practice

Midwives work with women and their families in many different settings. While the vast majority of nurse-midwives work in hospitals, some nurse-midwives and virtually all direct-entry midwives work within the community or home. In many states, midwives form birthing centers where a group of midwives work together. Midwives generally support and encourage natural childbirth in all practice settings. Laws regarding who can practice midwifery and in what circumstances vary from state to state.

United Kingdom

Midwives are practitioners in their own right in the United Kingdom, and take responsibility for the antenatal, intrapartum and postnatal care of women, up until 28 days after the birth, or as required thereafter. Midwives are the lead health care professional attending the majority of births, mostly in a hospital setting, although home birth is a perfectly safe option for many births. There are a variety of routes to qualifying as a midwife. Most midwives now qualify via a direct entry course, which refers to a three- or four-year course undertaken at university that leads to either a degree or a diploma of higher education in midwifery and entitles them to apply for admission to the register. Following completion of nurse training, a nurse may become a registered midwife by completing an eighteen-month post-registration course (leading to a degree qualification), however this route is only available to adult branch nurses, and any child, mental health, or learning disability branch nurse must complete the full three-year course to qualify as a midwife. Midwifery students do not pay tuition fees and are eligible for financial support for living costs while training. Funding varies depending on which country within the UK the student is located and whether they are taking a degree or

diploma course. Midwifery degrees are paid for by the National Health Service (NHS). Some students may also be eligible for NHS bursaries.

All practising midwives must be registered with the Nursing and Midwifery Council and also must have a Supervisor of Midwives through their local supervising authority. Most midwives work within the National Health Service, providing both hospital and community care, but a significant proportion work independently, providing total care for their clients within a community setting. However, recent government proposals to require insurance for all health professionals is threatening independent midwifery in England.

Midwives are at all times responsible for the woman for whom they are caring, to know when to refer complications to medical staff, to act as the woman's advocate, and to ensure the mother retains choice and control over her childbirth experience. Many midwives are opposed to the "medicalisation" of childbirth, preferring a more approach to care, ensuring a satisfactory outcome for mother and baby.

Midwifery training

Midwifery training is considered one of the most challenging and competitive courses amongst other healthcare subjects. Most midwives undergo a 32 month vocational training program, or an 18 month nurse conversion course (on top of the 32 month nurse training course). Thus midwives potentially could have had up to 5 years of total training. Midwifery training consists of classroom based learning provided by select Universities in conjunction with hospital and community based training placements at NHS Trusts.

Midwives may train to be community Health Visitors (as may Nurses).

Community midwives

Many midwives also work in the community. The role of community midwives include the initial appointments with pregnant women, managing clinics, postnatal care in the home, and attending home births.

Canada

Midwifery was reintroduced as a regulated profession in Canada in the 1990s. After several decades of intensive political lobbying by midwives and consumers, fully integrated, regulated and publicly funded midwifery is now part of the health system in the provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Nova Scotia, and in the Northwest Territories and Nunavut. Midwifery legislation has recently been proclaimed in New Brunswick where the government is in the process of integrating midwifery services there. Only Prince Edward Island, Yukon and Newfoundland and Labrador do not have legislation in place for the practice of midwifery.

Midwives in Canada come from a variety of backgrounds including: Aboriginal, post nursing certification, direct-entry and "lay" or traditional midwifery. However, after a process of assessment by the provincial regulatory bodies, registrants are all simply known as 'midwives', 'registered midwives' or by the French-language equivalent, 'sage femme', regardless of their route of training. From the original 'alternative' style of midwifery in the 1960s and 1970s, midwifery practice is offered in a variety of ways within regulated provinces: midwives offer continuity of care within small group practices, choice of birthplace, and a focus on the woman as the primary decision-maker in her maternity care. When women or their newborns experience complications, midwives will work in consultation with an appropriate specialist. Registered midwives have access to appropriate diagnostics like blood tests and ultrasounds and can prescribe a limited schedule of medications. Founding principles of the Canadian model of midwifery include informed choice, choice of birth place, continuity of care from a small group of midwives and respect for the woman as the primary decision maker. Midwives typically have hospital privileges and support women's right to choose where she will have her baby. As fully integrated health care providers, Canada's midwifery homebirth outcomes have been excellent.

Four provinces offer a four year university baccalaureate degree in midwifery. In British Columbia, the program is offered at the University of British Columbia. In Ontario, the Midwifery Education Program (MEP)is offered by a consortium of McMaster University, Ryerson University and Laurentian University. In Manitoba the program is offered by University College of the North, which offers the only degree program exclusively for Aboriginal students; combining education in western and traditional Aboriginal midwifery. In Quebec, the programme is offered at the Université du Québec à Trois-Rivières. In northern Quebec and Nunavut, Inuit women are being educated to be midwives in their own communities. A Bridging program for internationally educated midwives is in place in Ontario at Ryerson University. A federally funded Multi-jurisdictional Midwifery Bridging Program is offered in Western Canada. Regulated provinces and territories admit internationally educated midwives to their regulatory body if they can demonstrate compentency through a Prior Learning and Experience Assessment (PLEA) process.

The legal recognition of midwifery has brought midwives into the mainstream of health care with universal funding for services, hospital privileges, rights to prescribe medications commonly needed during pregnancy, birth and postpartum, and rights to order blood work and ultrasounds for their own clients and full consultation access to physicians. To protect the tenets of midwifery and support midwives to provide woman-centered care, the regulatory bodies and professional associations have legislation and standards in place to provide protection, particularly for choice of birth place, informed choice and continuity of care. All regulated midwives have malpractice insurance. Any unregulated person who provides care with 'restricted acts' in regulated provinces or territories is practicing midwifery without a license and is subject to investigation and prosecution.

Prior to legislative changes, very few Canadian women had access to midwifery care, in part because it was not funded by the health care system. Legalising midwifery has made midwifery services available to a wide and diverse population of women and in many communities the number of available midwives does not meet the growing demand for services. Midwifery services are free to women living in midwifery regulated provinces.

New Zealand

Midwifery regained its status as an autonomous profession in New Zealand in 1990. The *Nurses Amendment Act* restored the professional and legal separation of midwifery from nursing, and established midwifery and nursing as separate and distinct professions. Nearly all midwives gaining registration now are direct entry midwives who have not undertaken any nursing training. Registration requires a Bachelor of Midwifery degree. this is currently a three year full time programme but is in the process of being reviewed by the New Zealand midwifery regulatory authority.

Women must choose one of a midwife, a General Practitioner or an Obstetrician to provide their maternity care. About 78 percent choose a midwife (8 percent GP, 8 percent Obstetrician, 6 percent unknown.). Midwives provide maternity care from early pregnancy to 6 weeks postpartum. The midwifery scope of practise covers normal pregnancy and birth. The midwife will either consult or transfer care where there is a departure from normal. Antenatal and postnatal care is normally provided in the woman's home. Birth can be in the home, a primary birthing unit, or a hospital. Midwifery care is fully funded by the Government. (GP care may be fully funded. Obstetric care will incur a fee in addition to the government funding.)

Netherlands

Midwives are called **vroedvrouw** (female midwives), **vroedmeester** (male midwives), or **verloskundige** (general) in Dutch. Midwives are independent specialists in physiologic birth. In the Netherlands, home birth is still a common practice, although rates have declined during the past decades. In the period of 2005-2008, 29% of babies were delivered at home rather than in a hospital. Midwives are generally organized as private practices, some of those are hospital-based. In-hospital outpatient childbirth is available in most hospitals. In this case, a woman's own midwife delivers the baby at the delivery room of a hospital, without intervention of an obstetrician. In all settings, midwives will transfer care to an obstetrician in case of a complicated childbirth or need for emergency intervention.

Apart from childbirth and immediate postpartum care, midwives are the first line of care in pregnancy control and education of mothers-to-be. Typical information that is given to mothers includes information about food, alcohol, life style, travel, hobbies, sex, etc. Some midwifery practices give additional care in the form of preconceptional care and help with fertility problems.

Education in midwifery is direct entry, i.e. no previous education as a nurse is needed. A 4-year education program can be followed at four colleges, in Groningen, Amsterdam, Rotterdam and Maastricht.

All care by midwives is legal and it is totally reimbursed by all insurance companies. This includes prenatal care, childbirth (by midwives or obstetricians, at home or in the hospital), as well as postpartum/postnatal care for mother and baby at home (*kraamzorg*).

Japan

In Japan, midwifery was first regulated in 1868. Today, midwives must pass a national certification exam. Up until March 1, 2003 only women could be midwives.

Balochistan (Tribal Pakistan)

In Balochistan, midwives are the third most powerful leaders in the community, and the most powerful among women. People say that they give life to a child as the majority of tribal areas have no doctors. Midwives also solve problems between women. If there is a conflict between a man and a woman, the man has more power, and he will go to the tribal chief instead.

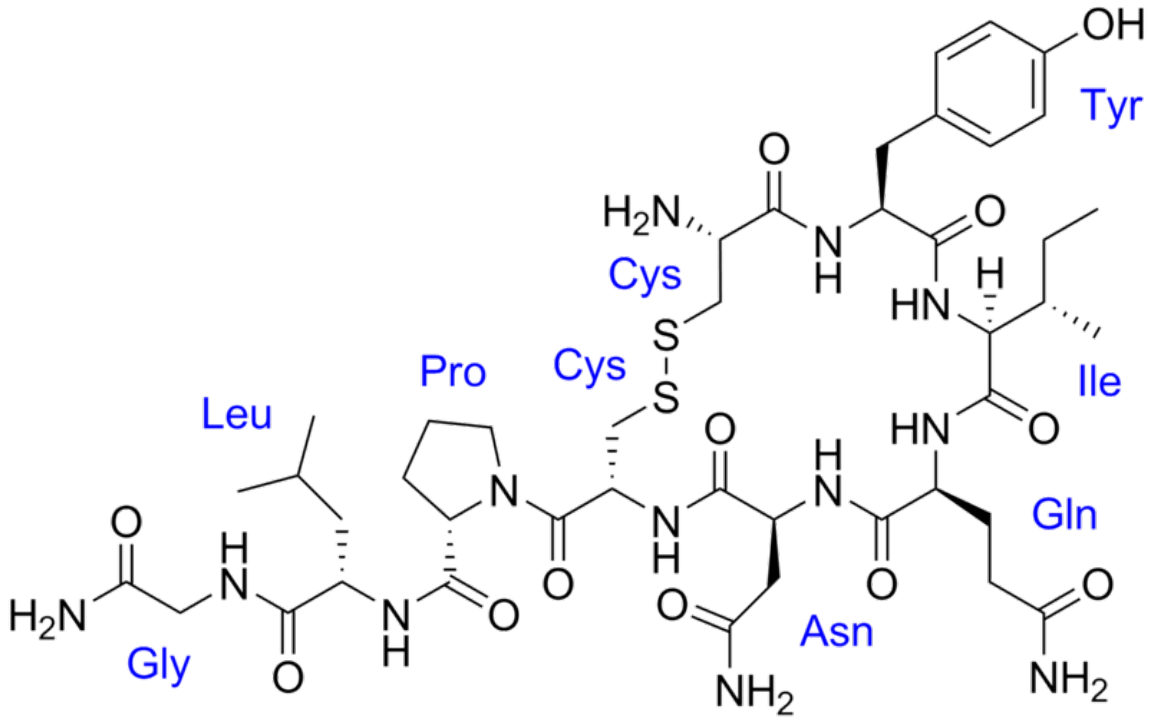
Mozambique

When a 16-year-long civil war ended in 1992, Mozambique's health care system was devastated and one in ten women were dying in childbirth. There were only 18 obstetricians for a population of 19 million. In 2004, Mozambique introduced a new health care initiative to train midwives in emergency obstetric care in an attempt to guarantee access to quality medical care during pregnancy and childbirth. These midwives now perform major surgeries including Cesareans and hysterectomies. As the figures now stand, Mozambique is one of the few countries on track to achieve the United Nations Millennium Development Goal (MDG) of reducing the maternal death rate by 75 percent by 2015.

Chapter 6

Contraction Stress Test and Labor Induction

Contraction stress test



Oxytocin

A **contraction stress test** (CST) is performed near the end of pregnancy to determine how well the fetus will cope with the contractions of childbirth. The aim is to induce contractions and monitor the fetus to check for heart rate abnormalities using a cardiotocograph.

Procedure

Nipple Stimulation

This is a procedure that relies on endogenous release of oxytocin following nipple stimulation, and is conducted by the patient. The nurse instructs the patient on the procedure, as follows. One nipple is massaged gently through clothing until a contraction begins, or for a maximum of 2 minutes. If at least 3 contractions in 10 minutes is not achieved, then the patient rests for 5 minutes and the other nipple is stimulated.

Oxytocin Challenge Test (OCT)

If adequate contractions (at least 3 in 10 minutes) cannot be achieved with nipple stimulation, an oxytocin challenge test may be performed. It involves the intravenous administration of exogenous oxytocin to the pregnant woman. The target is to achieve around three contractions every ten minutes.

Interpretation

***Positive:** presence of late decelerations with at least 50% of the contractions

***Negative:** no late or significant variable decelerations

***Equivocal—Suspicious:** presence of late decelerations with fewer than 50% of contractions) or significant variable decelerations

***Equivocal—Tachysystole:** Presence of contractions that occur more frequently than every 2 minutes or last longer than 90 seconds in the presence of late decelerations

***Equivocal—Unsatisfactory:** Fewer than three contractions occur within 10 minutes, or a tracing quality that cannot be interpreted

Results & Efficacy

The CST is used for its high negative predictive value. A negative result is highly predictive of fetal wellbeing and tolerance of labor. The test has a poor positive predictive value with false-posiive results in as many as 30% of cases.

History

The CST was the first antenatal surveillance test that was developed after the development of the cardiotocograph. The oxytocin challenge test was first described in 1972 and was standardised in 1975 when the parameters of contraction number and frequency were given.

Historically, a CST was done after a non reactive NST. Today, a biophysical profile (BPP) is usually performed.

Contraindications

This "stress test" is usually not performed if there are any signs of premature birth or placenta praevia. Other contraindications include but are not limited to previous uterine incision with scarring, previous myomectomy entering the uterine cavity, PROM and incompetent cervix.

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.

- 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.

Chapter 7

Childbirth

Childbirth (also called **labour**, **birth**, ***partus*** or **parturition**) is the culmination of a human pregnancy or gestation period with the birth of one or more newborn infants from a woman's uterus. The process of normal human childbirth is categorized in three stages of labour: the shortening and dilation of the cervix, descent and birth of the infant, and birth of the placenta. In many cases, with increasing frequency, childbirth is achieved through caesarean section, the removal of the neonate through a surgical incision in the abdomen, rather than through vaginal birth. In the U.S. and Canada it represents nearly 1 in 3 (31.8%) and 1 in 4 (22.5%) of all childbirths, respectively.

Signs and symptoms

Labour is accompanied by intense and prolonged pain. Pain levels reported by labouring women vary widely. Pain levels appear to be influenced by fear and anxiety levels. Some other factors may include experience with prior childbirth, age, ethnicity, preparation, physical environment and immobility.

Psychological

Childbirth can be an intense event and strong emotions, both positive and negative, can be brought to the surface.

While many women experience joy, relief, and elation upon the birth of their child, some women report symptoms compatible with post-traumatic stress disorder (PTSD) after birth. Between 70 and 80% of mothers in the United States report some feelings of sadness or "baby blues" after childbirth. Postpartum depression may develop in some women; about 10% of mothers in the United States are diagnosed with this condition. Abnormal and persistent fear of childbirth is known as tokophobia.

Preventive group therapy has proven effective as a prophylactic treatment for postpartum depression.

Childbirth is stressful for the infant. In addition to the normal stress of leaving the protected uterine environment, additional stresses associated with breech birth, such as asphyxiation, may affect the infant's brain.

Normal human birth

Mechanism of vaginal birth

Because humans are bipedal with an erect stance and have, in relation to the size of the pelvis, the biggest head of any mammalian species, human fetuses and human female pelvises are adapted to make birth possible.

The erect posture causes the weight of the abdominal contents to thrust on the pelvic floor, a complex structure which must not only support this weight but allow three channels to pass through it: the urethra, the vagina and the rectum. The relatively large head and shoulders require a specific sequence of maneuvers to occur for the bony head and shoulders to pass through the bony ring of the pelvis. A failure of these maneuvers results in a longer and more painful labor and can even arrest labor entirely. All changes in the soft tissues of the cervix and the birth canal depend on the successful completion of these six phases:

1. **Engagement** of the fetal head in the transverse position. The baby's head is facing across the pelvis at one or other of the mother's hips.
2. **Descent and flexion** of the fetal head.
3. **Internal rotation**. The fetal head rotates 90 degrees to the occipito-anterior position so that the baby's face is towards the mother's rectum.
4. **Delivery by extension**. The fetal head passes out of the birth canal. Its head is tilted backwards so that its forehead leads the way through the vagina.
5. **Restitution**. The fetal head turns through 45 degrees to restore its normal relationship with the shoulders, which are still at an angle.
6. **External rotation**. The shoulders repeat the corkscrew movements of the head, which can be seen in the final movements of the fetal head.

The fetal head may temporarily change shape substantially (becoming more elongated) as it moves through the birth canal. This change in the shape of the fetal head is called *molding* and is much more prominent in women having their first vaginal delivery.

Latent phase

The latent phase of labor, also called prodromal labor, may last many days and the contractions are an intensification of the Braxton Hicks contractions that may start around 26 weeks gestation. Cervical effacement occurs during the closing weeks of pregnancy and is usually complete or near complete, by the end of the latent phase. Cervical effacement or cervical dilation is the thinning and stretching of the cervix. The degree of cervical effacement may be felt during a vaginal examination. A 'long' cervix implies that not much has been taken into the lower segment, and vice versa for a 'short' cervix. Latent phase ends with the onset of active first stage; when the cervix is about 3 cm dilated.

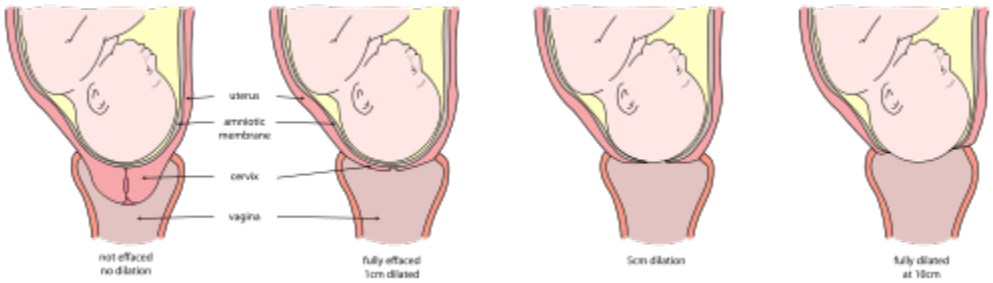
First stage: dilation

There are several factors that midwives and clinicians use to assess the labouring mother's progress, and these are defined by the Bishop Score. The Bishop score is also used as a means to predict whether the mother is likely to spontaneously progress into second stage (delivery).

The first stage of labor starts classically when the effaced (thinned) cervix is 3 cm dilated. There is a variation in this point as some women may have active contractions prior to reaching this point, or they may reach this point without regular contractions. The onset of actual labor is defined when the cervix begins to progressively dilate. Rupture of the membranes, or a blood stained 'show' may or may not occur at or around this stage.

Uterine muscles form opposing spirals from the top of the upper segment of the uterus to its junction with the lower segment. During effacement, the cervix becomes incorporated into the lower segment of the uterus. During a contraction, these muscles contract causing shortening of the upper segment and drawing upwards of the lower segment, in a gradual expulsive motion. This draws the cervix up over the baby's head. Full dilation is reached when the cervix has widened enough to allow passage of the baby's head, around 10 cm dilation for a term baby.

The duration of labour varies widely, but active phase averages some 8 hours for women giving birth to their first child ("primiparae") and 4 hours for women who have already given birth ("multiparae"). Active phase arrest is defined as in a primigravid woman as the failure of the cervix to dilate at a rate of 1.2 cm/hr over a period of at least two hours. This definition is based on Friedman's Curve, which plots an ideal rate of cervical dilation and fetal descent during active labor. Some practitioners may diagnose "Failure to Progress", and consequently, perform an unnecessary Cesarean. However, as is the case with any pre-emptive diagnosis, doing so is severely discouraged due to the extra expense and healing time involved with Cesarean operations.



Sequence of cervix dilation during labor

Second stage: fetal expulsion

This stage begins when the cervix is fully dilated, and ends when the baby is finally born. As pressure on the cervix increases, the Ferguson reflex increases uterine contractions so

that the second stage can go ahead. At the beginning of the normal second stage, the head is fully engaged in the pelvis; the widest diameter of the head has successfully passed through the pelvic brim. Ideally it has successfully also passed below the interspinous diameter. This is the narrowest part of the pelvis. If these have been accomplished, what remains is for the fetal head to pass below the pubic arch and out through the introitus. This is assisted by the additional maternal efforts of "bearing down" or pushing. The fetal head is seen to 'crown' as the labia part. At this point, the woman may feel a burning or stinging sensation.

Birth of the fetal head signals the successful completion of the fourth mechanism of labour (delivery by extension), and is followed by the fifth and sixth mechanisms (restitution and external rotation).

A newborn baby with umbilical cord ready to be clamped

The second stage of labour will vary to some extent, depending on how successfully the preceding tasks have been accomplished.

Third stage: umbilical cord closure and placental expulsion

Breastfeeding during and after the third stage, the placenta is visible in the bowl to the right.

The period from just after the fetus is expelled until just after the placenta is expelled is called the *third stage of labor*.

The umbilical cord is routinely clamped and cut in this stage, but it would normally close naturally even if not clamped. A 2008 Cochrane Review looked into the timing of clamping the umbilical cord. It found that the time of clamping made no difference to the mother, but did have effects for the baby. If the chord is clamped after 2–3 minutes, the infant receives increased amounts of haemoglobin in their first months of life, but may have an increased risk of needing phototherapy to treat jaundice. Sometimes a newborn's liver is slow to break down all of the red cells they had in the womb, particularly if they are left with more fetal blood from delayed cord clamping and phototherapy helps to speed the breakdown.

Placental expulsion begins as a physiological separation from the wall of the uterus. The period from just after the fetus is expelled until just after the placenta is expelled is called the *third stage of labor*. The placenta is usually expelled within 15–30 minutes of the baby being born. Placental expulsion can be managed actively, for example by giving oxytocin via intramuscular injection followed by cord traction to assist in delivering the placenta. Alternatively, it can be managed expectantly, allowing the placenta to be expelled without medical assistance. A Cochrane database study suggests that blood loss

and the risk of postpartum bleeding will be reduced in women offered active management of the third stage of labour.

When the amniotic sac has not ruptured during labour or pushing, the infant can be born with the membranes intact. This is referred to as "being born in the caul." The caul is harmless and its membranes are easily broken and wiped away. With the advent of modern interventive obstetrics, artificial rupture of the membranes has become common, so babies are rarely born in the caul.

Fourth stage

The "fourth stage of labor" is a term used in two different senses:

- It can refer to the immediate puerperium, or the hours immediately after delivery of the placenta.
- It can be used in a more metaphorical sense to describe the weeks following delivery.

Afterwards

Many cultures feature initiation rites for newborns, such as naming ceremonies, baptism, and others.

Mothers are often allowed a period where they are relieved of their normal duties to recover from childbirth. The length of this period varies. In many countries, taking time off from work to care for a newborn is called "maternity leave" or "parental leave" and can vary from a few days to several months.

Station

Refers to the relationship of the fetal presenting part to the level of the ischial spines. When the presenting part is at the ichial spines the station is 0 (synonymous with engagement). If the presenting fetal part is above the spines, the distance is measured and described as minus stations, which range from -1 to -4 cm. If the presenting part is below the ischial spines, the distance is stated as plus stations (+1 to +4 cm). At +3 and +4 the presenting part is at the perineum and can be seen. (Edited by Dr.Avadh Sahi)

Management

Eating or drinking during labour has no harmful effects on outcomes.

Pain control

Non pharmaceutical

Some women prefer to avoid analgesic medication during childbirth. They can still try to alleviate labor pain using psychological preparation, education, massage, hypnosis, or water therapy in a tub or shower. Some women like to have someone to support them during labor and birth, such as the father of the baby, the woman's mother, a sister, a close friend, a partner or a doula. Some women deliver in a squatting or crawling position in order to more effetively push during the second stage and so that gravity can aid the descent of the baby through the birth canal.

The human body also has a chemical response to pain, by releasing endorphins. Endorphins are present before, during, and immediately after childbirth. Some homebirth advocates believe that this hormone can induce feelings of pleasure and euphoria during childbirth, reducing the risk of maternal depression some weeks later.

Water birth is an option chosen by some women for pain relief during labor and childbirth, and some studies have shown waterbirth in an uncomplicated pregnancy to reduce the need for analgesia, without evidence of increased risk to mother or newborn. Hot water tubs are available in many hospitals and birthing centres.

Meditation and mind medicine techniques are also used for pain control during labour and delivery. These techniques are used in conjunction with progressive muscle relaxation and many other forms of relaxation for the mind and body to aid in pain control for women during childbirth. One such technique is the use of hypnosis in childbirth. There are a number of organizations that teach women and their partners to use a variety of techniques to assist with labor comfort, without the use of pharmaceuticals.

A new mode of analgesia is sterile water injection placed just underneath the skin in the most painful spots during labor. A control trial in Iran of 0.5mL injections was conducted with normal saline which revealed a statistical superiority with water over saline.

Pharmaceutical

Different measures for pain control have varying degrees of success and side effects to the woman and her baby. In some countries of Europe, doctors commonly prescribe inhaled nitrous oxide gas for pain control, especially as 50% nitrous oxide, 50% oxygen, known as Entonox; in the UK, midwives may use this gas without a doctor's prescription. Pethidine (with or without promethazine) may be used early in labour, as well as other opioids such as fentanyl, but if given too close to birth there is a risk of respiratory depression in the infant.

Popular medical pain control in hospitals include the regional anesthetics epidural blocks, and spinal anaesthesia. Epidural analgesia is a generally safe and effective method of relieving pain in labour, but is associated with longer labour, more operative intervention (particularly instrument delivery), and increases in cost. Generally, pain and cortisol increased throughout labor in women without EDA. Pain and stress hormones rise throughout labor for women without epidurals, while pain, fear, and stress hormones

decrease upon administration of epidural analgesia, but may rise again later. Medicine administered via epidural can cross the placenta and enter the bloodstream of the fetus. Epidural analgesia has no statistically significant impact on the risk of caesarean section, and does not appear to have an immediate effect on neonatal status as determined by Apgar scores.

Augmentation

Augmentation is a procedure which attempts to speed up the process of labour. Oxytocin has been used to increase the rate of vaginal delivery in those with a slow progress of labor.

Instrumental delivery

Obstetric forceps or ventouse may be used to facilitate childbirth.

- The woman will have her legs supported in stirrups.
- If an anaesthetic is not already in place it will be given.
- Episiotomy might be needed.
- A trial forceps might be performed, which is abandoned in favor of a caesarean section if delivery is not optimal.

Multiple births

Twins can be delivered vaginally. In some cases twin delivery is done in a larger delivery room or in the theatre, just in case complications occur e.g.

- Both twins born vaginally - this can occur both presented head first or where one comes head first and the other is breech and/or helped by a forceps/ventouse delivery
- One twin born vaginally and the other by caesarean section.
- If the twins are joined at any part of the body - called conjoined twins, delivery is mostly by caesarean section.

Support

Baby on warming tray attended to by her father

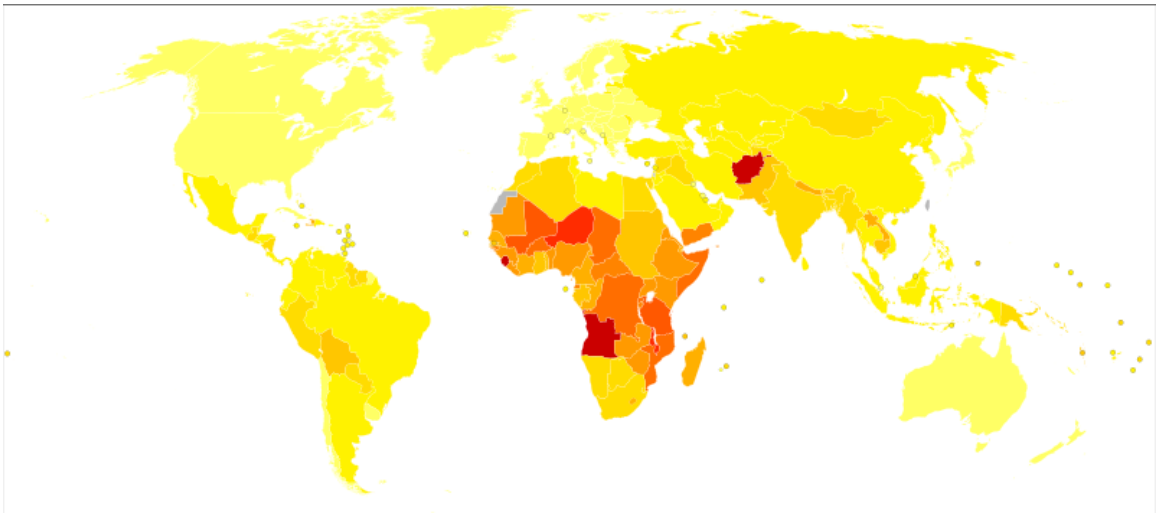
There is increasing evidence to show that the participation of the woman's partner in the birth leads to better birth and also post-birth outcomes, providing the partner does not exhibit excessive anxiety. Research also shows that when a labouring woman was supported by a female helper such as a family member or doula during labour, she had less need for chemical pain relief, the likelihood of caesarean section was reduced, use of forceps and other instrumental deliveries were reduced, there was a reduction in the length of labour, and the baby had a higher Apgar score (Dellman 2004, Vernon 2006). However, little research has been conducted to date about the conflicts between partners, professionals, and the mother.

Collecting stem cells

It is possible to collect two types of stem cells during childbirth: amniotic stem cells or umbilical cord blood stem cells. To collect amniotic stem cells, it is necessary to do amniocentesis before or during the birth. Amniotic stem cells are multipotent and very active, useful for both autologous or donor use. There are private banks in US; the first is Biocell Center in Boston.

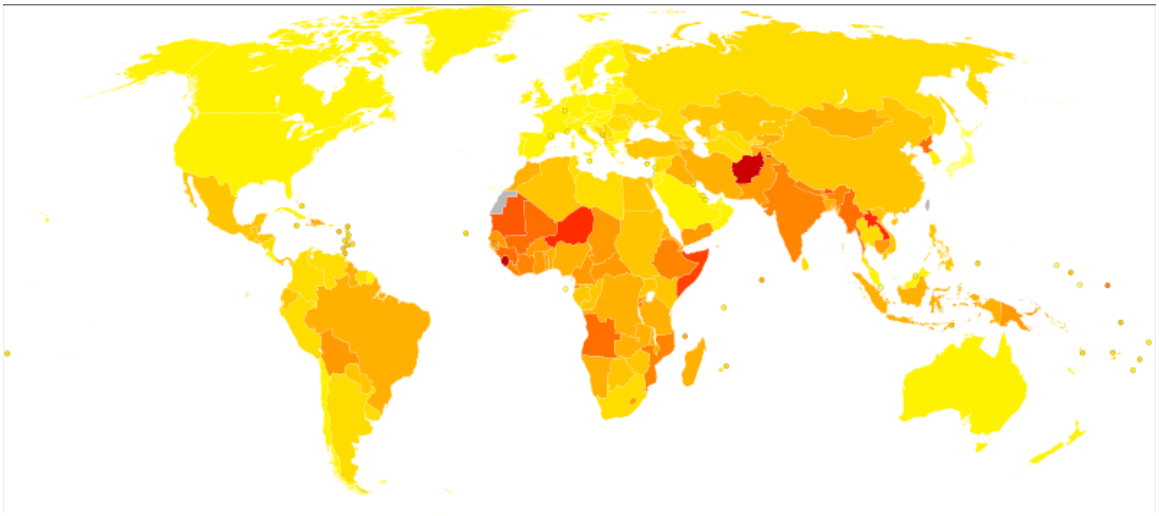
Umbilical cord blood stem cells are also active, but less multipotent than amniotic stem cells. There are a lot of banks of cord blood, both private and public and for autologous or eterologous use.

Complications



Disability-adjusted life year for maternal conditions per 100,000 inhabitants in 2002.

- no data
- less than 100
- 100-400
- 400-800
- 800-1200
- 1200-1600
- 1600-2000
- 2000-2400
- 2400-2800
- 2800-3200
- 3200-3600
- 3600-4000
- more than 4000



Disability-adjusted life year for perinatal conditions per 100,000 inhabitants in 2002.
no data
less than 100
100-400
400-800
800-1200
1200-1600
1600-2000
2000-2400
2400-2800
2800-3200
3200-3600
3600-4000
more than 4000

Childbirth is an inherently dangerous and risky activity, subject to many complications. The "natural" mortality rate of childbirth—where nothing is done to avert maternal death—has been estimated as being 1500 deaths per 100,000 births.. Modern medicine has greatly alleviated the risk of childbirth. In modern Western countries, such as the United States or Sweden, the current maternal mortality rate is around 10 deaths per 100,000 births.

Birthing complications may be maternal or fetal, and long term or short term.

Labor complications

The second stage of labor may be delayed or lengthy due to:

- malpresentation (breech birth (i.e. buttocks or feet first), face, brow, or other)
- failure of descent of the fetal head through the pelvic brim or the interspinous diameter

- poor uterine contraction strength
- active phase arrest
- cephalo-pelvic disproportion (CPD)
- shoulder dystocia

Secondary changes may be observed: swelling of the tissues, maternal exhaustion, fetal heart rate abnormalities. Left untreated, severe complications include death of mother and/or baby, and genitovaginal fistula. These are commonly seen in Third World countries where births are often unattended or attended by poorly trained community members.

Maternal complications

Vaginal birth injury with visible tears or episiotomies are common. Internal tissue tearing as well as nerve damage to the pelvic structures lead in a proportion of women to problems with prolapse, incontinence of stool or urine and sexual dysfunction. Fifteen percent of women become incontinent, to some degree, of stool or urine after normal delivery, this number rising considerably after these women reach menopause. Vaginal birth injury is a necessary, but not sufficient, cause of all non hysterectomy related prolapse in later life. Risk factors for significant vaginal birth injury include:

- A baby weighing more than 9 pounds.
- The use of forceps or vacuum for delivery. These markers are more likely to be signals for other abnormalities as forceps or vacuum are not used in normal deliveries.
- The need to repair large tears after delivery.

Pelvic girdle pain. Hormones and enzymes work together to produce ligamentous relaxation and widening of the symphysis pubis during the last trimester of pregnancy. Most girdle pain occurs before birthing, and is known as diastasis of the pubic symphysis. Predisposing factors for girdle pain include maternal obesity.

Infection remains a major cause of maternal mortality and morbidity in the developing world. The work of Ignaz Semmelweis was seminal in the pathophysiology and treatment of puerperal fever and saved many lives.

Hemorrhage, or heavy blood loss, is still the leading cause of death of birthing mothers in the world today, especially in the developing world. Heavy blood loss leads to hypovolemic shock, insufficient perfusion of vital organs and death if not rapidly treated. Blood transfusion may be life saving. Rare sequelae include Hypopituitarism Sheehan's syndrome.

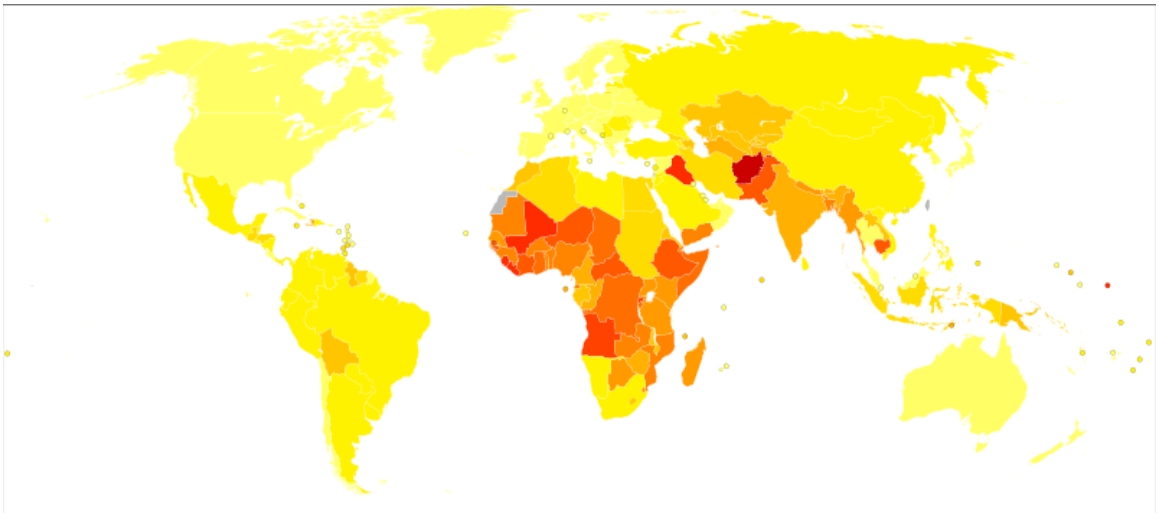
The maternal mortality rate (MMR) varies from 9 per 100,000 live births in the US and Europe to 900 per 100,000 live births in Sub-Saharan Africa. Every year, more than half a million women die in pregnancy or childbirth.

Fetal complications

Mechanical fetal injury

Risk factors for fetal birth injury include fetal macrosomia (big baby), maternal obesity, the need for instrumental delivery, and an inexperienced attendant. Specific situations that can contribute to birth injury include breech presentation and shoulder dystocia. Most fetal birth injuries resolve without long term harm, but brachial plexus injury may lead to Erb's palsy or Klumpke's paralysis.

Neonatal infection



Disability-adjusted life year for neonatal infections and other (perinatal) conditions per 100,000 inhabitants in 2004. Excludes prematurity and low birth weight, birth asphyxia and birth trauma which have their own maps/data.

- no data
- less than 150
- 150-300
- 300-450
- 450-600
- 600-750
- 750-900
- 900-1050
- 1050-1200
- 1200-1350
- 1350-1500
- 1500-1850
- more than 1850

Neonates are prone to infection in the first month of life. Some organisms such as S. agalactiae (Group B Streptococcus) or (GBS) are more prone to cause these occasionally fatal infections. Risk factors for GBS infection include:

- prematurity (birth prior to 37 weeks gestation)
- a sibling who has had a GBS infection
- prolonged labour or rupture of membranes

Untreated sexually transmitted infections are associated with congenital and perinatal infections in neonates, particularly in the areas where rates of infection remain high. The overall perinatal mortality rate associated with untreated syphilis, for example, approached 40%.

Neonatal death

Infant deaths (*neonatal deaths* from birth to 28 days, or *perinatal deaths* if including fetal deaths at 28 weeks gestation and later) are around 1% in modernized countries.

The most important factors affecting mortality in childbirth are adequate nutrition and access to quality medical care ("access" is affected both by the cost of available care, and distance from health services). "Medical care" in this context does not refer specifically to treatment in hospitals, but simply routine prenatal care and the presence, at the birth, of an attendant with birthing skills.

A 1983-1989 study by the Texas Department of State Health Services highlighted the differences in neonatal mortality (NMR) between high risk and low risk pregnancies. NMR was 0.57% for doctor-attended high risk births, and 0.19% for low risk births attended by non-nurse midwives. Conversely, some studies demonstrate a higher perinatal mortality rate with assisted home births. Around 80% of pregnancies are low-risk. Factors that may make a birth high risk include prematurity, high blood pressure, gestational diabetes and a previous cesarean section.

Intrapartum asphyxia

Intrapartum asphyxia is the impairment of the delivery of oxygen to the brain and vital tissues during the progress of labour. This may exist in a pregnancy already impaired by maternal or fetal disease, or may rarely arise *de novo* in labour. This can be termed *fetal distress*, but this term may be emotive and misleading. True intrapartum asphyxia is not as common as previously believed, and is usually accompanied by multiple other symptoms during the immediate period after delivery. Monitoring might show up problems during birthing, but the interpretation and use of monitoring devices is complex and prone to misinterpretation. Intrapartum asphyxia can cause long-term impairment, particularly when this results in tissue damage through encephalopathy.

Professions associated with childbirth

Model of pelvis used in the beginning of the 20th century to teach technical procedures for a successful childbirth. Museum of the History of Medicine, Porto Alegre, Brazil

Childbirth educators are instructors who have certified to educate pregnant women and their partners about the nature of pregnancy, labor signs and stages, techniques for giving birth, breastfeeding and newborn baby care. Classes can be found in hospital settings or through many independent certifying organizations such as Birthing From Within, BirthWorks, Brio Birth, CAPPA, HypBirth, HypnoBabies, HypnoBirthing, ICTC, ICEA, Lamaze, The Bradley Method, etc. Each organization teaches its own standardized curriculum and each emphasizes different techniques. Information about each can be obtained through their individual websites.

Doulas are assistants who support mothers during pregnancy, labour, birth, and postpartum. They are not medical attendants; rather, they provide emotional support and non-medical pain relief for women during labour.

Book about natural childbirth

Midwives provide care to low-risk pregnant mothers. Midwives may be licensed and registered, or may be lay practitioners. Jurisdictions with legislated midwives will typically have a registering and disciplinary body, such as a College of Midwifery. Registered midwives are trained to assist a mother with labour and birth, either through direct-entry or nurse-midwifery programs. Lay midwives, who are usually not licensed or registered, typically gain experience through apprenticeship with other lay midwives.

Medical doctors who practice obstetrics include categorically specialized obstetricians; family practitioners and general practitioners whose training, skills and practices include obstetrics; and in some contexts general surgeons. These physicians and surgeons variously provide care across the whole spectrum of normal and abnormal births and pathological labour conditions. Categorically specialized obstetricians are qualified surgeons, so they can undertake surgical procedures relating to childbirth. Some family practitioners or general practitioners are also privileged to perform obstetrical surgery. Obstetrical procedures include cesarean sections, episiotomies, and assisted delivery. Categorical specialists in obstetrics are commonly dually trained in obstetrics and gynecology (OB/GYN), and may provide other medical and surgical gynecological care, and may incorporate more general, well-woman, primary care elements in their practices. Maternal-fetal medicine specialists are obstetrician/gynecologists subspecialized in managing and treating high-risk pregnancy and delivery.

Obstetric nurses assist midwives, doctors, women, and babies prior to, during, and after the birth process, in the hospital system. Some midwives are also obstetric nurses. Obstetric nurses hold various certifications and typically undergo additional obstetric training in addition to standard nursing training.

Society and culture

Childbirth routinely occurs in hospitals in much of Western society, although prior to the 20th century and in some countries to the present day has more typically occurred at home.[1]

In Western and other cultures, age is reckoned from the date of birth, and sometimes the birthday is celebrated annually. East Asian age reckoning starts newborns at "1", incrementing each Lunar New Year.

Some families view the placenta as a special part of birth, since it has been the child's life support for so many months. Some parents like to see and touch this organ. In some cultures, parents plant a tree along with the placenta on the child's first birthday. The placenta may be eaten by the newborn's family, ceremonially or otherwise (for nutrition; the great majority of animals in fact do this naturally). Most recently there is a category of birth professionals available who will encapsulate placenta for use as placenta medicine by postpartum mothers. The placenta is believed to provide hormones which ease the emotional roller coaster of the postpartum period and even prevent some cases of postpartum depression. The placenta is steamed and then dried in a dehydrator, after which it is made into gel caps that are taken for weeks or months. There is some research showing benefits for milk production in women and other positive studies in animal populations. Anecdotal reports suggest that women say that they suffer less postpartum blues, depression and anxiety using placenta medicine.

Chapter 8

Complications of Pregnancy

Complications of pregnancy	
ICD-10	O00.-O48.
ICD-9	630-648
MeSH	D011248

Complications of pregnancy are the symptoms and problems that are associated with pregnancy. There are both routine problems and serious, even potentially fatal problems. The routine problems are normal complications, and pose no significant danger to either the woman or the fetus. Serious problems can cause both maternal death and fetal death if untreated.

Maternal routine problems

Back pain

- Common, particularly in the third trimester when the patient's center of gravity has shifted.
- *Treatment*: mild exercise, gentle massage, heating pads, paracetamol (acetaminophen), and (in severe cases) muscle relaxants or narcotics

Carpal tunnel syndrome

- Occurs in between an estimated 21% to 62% of cases, possibly due to edema.

Constipation

- *Cause*: decreased bowel motility secondary to elevated progesterone (normal in pregnancy), which can lead to greater absorption of water.
- *Treatment*: increased PO fluids, stool softeners, bulking agents Drinking plenty of water and eating fruit and fiber enriched foods often help

A woman experiencing sudden defecation should report this to her practitioner.

Contractions

- occasional, irregular, painless contractions that occur several times per day are normal and are known as Braxton Hicks contractions
- *Caused by*: dehydration
- *Treatment*: fluid intake
- regular contractions (every 10-15 min) are a sign of preterm labor and should be assessed by cervical exam.

Dehydration

- *Caused by*: expanded intravascular space and increased Third spacing of fluids
- *Treatment*: fluid intake
- *Complication*: uterine contractions, which may occur because dehydration causes body release of ADH, which is similar to oxytocin in structure. Oxytocin itself can cause uterine contractions and thus ADH can cross-react with oxytocin receptors and also cause contractions.

Edema

- *Caused by*: compression of the inferior vena cava (IVC) and pelvic veins by the uterus leads to increased hydrostatic pressure in lower extremities.
- *Treatment*: raising legs above the heart, patient sleeps on her side

Gastroesophageal Reflux Disease (GERD)

- *Caused by*: relaxation of the lower esophageal sphincter (LES) and increased transit time in the stomach (normal in pregnancy)
- *Treatment*: antacids, multiple small meals a day, avoid lying down within an hour of eating, H2 blockers, proton pump inhibitors

Hemorrhoids

- *Caused by*: increased venous stasis and IVC compression leading to congestion in venous system along with increased abdominal pressure secondary to constipation.
- *Treatment*: topical anesthetics, steroids, treatment of constipation

Pica

- cravings for nonedible items such as dirt or clay. Commonly, avoid ice chips; it may worsen anemia

Caused by Iron deficiency which is normal during pregnancy and can be overcome with Iron supplements or prenatal vitamins.

Lower abdominal pain

- *Caused by*: rapid expansion of the uterus and stretching of ligaments such as the round ligament.
- *Treatment*: paracetamol (acetaminophen)

Increased urinary frequency

- *Caused by*: increased intravascular volume, elevated GFR (glomerular filtration rate), and compression of the bladder by the expanding uterus. Patients are advised to continue fluid intake despite this. Urinalysis and culture should be ordered to rule out infection, which can also cause increased urinary frequency but typically is accompanied by dysuria (pain when urinating).

Varicose veins

- *Caused by*: relaxation of the venous smooth muscle and increased intravascular pressure.
- *Treatment*: elevation of the legs, pressure stockings
- relieve swelling and pain with warm sitz bath.
- Avoid obesity, lengthy standing or sitting, constrictive clothing and constipation and bearing down with bowel movements

Diastasis recti or abdominal separation

- *Caused by*: excessive stretching of the abdominal muscles.
- *Treatment*: paliative care, surgery and/or rehabilitation after childbirth

Serious maternal problems

The following problems originate mainly in the mother.

Pelvic girdle pain (PGP)

- *Caused by*: PGP disorder is complex and multi-factorial and likely to be represented by a series of sub-groups with different underlying pain drivers from peripheral or central nervous system, altered laxity/stiffness of muscles, laxity to injury of tendinous/ligamentous structures to 'mal-adaptive' body mechanics. Musculo-Skeletal Mechanics involved in gait and weightbearing activities can be mild to grossly impaired. PGP can begin peri or postpartum. For most women PGP resolves in weeks after delivery but for some it can last for years resulting in a reduced tolerance for weightbearing activities.
- *Treatment*: The degree of treatment is based on the severity. A mild case would require rest, rehabiltation therapy and pain is usually manageable. More severe cases would also include mobility aids, strong analgesics and sometimes surgery.

One of the main factors in helping women cope is with education, information and support. Many treatment options are available.

Severe hypertensive states

Potential severe hypertensive states of pregnancy are mainly:

- Preeclampsia = gestational hypertension, proteinuria (>300 mg), and edema. Severe preeclampsia involves a BP over 160/110 (with additional signs)
- Eclampsia = seizures in a preeclamptic patient
- HELLP syndrome = Hemolytic anemia, Elevated liver enzymes and low platelet count
- Acute fatty liver of pregnancy is sometimes included in the preeclamptic spectrum.

Deep vein thrombosis

Deep vein thrombosis (DVT) has an incidence of 0.5 to 7 per 1,000 pregnancies, and is the second most common cause of maternal death in developed countries after bleeding.

- *Caused by*: Hypercoagulability as a physiological response to potential massive bleeding at childbirth.
- *Treatment*: Prophylactic treatment, e.g. with low molecular weight heparin may be indicated when there are additional risk factors for deep vein thrombosis.

Serious fetal problems

The following problems occur in the fetus or placenta, but may have serious consequences on the mother as well.

Ectopic pregnancy (implantation of the embryo outside the uterus)

- *Caused by*: Unknown, but risk factors include smoking, advanced maternal age, and prior damage to the Fallopian tubes.
- *Treatment*: If there is no spontaneous resolution, the pregnancy must be aborted either surgically or by the drug methotrexate.

Placental abruption (separation of the placenta from the uterus)

- *Caused by*: Various causes; risk factors include maternal hypertension, trauma, and drug use.
- *Treatment*: Immediate delivery if the fetus is mature (36 weeks or older), or if a younger fetus or the mother is in distress. In less severe cases with immature fetuses, the situation may be monitored in hospital, with treatment if necessary.

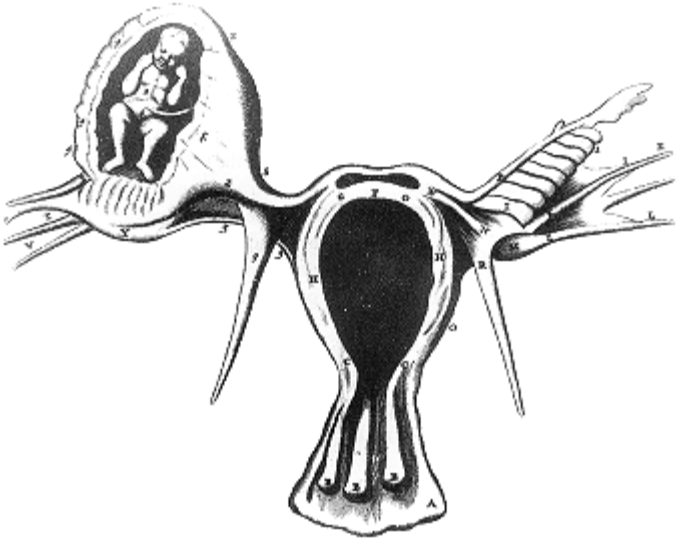
Multiple pregnancies

Multiples may become monochorionic, sharing the same chorion, with resultant risk of twin-to-twin transfusion syndrome. Monochorionic multiples may evenbecome monoamniotic, sharing the same amniotic sac, resulting in risk of umbilical cord compression and entanglement. In very rare cases, there may be conjoined twins, possibly impairing function of internal organs.

Chapter 9

Ectopic Pregnancy

Ectopic pregnancy



Ectopic by Reinier de Graaf

ICD-10	O00.
ICD-9	633
DiseasesDB	4089
MedlinePlus	000895
eMedicine	med/3212 emerg/478 radio/231
MeSH	D011271

An **ectopic pregnancy**, or **eccysis**, is a complication of pregnancy in which the pregnancy implants outside the uterine cavity. With rare exceptions, ectopic pregnancies are not viable. Furthermore, they are dangerous for the mother, internal bleeding being a common complication. Most ectopic pregnancies occur in the Fallopian tube (so-called

tubal pregnancies), but implantation can also occur in the cervix, ovaries, and abdomen. An ectopic pregnancy is a potential medical emergency, and, if not treated properly, can lead to death.

In a normal pregnancy, the fertilized egg enters the uterus and settles into the uterine lining where it has plenty of room to divide and grow. About 1% of pregnancies are in an ectopic location with implantation not occurring inside of the womb, and of these 98% occur in the Fallopian tubes.

Detection of ectopic pregnancy in early gestation has been achieved mainly due to enhanced diagnostic capability. Despite all these notable successes in diagnostics and detection techniques ectopic pregnancy remains a source of serious maternal morbidity and mortality worldwide, especially in countries with poor prenatal care.

In a typical ectopic pregnancy, the embryo adheres to the lining of the fallopian tube and burrows into the tubal lining. Most commonly this invades vessels and will cause bleeding. This intratubal bleeding hematosalpinx expels the implantation out of the tubal end as a tubal abortion. Tubal abortion is a common type of miscarriage. There is no inflammation of the tube in ectopic pregnancy. The pain is caused by prostaglandins released at the implantation site, and by free blood in the peritoneal cavity, which is a local irritant. Sometimes the bleeding might be heavy enough to threaten the health or life of the woman. Usually this degree of bleeding is due to delay in diagnosis, but sometimes, especially if the implantation is in the proximal tube (just before it enters the uterus), it may invade into the nearby Sampson artery, causing heavy bleeding earlier than usual.

If left untreated, about half of ectopic pregnancies will resolve without treatment. These are the tubal abortions. The advent of methotrexate treatment for ectopic pregnancy has reduced the need for surgery; however, surgical intervention is still required in cases where the Fallopian tube has ruptured or is in danger of doing so. This intervention may be laparoscopic or through a larger incision, known as a laparotomy.

Classification

Tubal pregnancy

The vast majority of ectopic pregnancies implant in the Fallopian tube. Pregnancies can grow in the fimbrial end (5% of all ectopics), the ampullary section (80%), the isthmus (12%), and the cornual and interstitial part of the tube (2%). Mortality of a tubal pregnancy at the isthmus or within the uterus (interstitial pregnancy) is higher as there is increased vascularity that may result more likely in sudden major internal hemorrhage. A review published in 2010 supports the hypothesis that tubal ectopic pregnancy is caused by a combination of retention of the embryo within the fallopian tube due to impaired embryo-tubal transport and alterations in the tubal environment allowing early implantation to occur.

Nontubal ectopic pregnancy

Two percent of ectopic pregnancies occur in the ovary, cervix, or are intraabdominal. Transvaginal ultrasound examination is usually able to detect a cervical pregnancy. An ovarian pregnancy is differentiated from a tubal pregnancy by the Spiegelberg criteria.

While a fetus of ectopic pregnancy is typically not viable, very rarely, a live baby has been delivered from an abdominal pregnancy. In such a situation the placenta sits on the intraabdominal organs or the peritoneum and has found sufficient blood supply. This is generally bowel or mesentery, but other sites, such as the renal (kidney), liver or hepatic (liver) artery or even aorta have been described. Support to near viability has occasionally been described, but even in third world countries, the diagnosis is most commonly made at 16 to 20 weeks gestation. Such a fetus would have to be delivered by laparotomy. Maternal morbidity and mortality from extrauterine pregnancy is high as attempts to remove the placenta from the organs to which it is attached usually lead to uncontrollable bleeding from the attachment site. If the organ to which the placenta is attached is removable, such as a section of bowel, then the placenta should be removed together with that organ. This is such a rare occurrence that true data are unavailable and reliance must be made on anecdotal reports. However, the vast majority of abdominal pregnancies require intervention well before fetal viability because of the risk of hemorrhage.

Heterotopic pregnancy

In rare cases of ectopic pregnancy, there may be two fertilized eggs, one outside the uterus and the other inside. This is called a heterotopic pregnancy. Often the intrauterine pregnancy is discovered later than the ectopic, mainly because of the painful emergency nature of ectopic pregnancies. Since ectopic pregnancies are normally discovered and removed very early in the pregnancy, an ultrasound may not find the additional pregnancy inside the uterus. When hCG levels continue to rise after the removal of the ectopic pregnancy, there is the chance that a pregnancy inside the uterus is still viable. This is normally discovered through an ultrasound.

Although rare, heterotopic pregnancies are becoming more common, likely due to increased use of IVF. The survival rate of the uterine fetus of an ectopic pregnancy is around 70%.

Successful pregnancies have been reported from ruptured tubal pregnancy continuing by the placenta implanting on abdominal organs or on the outside of the uterus.

Persistent ectopic pregnancy

A persistent ectopic pregnancy refers to the continuation of trophoplastic growth after a surgical intervention to remove an ectopic pregnancy. After a conservative procedure that attempts to preserve the affected fallopian tube such as a salpingotomy, in about 15-20% the major portion of the ectopic growth may have been removed, but some trophoblastic tissue, perhaps deeply embedded, has escaped removal and continues to grow, generating

a new rise in hCG levels. After weeks this may lead to new clinical symptoms including bleeding. For this reason hCG levels may have to be monitored after removal of an ectopic to assure their decline, also methotrexate can be given at the time of surgery prophyllactically.

Signs and symptoms

Early symptoms are either absent or subtle. Clinical presentation of ectopic pregnancy occurs at a mean of 7.2 weeks after the last normal menstrual period, with a range of 5 to 8 weeks. Later presentations are more common in communities deprived of modern diagnostic ability.

Early signs include:

- Pain in the lower abdomen, and inflammation (Pain may be confused with a strong stomach pain, it may also feel like a strong cramp)
- Pain while urinating
- Pain and discomfort, usually mild. A corpus luteum on the ovary in a normal pregnancy may give very similar symptoms.
- Vaginal bleeding, usually mild. An ectopic pregnancy is usually a failing pregnancy and falling levels of progesterone from the corpus luteum on the ovary cause withdrawal bleeding. This can be indistinguishable from an early miscarriage or the 'implantation bleed' of a normal early pregnancy.
- Pain while having a bowel movement

Patients with a late ectopic pregnancy typically experience pain and bleeding. This bleeding will be both vaginal and internal and has two discrete pathophysiologic mechanisms:

- External bleeding is due to the falling progesterone levels.
- Internal bleeding (hematoperitoneum) is due to hemorrhage from the affected tube.

The differential diagnosis at this point is between miscarriage, ectopic pregnancy, and early normal pregnancy. The presence of a positive pregnancy test virtually rules out pelvic infection as it is rare indeed to find pregnancy with an active Pelvic Inflammatory Disease (PID). The most common misdiagnosis assigned to early ectopic pregnancy is PID.

More severe internal bleeding may cause:

- Lower back, abdominal, or pelvic pain.
- Shoulder pain. This is caused by free blood tracking up the abdominal cavity and irritating the diaphragm, and is an ominous sign.
- There may be cramping or even tenderness on one side of the pelvis.

- The pain is of recent onset, meaning it must be differentiated from cyclical pelvic pain, and is often getting worse.

Ectopic pregnancy can mimic symptoms of other diseases such as appendicitis, other gastrointestinal disorder, problems of the urinary system, as well as pelvic inflammatory disease and other gynaecologic problems.

Causes

There are a number of risk factors for ectopic pregnancies. However, in as many as one third to one half of ectopic pregnancies, no risk factors can be identified. Risk factors include: pelvic inflammatory disease, infertility, use of an intrauterine device (IUD), endometriosis, those who have been exposed to DES, tubal surgery, intrauterine surgery (e.g. D&C), smoking, previous ectopic pregnancy, and tubal ligation.

Cilial damage and tube occlusion

Hair-like cilia located on the internal surface of the Fallopian tubes carry the fertilized egg to the uterus. Fallopian cilia are sometimes seen in reduced numbers subsequent to an ectopic pregnancy, leading to a hypothesis that cilia damage in the Fallopian tubes is likely to lead to an ectopic pregnancy. Women with pelvic inflammatory disease (PID) have a high occurrence of ectopic pregnancy. This results from the build-up of scar tissue in the Fallopian tubes, causing damage to cilia. If however both tubes were completely blocked, so that sperm and egg were physically unable to meet, then fertilization of the egg would naturally be impossible, and neither normal pregnancy nor ectopic pregnancy could occur. Tubal surgery for damaged tubes might remove this protection and increase the risk of ectopic pregnancy. Intrauterine adhesions (IUA) present in Asherman's syndrome can cause ectopic cervical pregnancy or, if adhesions partially block access to the tubes via the ostia, ectopic tubal pregnancy. Asherman's syndrome usually occurs from intrauterine surgery, most commonly after D&C. Endometrial/pelvic/genital tuberculosis, another cause of Asherman's syndrome, can also lead to ectopic pregnancy as infection may lead to tubal adhesions in addition to intrauterine adhesions.

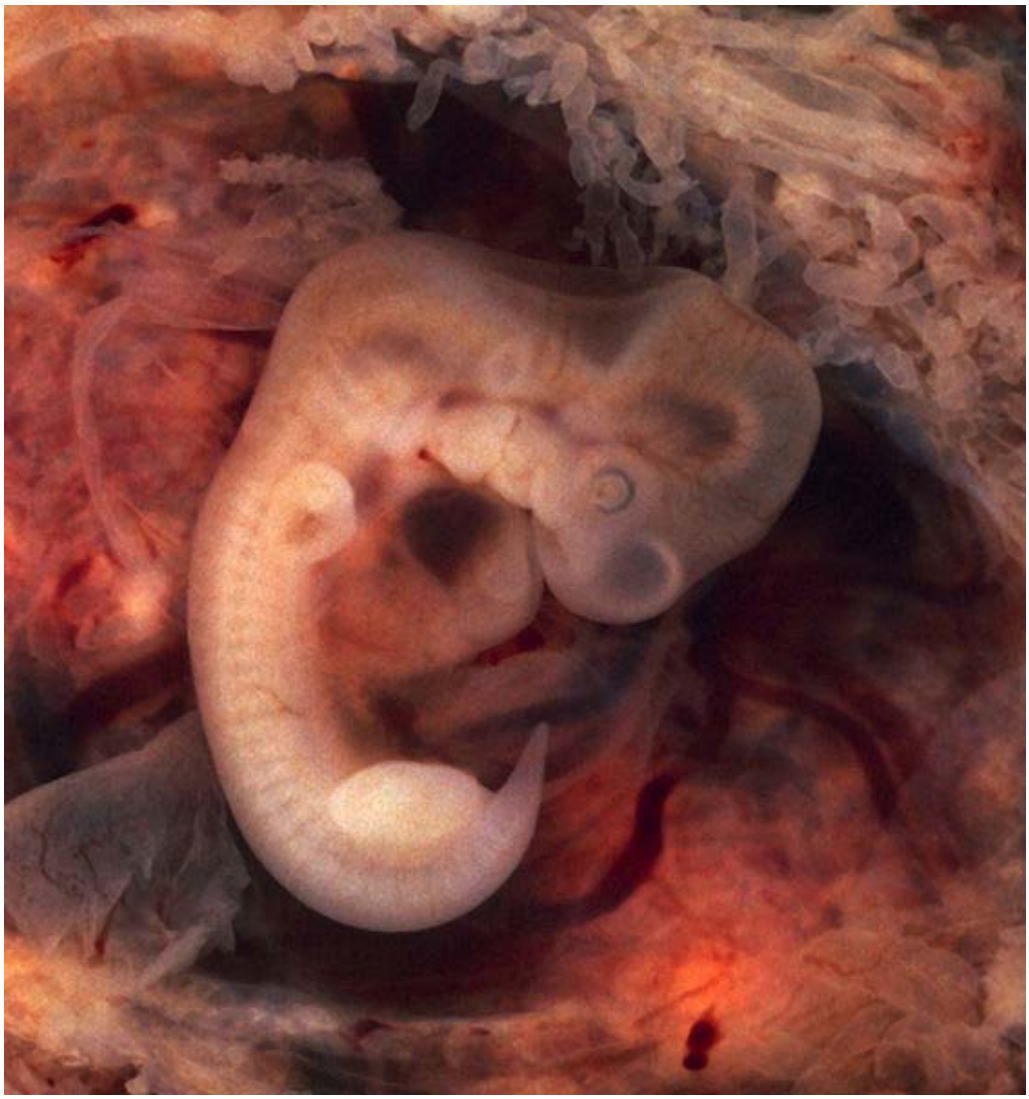
Tubal ligation can predispose to ectopic pregnancy. Seventy percent of pregnancies after tubal cautery are ectopic, while 70% of pregnancies after tubal clips are intrauterine. Reversal of tubal sterilization (Tubal reversal) carries a risk for ectopic pregnancy. This is higher if more destructive methods of tubal ligation (tubal cautery, partial removal of the tubes) have been used than less destructive methods (tubal clipping). A history of a tubal pregnancy increases the risk of future occurrences to about 10%. This risk is not reduced by removing the affected tube, even if the other tube appears normal. The best method for diagnosing this is to do an early ultrasound.

Other

Although some investigations have shown that patients may be at higher risk for ectopic pregnancy with advancing age, it is believed that age is a variable which could act as a

surrogate for other risk factors. Also, it has been noted that smoking is associated with ectopic risk. Vaginal douching is thought by some to increase ectopic pregnancies. Women exposed to diethylstilbestrol (DES) in utero (aka "DES Daughters") also have an elevated risk of ectopic pregnancy, up to 3 times the risk of unexposed women. It has also been suggested that pathologic generation of nitric oxide through increased iNOS production may decrease tubal ciliary beats and smooth muscle contractions and thus affect embryo transport, which may consequently result in ectopic pregnancy.

Diagnosis



An opened oviduct with an ectopic pregnancy at about 7 weeks gestational age

An ectopic pregnancy should be considered in any woman with abdominal pain or vaginal bleeding who has a positive pregnancy test. An ultrasound showing a gestational sac with fetal heart in the fallopian tube is clear evidence of ectopic pregnancy.

An abnormal rise in blood β-human chorionic gonadotropin (β-hCG) levels may indicate an ectopic pregnancy. The threshold of discrimination of intrauterine pregnancy is around 1500 IU/ml of β-hCG. A high resolution, transvaginal ultrasound showing no intrauterine pregnancy is presumptive evidence that an ectopic pregnancy is present if the threshold of discrimination for β-hCG has been reached. An empty uterus with levels higher than 1500 IU/ml may be evidence of an ectopic pregnancy, but may also be consistent with an intrauterine pregnancy which is simply too small to be seen on ultrasound. If the diagnosis is uncertain, it may be necessary to wait a few days and repeat the blood work. This can be done by measuring the β-hCG level approximately 48hrs later and repeating the ultrasound. If the β-hCG falls on repeat examination, this strongly suggests a spontaneous abortion or rupture.

A laparoscopy or laparotomy can also be performed to visually confirm an ectopic pregnancy. Often if a tubal abortion or tubal rupture has occurred, it is difficult to find the pregnancy tissue. A laparoscopy in very early ectopic pregnancy rarely shows a normal looking fallopian tube.

Culdocentesis, in which fluid is retrieved from the space separating the vagina and rectum, is a less commonly performed test that may be used to look for internal bleeding. In this test, a needle is inserted into the space at the very top of the vagina, behind the uterus and in front of the rectum. Any blood or fluid found may have been derived from a ruptured ectopic pregnancy.

Cullen's sign can indicate a ruptured ectopic pregnancy.

Treatment

Medical

Early treatment of an ectopic pregnancy with methotrexate is a viable alternative to surgical treatment since at least 1993. If administered early in the pregnancy, methotrexate terminates the growth of the developing embryo; this may cause an abortion, or the tissue may then be either resorbed by the woman's body or pass with a menstrual period. Contraindications include liver, kidney, or blood disease, as well as an ectopic mass > 3.5 cm.

Surgical

If hemorrhage has already occurred, surgical intervention may be necessary. However, whether to pursue surgical intervention is an often difficult decision in a stable patient with minimal evidence of blood clot on ultrasound.

Surgeons use laparoscopy or laparotomy to gain access to the pelvis and can either incise the affected Fallopian and remove only the pregnancy (salpingostomy) or remove the affected tube with the pregnancy (salpingectomy). The first successful surgery for an ectopic pregnancy was performed by Robert Lawson Tait in 1883.

Complications

The most common complication is rupture with internal haemorrhage which may lead to hypovolaemic shock. Death from rupture is rare in women who have access to modern medical facilities. Infertility occurs in 10 - 15% of women who have had an ectopic pregnancy.

Prognosis

Future fertility

Fertility following ectopic pregnancy depends upon several factors, the most important of which is a prior history of infertility. The treatment choice, whether surgical or nonsurgical, also plays a role. For example, the rate of intrauterine pregnancy may be higher following methotrexate compared to surgical treatment. Rate of fertility may be better following salpingostomy than salpingectomy.

Cases with live birth

There have been cases where ectopic pregnancy lasted many months and ended in a live baby delivered by laparotomy.

On 19 April 2008 an English woman, Jayne Jones (age 37) who had an ectopic pregnancy attached to the omentum, the fatty covering of her large bowel, gave birth. The baby was delivered by a laparotomy at 28 weeks gestation. The surgery, the first of its kind to be performed in the UK, was successful, and both mother and baby survived.

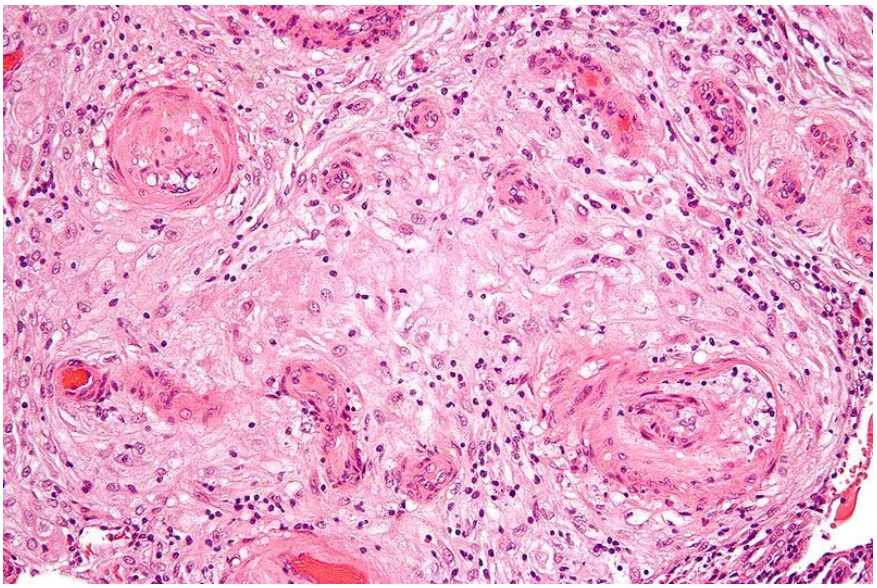
On May 29, 2008 an Australian woman, Meera Thangarajah (age 34), who had an ectopic pregnancy in the ovary, gave birth to a healthy full term 6 pound 3 ounce (2.8 kg) baby girl, Durga, via Caesarean section. She had no problems or complications during the 38-week pregnancy.

The case of Olivia, Mary and Ronan had an extrauterine fetus (Ronan) and intrauterine twins. All three survived. The intrauterine twins were taken out first.

Chapter 10

Pre-Eclampsia

Pre-eclampsia



Micrograph showing hypertrophic decidual vasculopathy, a histomorphologic finding seen in gestational hypertension - a component of preeclampsia. H&E stain.

ICD-10	O11., O13., O14.
ICD-9	642.4-642.7
DiseasesDB	10494
MedlinePlus	000898
eMedicine	med/1905 ped/1885
MeSH	D011225

Pre-eclampsia is a medical condition in which hypertension arises in pregnancy (pregnancy-induced hypertension) in association with significant amounts of protein in the urine.

Pre-eclampsia refers to a set of symptoms rather than any causative factor, and there are many different causes for the condition. It appears likely that there are substances from the placenta that can cause endothelial dysfunction in the maternal blood vessels of susceptible women. While blood pressure elevation is the most visible sign of the disease, it involves generalized damage to the maternal endothelium, kidneys, and liver, with the release of vasoconstrictive factors being secondary to the original damage.

Pre-eclampsia may develop from 20 weeks gestation (it is considered early onset before 32 weeks, which is associated with increased morbidity). Its progress differs among patients; most cases are diagnosed pre-term. Pre-eclampsia may also occur up to six weeks post-partum. Apart from Caesarean section or induction of labor (and therefore delivery of the placenta), there is no known cure. It is the most common of the dangerous pregnancy complications; it may affect both the mother and the unborn child.

Diagnosis

Pre-eclampsia is diagnosed when a pregnant woman develops high blood pressure (two separate readings taken at least 6 hours apart of 140/90 or more) *and* 300 mg of protein in a 24-hour urine sample (proteinuria). A rise in baseline blood pressure (BP) of 30 mmHg systolic or 15 mmHg diastolic, while not meeting the absolute criteria of 140/90, is still considered important to note, but is not considered diagnostic. Swelling or edema (especially in the hands and face) was originally considered an important sign for a diagnosis of pre-eclampsia, but in current medical practice only hypertension and proteinuria are necessary for a diagnosis. Pitting edema (unusual swelling, particularly of the hands, feet, or face, notable by leaving an indentation when pressed on) can be significant, and should be reported to a health care provider.

"Severe preeclampsia" involves a BP over 160/110, and additional symptoms.

Pre-eclampsia may progress to eclampsia, characterized by the appearance of tonic-clonic seizures. This happens only very rarely with proper treatment.

Although eclampsia is potentially fatal, pre-eclampsia is often asymptomatic, and so its detection depends on signs or investigations. Nonetheless, one symptom is crucially important because it is often misinterpreted. The epigastric pain, which reflects hepatic involvement and is typical of the HELLP syndrome, may easily be confused with heartburn, a very common problem of pregnancy. It can be distinguished from heartburn when it is not burning in quality, does not spread upwards towards the throat, is associated with hepatic tenderness, may radiate through to the back, and is not relieved by giving antacids. It is often very severe, described by sufferers as the worst pain they have ever experienced. Affected women are not uncommonly referred to general surgeons as suffering from an acute abdomen (for example, acute cholecystitis).

In general, none of the signs of pre-eclampsia are specific, and even convulsions in pregnancy are more likely to have causes other than eclampsia in modern practice. Diagnosis, therefore, depends on finding a coincidence of several pre-eclamptic features, the final proof being their regression after delivery.

Some women develop high blood pressure without proteinuria (protein in urine), which is called pregnancy-induced hypertension (**PIH**) or gestational hypertension. Both pre-eclampsia and PIH are regarded as very serious conditions and require careful monitoring of mother and fetus.

Epidemiology

Pre-eclampsia occurs in as many as 10% of pregnancies, usually in the second or third trimester and after the 32nd week. Some women will experience pre-eclampsia as early as 20 weeks, though this is rare. It is much more common in women who are pregnant for the first time, and its frequency drops significantly in second pregnancies. While change of paternity in a subsequent pregnancy is now thought to lower risk except in those with a family history of hypertensive pregnancy, since increasing maternal age raises risk, it has been difficult to evaluate how significant paternity change actually is and studies are providing conflicting data on this point.

Pre-eclampsia is also more common in women who have preexisting hypertension, diabetes, autoimmune diseases such as lupus, various inherited thrombophilias such as Factor V Leiden, renal disease, women with a family history of pre-eclampsia, obese women, and women with a multiple gestation (twins or multiple birth). The single most significant risk for developing pre-eclampsia is having had pre-eclampsia in a previous pregnancy.

Pre-eclampsia may also occur in the immediate post-partum period. This is referred to as "postpartum pre-eclampsia". The most dangerous time for the mother is the 24–48 hours postpartum and careful attention should be paid to pre-eclampsia signs and symptoms.

Causes

The pre-eclampsia syndrome is thought in many cases to be caused by a shallowly implanted placenta which becomes hypoxic, leading to an immune reaction characterized by secretion of upregulated inflammatory mediators from the placenta, and acting on the vascular endothelium. The shallow implantation is thought to stem from the maternal immune system's response to the placenta. This theory emphasizes the role of the maternal immune system, and refers to evidence suggesting a lack of established immunological tolerance in pregnancy, resulting in an immune response against paternal antigens from the fetus and its placenta. In some cases of pre-eclampsia it is thought that the mother lacks the receptors for the proteins the placenta is using to downregulate the maternal immune system's response to it. This view is also consistent with evidence showing many miscarriages to be an immunological disorder where the mother's immune system "unleashes a destructive attack on the tissues of the developing child."

In many cases of the pre-eclampsia syndrome, however, the maternal response to the placenta appears to have allowed for normal implantation. It is possible that women with higher baseline levels of inflammation stemming from underlying conditions such as chronic hypertension or autoimmune disease may have less tolerance for the inflammatory burden of pregnancy.

If severe, pre-eclampsia progresses to *fulminant pre-eclampsia,* with headaches, visual disturbances, and epigastric pain, and further to HELLP syndrome and eclampsia. Placental abruption is associated with hypertensive pregnancies. These are life-threatening conditions for both the developing baby and the mother.

Many theories have attempted to explain why pre-eclampsia arises, and have linked the syndrome to the presence of the following:

- endothelial cell injury
- immune rejection of the placenta
- compromised placental perfusion
- altered vascular reactivity
- imbalance between prostacyclin and thromboxane
- decreased glomerular filtration rate with retention of salt and water
- decreased intravascular volume
- increased central nervous system irritability
- disseminated intravascular coagulation
- uterine muscle stretch (ischemia)
- dietary factors, including vitamin deficiency
- genetic factors
- air pollution
- obesity

The current understanding of the syndrome is as a two-stage process, with a highly variable first stage which predisposes the placenta to hypoxia, followed by the release of soluble factors which result in many of the other observed phenomena. Many of the older theories can be subsumed under this umbrella, as the soluble factors have been shown to cause, for example, endothelial cell injury, altered vascular reactivity, the classic lesion of glomerular endotheliosis, decreased intravascular volume, inflammation, etc. Underlying maternal susceptibility to the damage is likely implicated as well.

Pathogenesis

Although much research into the etiology and mechanism of pre-eclampsia has taken place, its exact pathogenesis remains uncertain. Some studies support notions of inadequate blood supply to the placenta making it release particular hormones or chemical agents that, in mothers predisposed to the condition, leads to damage of the endothelium (lining of blood vessels), alterations in metabolism, inflammation, and other possible reactions.

Abnormalities in the maternal immune system and insufficiency of gestational immune tolerance seem to play major roles in pre-eclampsia. One of the main differences found in pre-eclampsia is a shift toward Th_1 responses and the production of IFN-γ. The origin of IFN-γ is not clearly identified and could be the natural killer cells of the uterus, the placental dendritic cells modulating responses of T helper cells, alterations in synthesis of or response to regulatory molecules, or changes in the function of regulatory T cells in pregnancy. Aberrant immune responses promoting pre-eclampsia may also be due to an altered fetal allorecognition or to inflammatory triggers. It has been documented that fetal cells such as fetal erythroblasts as well as cell-free fetal DNA are increased in the maternal circulation in women who develop pre-eclampsia. These findings have given rise to the hypothesis that pre-eclampsia is a disease process by which a placental lesion such as hypoxia allows increased fetal material into maternal circulation that leads to an immune response and endothelial damage ultimately resulting in pre-eclampsia and eclampsia.

Some studies suggest that hypoxia resulting from inadequate perfusion upregulates sFlt-1, a VEGF and PlGF antagonist, leading to a damaged maternal endothelium and restriction of placental growth. In addition, endoglin, a TGF-beta antagonist, is elevated in pregnant women who develop pre-eclampsia. Soluble endoglin is likely upregulated by the placenta in response to an upregulation of cell-surface endoglin produced by the maternal immune system, although there is also the potential that sEng is produced by the maternal endothelium. Levels of both sFlt-1 and sEng increase as severity of disease increases, with levels of sEng surpassing levels of sFlt-1 in HELLP syndrome cases. Recent data indicate that Gadd45a stress signaling regulates elevated sFlt-1 expression in pre-eclampsia.

Both sFlt-1 and sEng are upregulated in all pregnant women to some extent, supporting the idea that hypertensive disease in pregnancy is a normal pregnancy adaptation gone awry. As natural killer cells are intimately involved in placentation and as placentation involves a degree of maternal immune tolerance for a foreign placenta which requires maternal resources for its support, it is not surprising that the maternal immune system might respond more negatively to the arrival of some placentae under certain circumstances, such as a placenta which is more invasive than normal. Initial maternal rejection of the placental cytotrophoblasts may be the cause of the inadequately remodeled spiral arteries in those cases of pre-eclampsia associated with shallow implantation, leading to downstream hypoxia and the appearance of maternal symptoms in response to upregulated sFlt-1 and sEng.

Differential diagnosis

Pre-eclampsia-eclampsia can mimic and be confused with many other diseases, including chronic hypertension, chronic renal disease, primary seizure disorders, gallbladder and pancreatic disease, immune or thrombotic thrombocytopenic purpura, antiphospholipid syndrome and hemolytic-uremic syndrome. It must always be considered a possibility in any pregnant woman beyond 20 weeks of gestation. It is particularly difficult to diagnose when preexisting disease such as hypertension is present.

Complications

Eclampsia can occur after the onset of pre-eclampsia. Eclampsia, which is a more serious condition, complicates 1 in 2000 maternities in the United Kingdom and carries a maternal mortality of 1.8 percent. The HELLP syndrome is more common, probably about 1 in 500 maternities, but may be as dangerous as eclampsia itself. These two major maternal crises can present unheralded by prodromal signs of pre-eclampsia.

Cerebral hemorrhage is a lesion that can kill with pre-eclampsia or eclampsia. In that cerebral hemorrhage is a known complication of severe hypertension in other contexts, it must be assumed that this is a major predisposing factor in this situation, although this has not been proven. Adult respiratory distress syndrome appears to have become more common, it is not known whether this is a consequence of modern methods of respiratory support rather than of the disease itself.

Uric acid levels may help to predict maternal complications among patients with pre-eclampsia according to a systematic review and decision analysis. In this study, the sensitivity was 68% and specificity was 68%. In this study which assumed a prevalence of maternal complications was 5%, the positive predictive value of 6.2% and negative predictive value of 98.6% (click here to adjust these results for patients at higher or lower risk of maternal complications). In their clinical decision analysis, they presumed initially a distress ratio of 10 (defined as being the expected distress of severe complications valued as 10 times worse than the expected distress of a caesarean section), and under these assumptions, they concluded that there would be the least expected distress from using serum uric acid for clinical decision making. The writers of this study acknowledged that there were significant limitations to their review due to heterogeneity of the individual studies they examined with regards to several variables.

Treatment and prevention

The only known treatments for eclampsia or advancing pre-eclampsia are abortion or delivery, either by labor induction or Caesarean section. However, post-partum pre-eclampsia may occur up to 6 weeks following delivery even if symptoms were not present during the pregnancy. Post-partum pre-eclampsia is dangerous to the health of the mother since she may ignore or dismiss symptoms as simple post-delivery headaches and edema. Hypertension can sometimes be controlled with anti-hypertensive medication, but any effect this might have on the progress of the underlying disease is unknown.

Women with underlying inflammatory disorders such as chronic hypertension or autoimmune diseases would likely benefit from aggressive treatment of those conditions prior to conception, tamping down the overactive immune system.

Thrombophilias may be weakly linked to pre-eclampsia. There are no high quality studies to suggest that blood thinners will prevent pre-eclampsia in thrombophilic women.

Smoking may reduce risk of pre-eclampsia (although this association was not significant when other patient factors are taken into account) (though smoking is discouraged in pregnancy in general.)

Antihypertensive therapy

Antihypertensives may reduce maternal and fetal mortality among pregnancy patients with hypertension as compared to placebo according to a randomized controlled trial . Overall, after three weeks of treatment, MAP was lower in the isradipine group, but when compared with the placebo group, the difference in MAP did not have statistical significance. After treatment with isradipine, those patients with no proteinuria experienced a decrease of between 8.5 and 11.3 mmHg, whereas those with proteinuria experienced about only 1 mmHg difference in systolic blood pressure. Those treated with placebo in both groups did not experience much change in systolic blood pressure, regardless of proteinuria being present or not. Therefore, the authors concluded proteinuric patients may respond differently from nonproteinuric patients to this treatment, where the nonproteinuric patients responded the most to treatment with isradipine.

Labetolol or Nicardipine are also often times the antihypertensives of choice for eclampsia or pre-eclampsia according to the CHEST 2007 study. Especially Labetolol as it has little placental transfer.

Magnesium sulfate

In some cases, women with pre-eclampsia or eclampsia can be stabilized temporarily with magnesium sulfate intravenously to forestall seizures while steroid injections are administered to promote fetal lung maturation. Magnesium sulfate as a possible treatment was considered at least as far back as 1955, but only in recent years did its use in the UK replace the use of diazepam or phenytoin. Evidence for the use of magnesium sulfate came from the international MAGPIE study. When induced delivery needs to take place before 37 weeks gestation, it is accepted that there are additional risks to the baby from premature birth that will require additional monitoring and care.

Dietary and nutritional factors

Studies of protein/calorie supplementation have found no effect on pre-eclampsia rates, and dietary protein restriction does not appear to increase pre-eclampsia rates. No mechanism by which protein or calorie intake would affect either placentation or inflammation has been proposed.

Studies conducted on the effect of supplementation with antioxidants such as vitamin C and E found no change in pre-eclampsia rates. However, Drs. Padayatty and Levine with the NIH criticized the studies for overlooking several key factors that would have been important to the success of the supplementation.

Low levels of vitamin D may be a risk factor for pre-eclampsia, and calcium supplementation in women with low-calcium diets found no change in preeclampsia rates but did find a decrease in the rate of severe preeclamptic complications. Low selenium status is associated with higher incidence of pre-eclampsia. Some other vitamin may also play a role.

Aspirin supplementation

Aspirin supplementation is still being evaluated as to dosage, timing, and population and may provide a slight preventative benefit in some women; however, significant research has been done on aspirin and the results thus far are unimpressive.

Exercise

There is insufficient evidence to recommend either exercise or bedrest as preventative measures.

Induction of paternal tolerance

Many studies have also suggested the importance of a woman's immunological tolerance to her baby's father, whose genes are present in the young fetus and its placenta and which may pose a challenge to her immune system. As the theory is further investigated, researchers are increasingly studying the importance of a woman's continued exposure to her partner's semen as early as several years before conception. One study published in the American Journal of Obstetrics and Gynecology involved several hundreds of women and found that "women with a short period of cohabitation (less than 4 months) who used barrier methods for contraception had a substantially elevated risk for the development of pre-eclampsia compared with women with more than 12 months of cohabitation before conception". However, the results from a study conducted in 2004 show that the theory is still not conclusive. In that study, the researchers found that after adjustment and stratification, the effect of barrier contraceptive use on the development of pre-eclampsia had disappeared, with both arms having identical rates of pre-eclampsia. Although the study has since then been criticized for its subjective adjustment of data, it remains important because it demonstrates that there is still some contention over the degree to which failure of tolerance induction can be attributed to prior exposure to the partner's sperm.

Continued exposure to a partner's semen has a strong protective effect against pre-eclampsia, largely due to the absorption of several immune modulating factors present in seminal fluid.

Long periods of sexual cohabitation with the same partner fathering a woman's child significantly decreased her chances of suffering pre-eclampsia. As one early study described, "although preeclampsia is a disease of first pregnancies, the protective effect of multiparity is lost with change of partner". The study also concluded that although women with changing partners are strongly advised to use condoms to prevent sexually

transmitted diseases, "a certain period of sperm exposure within a stable relation, when pregnancy is aimed for, is associated with protection against preeclampsia".

Several other studies have since investigated the strongly decreased incidence of pre-eclampsia in women who had received blood transfusions from their partner, those with long, preceding histories of sex without barrier contraceptives, and in women who had been regularly performing oral sex, with one study concluding "induction of allogeneic tolerance to the paternal human leukocyte antigen (HLA) molecules of the fetus may be crucial. Data collected strongly suggest that exposure, and especially oral exposure to soluble HLA from semen can lead to transplantation tolerance."

Other studies have investigated the roles of semen in the female reproductive tracts of mice, showing that "insemination elicits inflammatory changes in female reproductive tissues", concluding that the changes "likely lead to immunological priming to paternal antigens or influence pregnancy outcomes". A similar series of studies confirmed the importance of immune modulation in female mice through the absorption of specific immune factors in semen, including TGF-Beta, lack of which is also being investigated as a cause of miscarriage in women and infertility in men.

According to the theory, the fetus and placenta both contain "foreign" proteins from paternal genes, but regular, preceding and coincident exposure to the father's semen may promote immune acceptance and subsequent implantation, a process which is significantly supported by as many as 93 currently identified immune regulating factors in seminal fluid.

Having already noted the importance of a woman's immunological tolerance to her baby's paternal genes, several Dutch reproductive biologists decided to take their research a step further. Consistent with the fact that human immune systems tolerate things better when they enter the body via the mouth, the Dutch researchers conducted a series of studies that confirmed a surprisingly strong correlation between a diminished incidence of pre-eclampsia and a woman's practice of oral sex, and noted that the protective effects were strongest if she swallowed her partner's semen. The researchers concluded that while any exposure to a partner's semen during sexual activity appears to decrease a woman's chances for the various immunological disorders that can occur during pregnancy, immunological tolerance could be most quickly established through oral introduction and gastrointestinal absorption of semen. Recognizing that some of the studies potentially included the presence of confounding factors, such as the possibility that women who regularly perform oral sex and swallow semen also engage in more frequent intercourse, the researchers also noted that, either way, "the data still overwhelmingly supports the main theory" behind all their studies—that repeated exposure to semen establishes the maternal immunological tolerance necessary for a safe and successful pregnancy.

A team from the University of Adelaide has also investigated to see if men who have fathered pregnancies which have ended in miscarriage or pre-eclampsia had low seminal levels of critical immune modulating factors such as TGF-Beta. The team has found that certain men, dubbed "dangerous males", are several times more likely to father

pregnancies that would end in either pre-eclampsia or miscarriage. Among other things, most of the "dangerous males" seemed to lack sufficient levels of the seminal immune factors necessary to induce immunological tolerance in their partners.

Administration of immune factors

As the theory of immune intolerance as a cause of pre-eclampsia has become accepted, women who suffer repeated pre-eclampsia, miscarriages, or In Vitro Fertilization failures could potentially be administered key immune factors such as TGF-beta along with the father's foreign proteins, possibly either orally, as a sublingual spray, or as a vaginal gel to be applied onto the vaginal wall before intercourse.

In 2006, researchers at the University of Adelaide developed a gel containing TGF-Beta for use in human populations. Later, GroPep, the company which was awarded the patent on a TGF-Beta3 variant, conducted trials where the miscarriage rate was halved in the mice studied. According to a GroPep news release later published, "a faulty immune response is implicated in the etiology of as many as 50% of all miscarriages." Their drug, PV903, was "targeted to treat recurrent miscarriages caused by an abnormal immune response to the foetus, a condition for which there is no current [drug] treatment." Stage I clinical trials of their vaginal gel were partly successful, succeeding in establishing the safety of the drug, but failing in their aim of increasing the number of specific immune cells measured in circulation, the necessary condition for affecting a desired immunological desensitization. The trials were later criticized for failing to recognize the synergistic effects of a large variety of immune factors naturally present in seminal fluid, which, acting together and with the localized presence of the foreign paternal proteins, modulate the female immune response so as to allow for implantation, and then the subsequent immune acceptance of the (foreign) fetus throughout a successful pregnancy. GroPep was later acquired by the biotechnology giant, Novozymes. The development of the PV903 drug has since then been placed on hold.

Chapter 11

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.

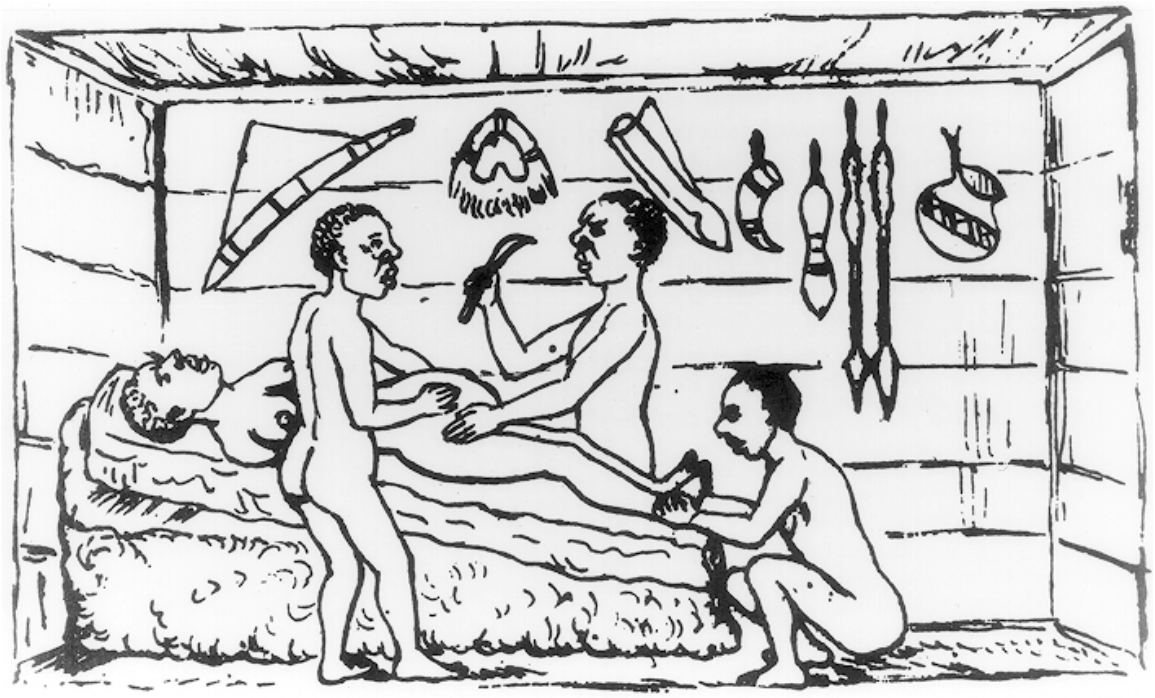
Some link with the Roman dictator Julius Caesar, or with Roman Emperors generally, exists in other languages as well. For example, the modern German, Danish, Dutch and Hungarian terms are respectively *Kaiserschnitt*, *kejsersnit*, *keizersnede*, and *császármetszés* (literally: "Emperor's cut"). The 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.

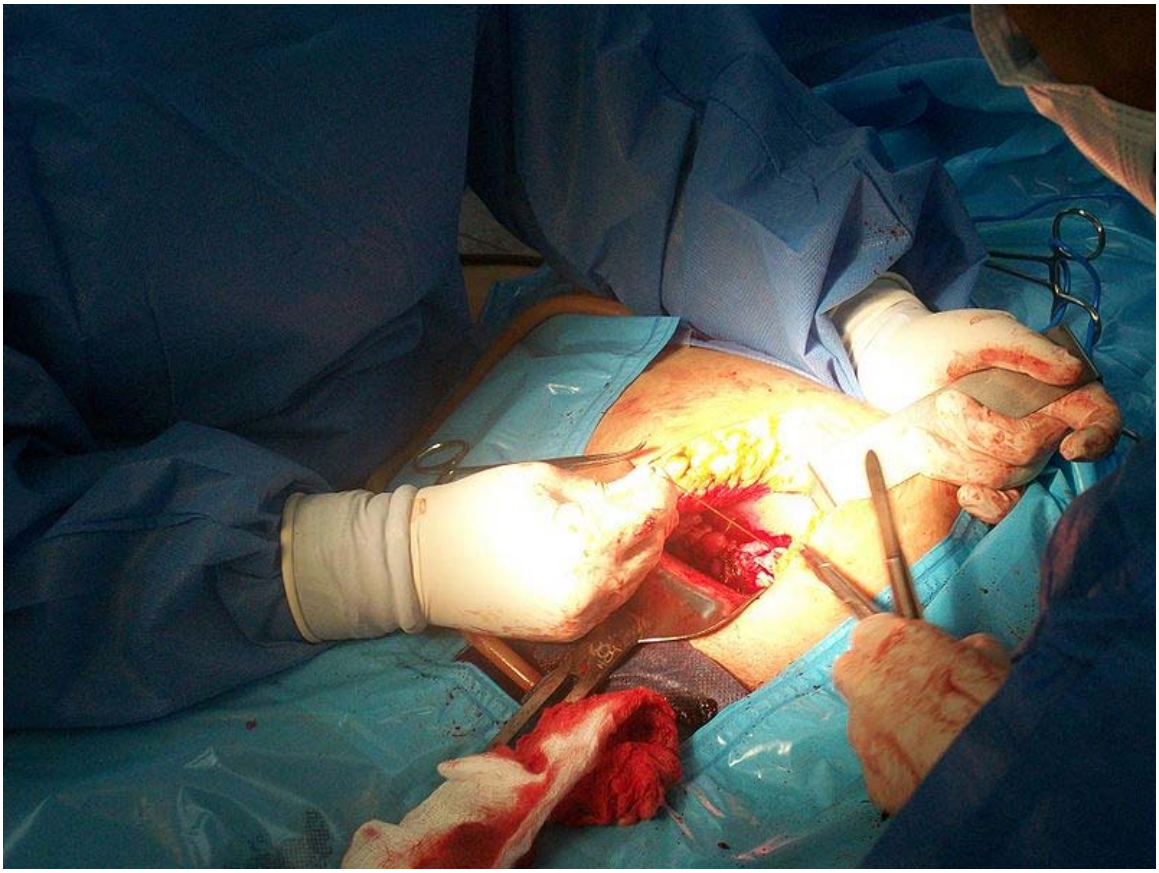
On March 5, 2000, Inés Ramírez performed a Caesarean section on herself and survived, as did her son, Orlando Ruiz Ramírez. She is believed to be the only woman to have performed a successful Caesarean section on herself.

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

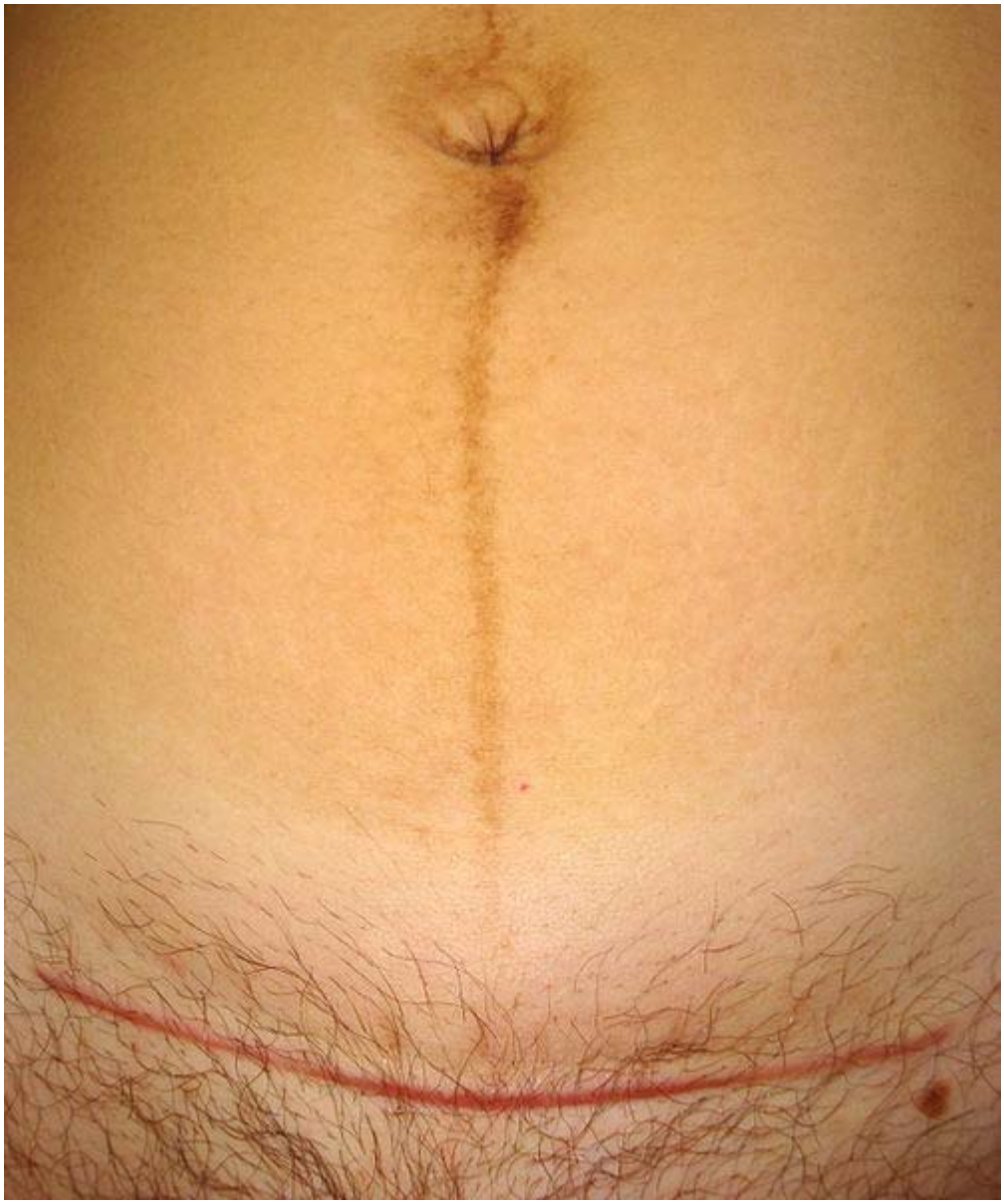
Closed Incision for *low transverse abdominal incision* after stapling has been completed

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 12

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.

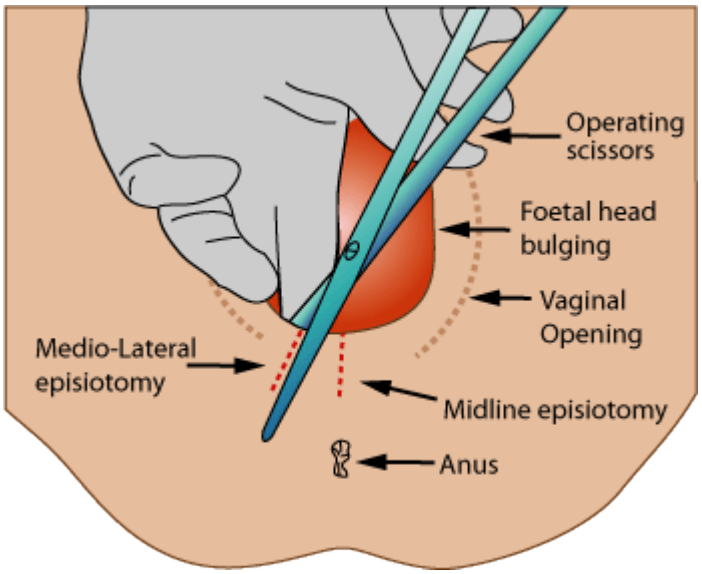
In 1981, the first human open fetal surgery in the world was performed at University of California, San Francisco under the direction of Dr. Michael Harrison. The fetus in question had a congenital hydronephrosis, a blockage in the urinary tract that caused the bladder to dangerously extend. To correct 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 13

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%.

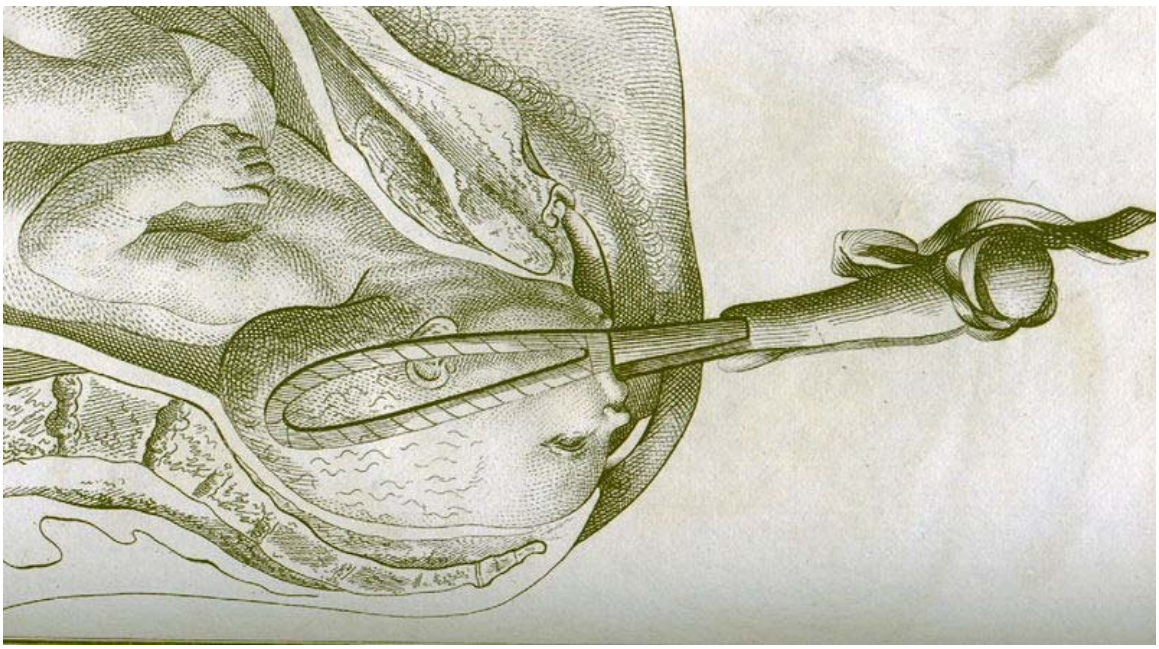
A perineal dilator can be used to stretch the perineal tissue gradually and train it in preparation for first births. The "Epi-no Birth Trainer" consists of a small inflatable silicone balloon pumped with the same pump as a sphygmomanometer. The Epi-no device has been shown to reduce perineal damage 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 14

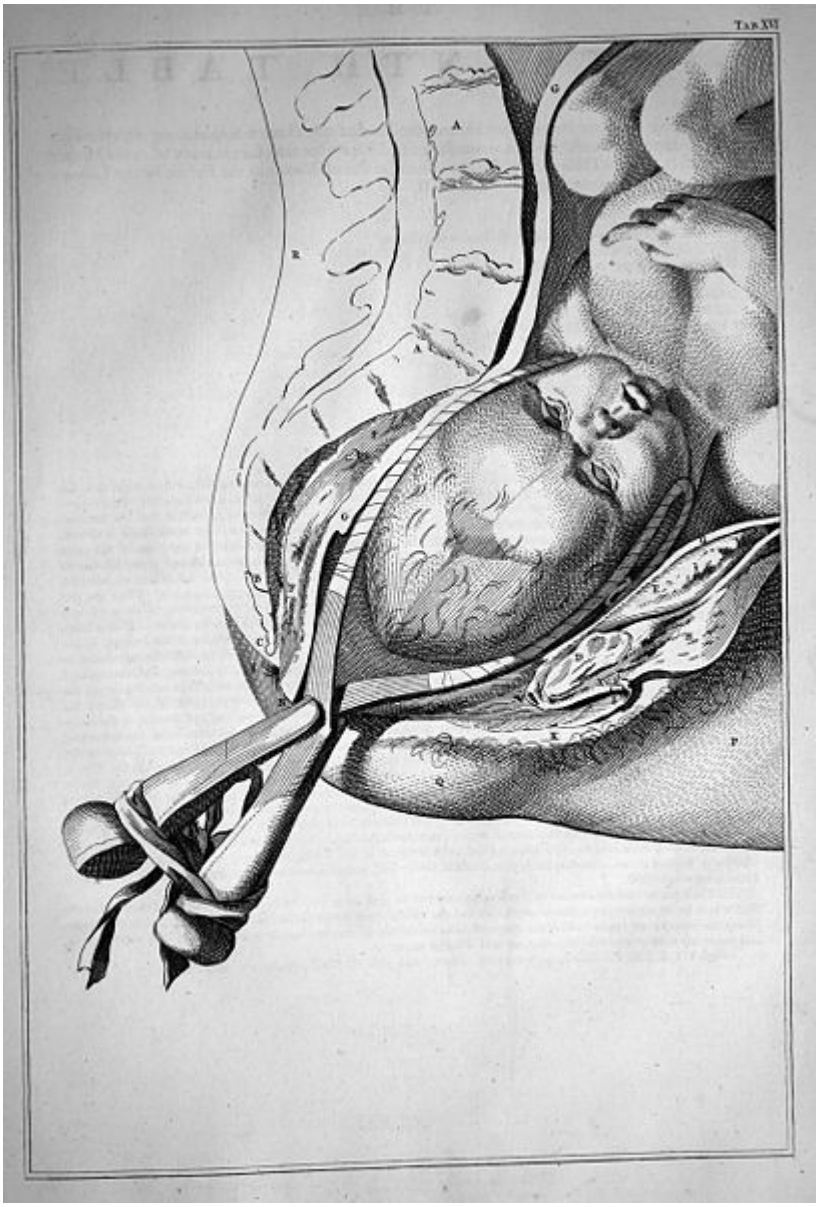
Forceps in Childbirth and Ventouse

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

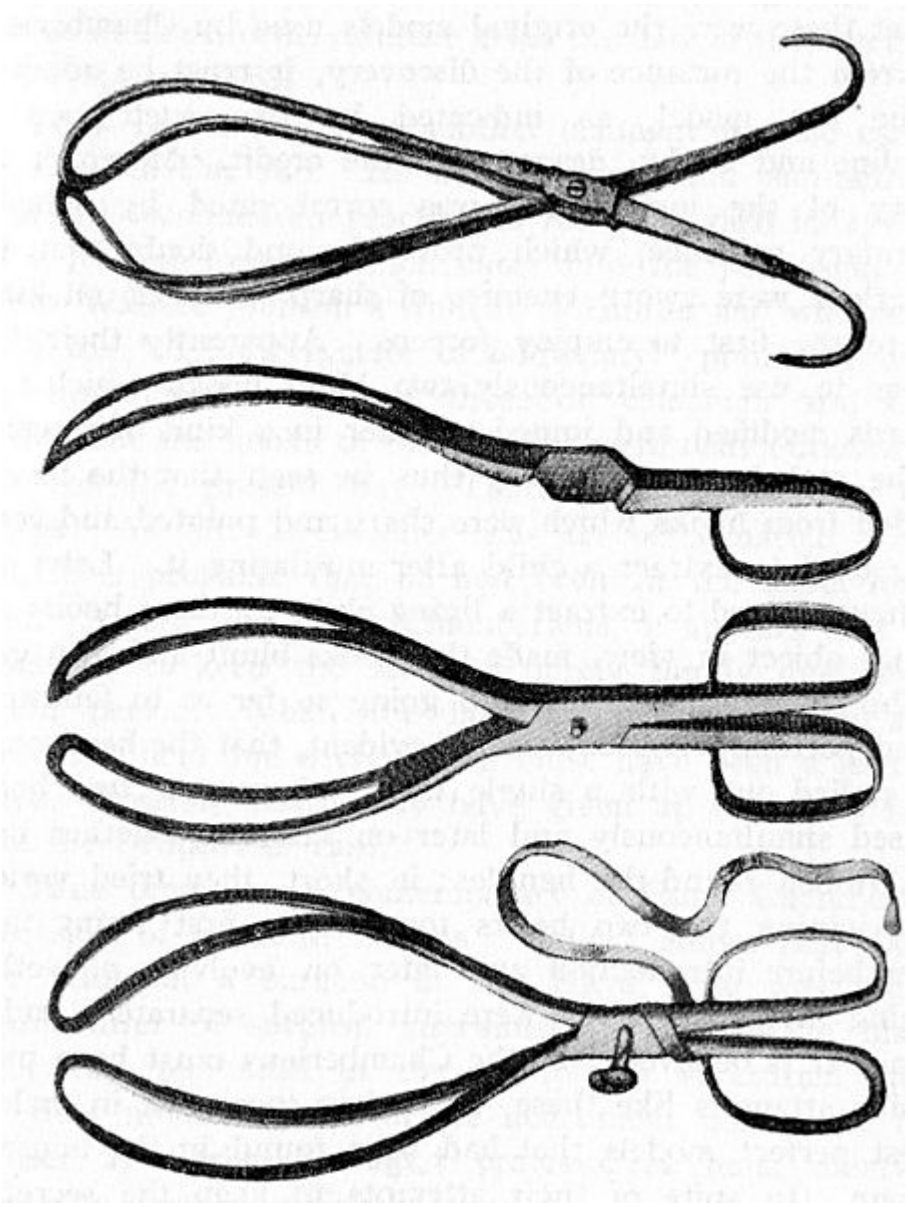
- The internal tissues, particularly the pelvic floor muscles, are bruised
- Facial bruising or temporary marks on the baby
- A rectovaginal fistula can result, where fecal material leaks from the bowel into the vagina
- Nerve damage (may be temporary or permanent)
- Skull fractures
- Cervical cord injury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

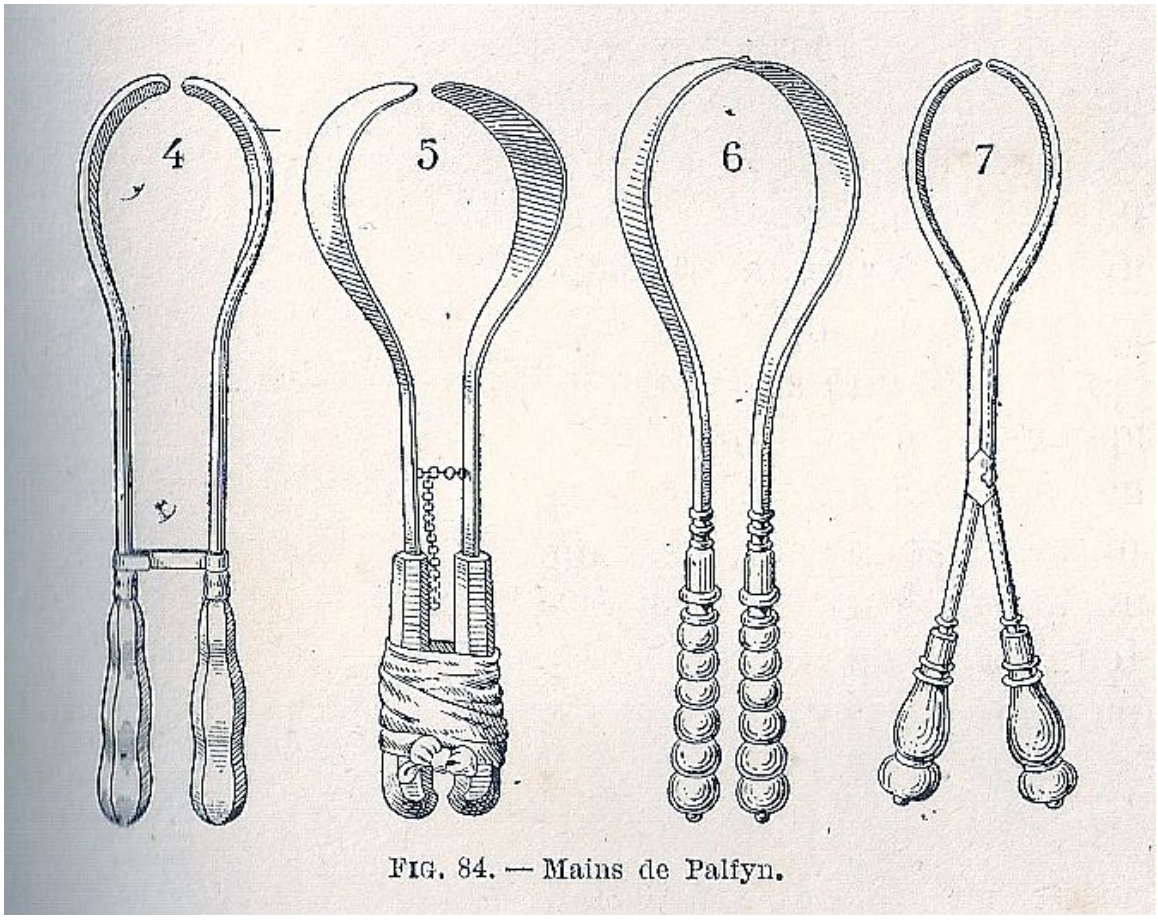
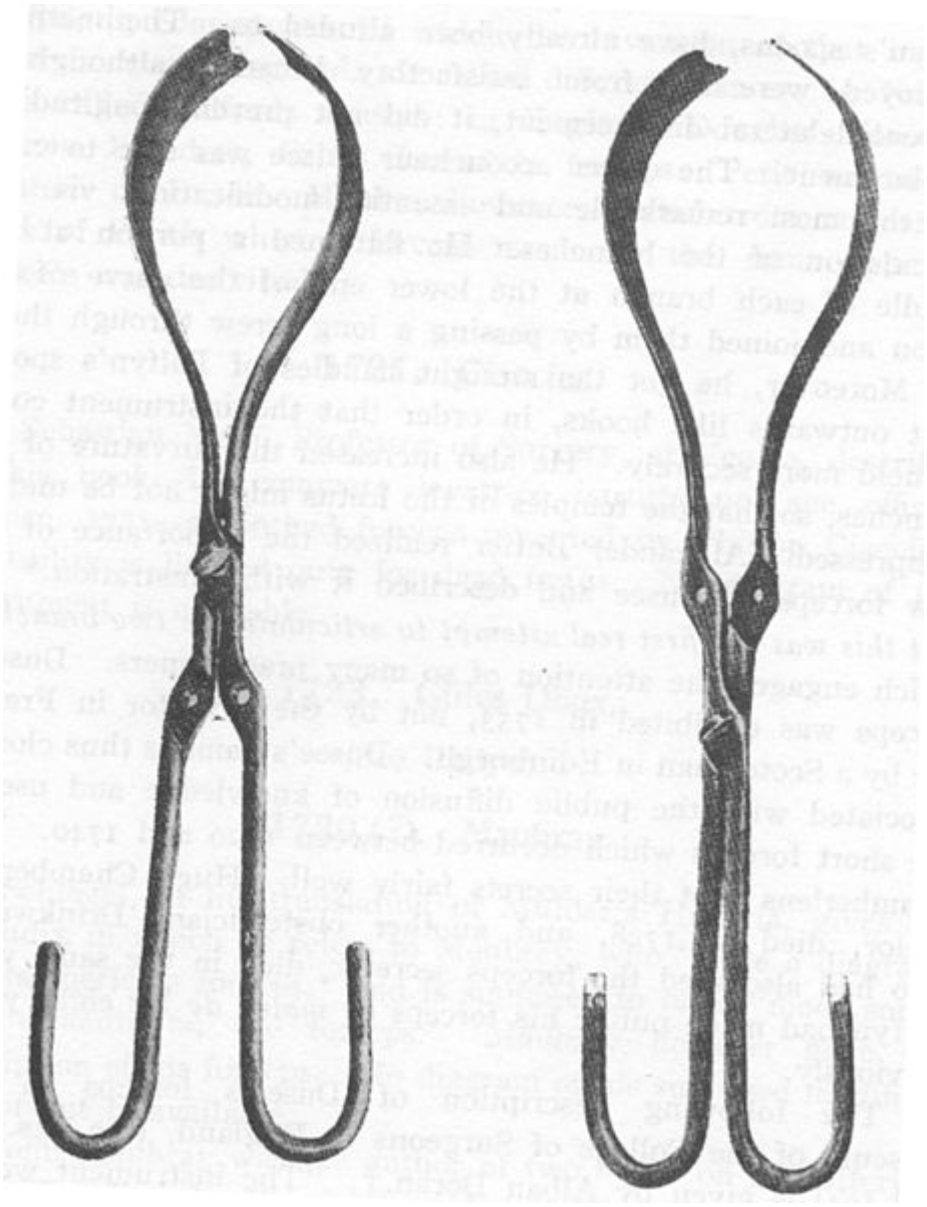


FIG. 84. — Mains de Palfyn.

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.



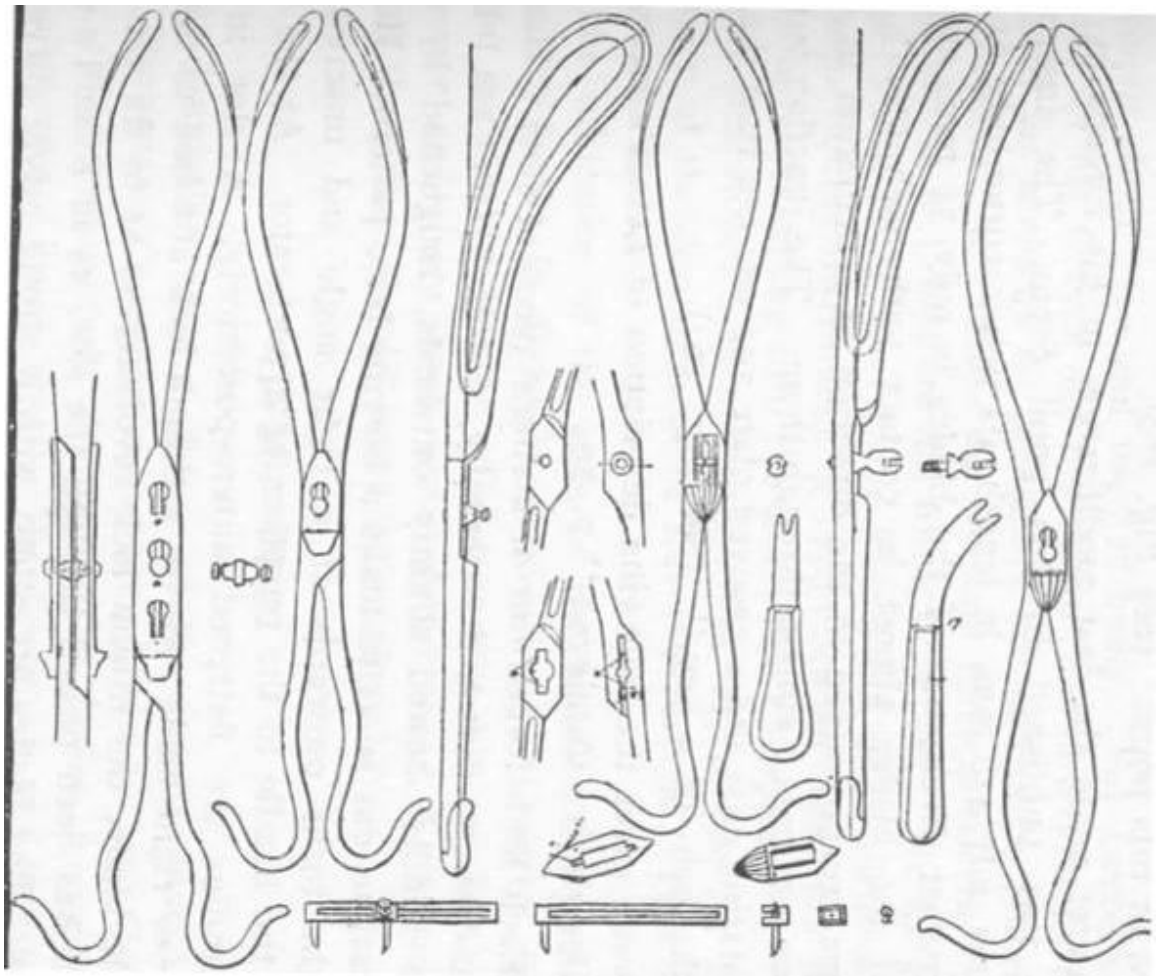
Dussee french forceps (circa 1725) with two different locks

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

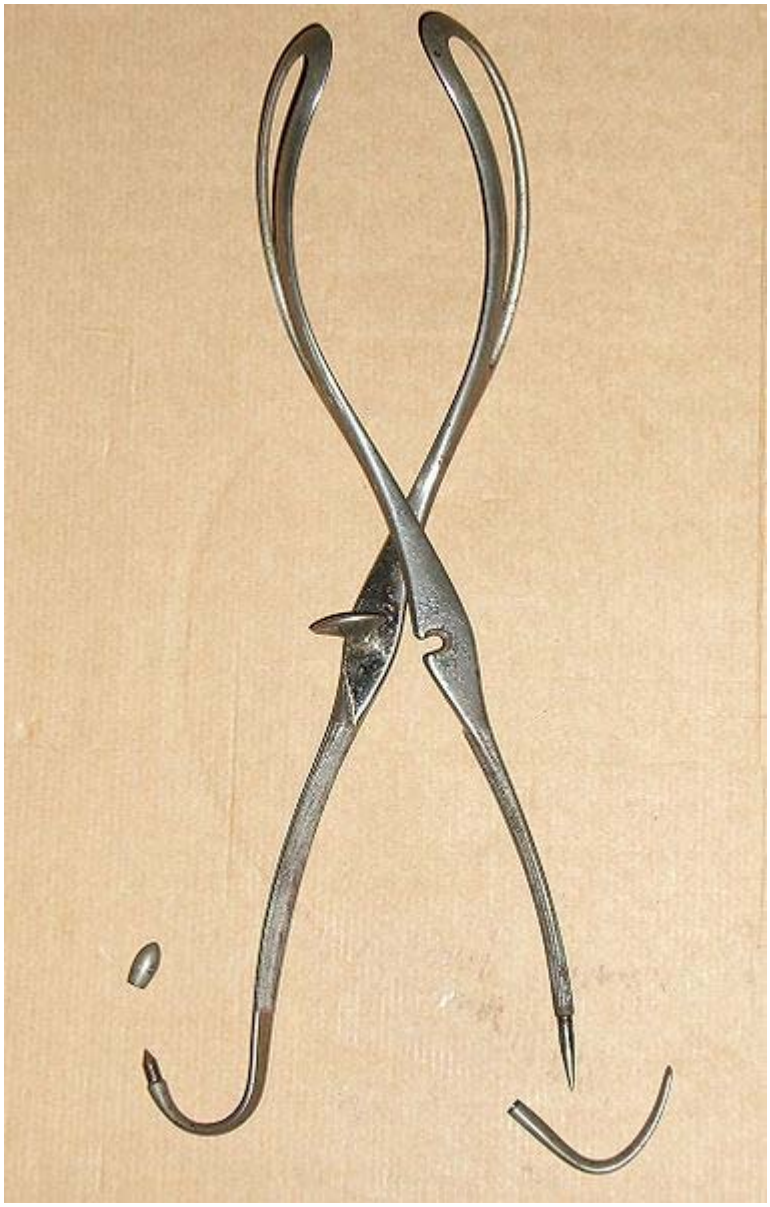
the past than today, which complicated the use of Chamberlen forceps. The absence of pelvic curvature of the branches (vertical curvature to accommodate the anatomical curvature of maternal sacrum) prohibited blades from reaching upper-part of the pelvis and exercising traction in the natural axis of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

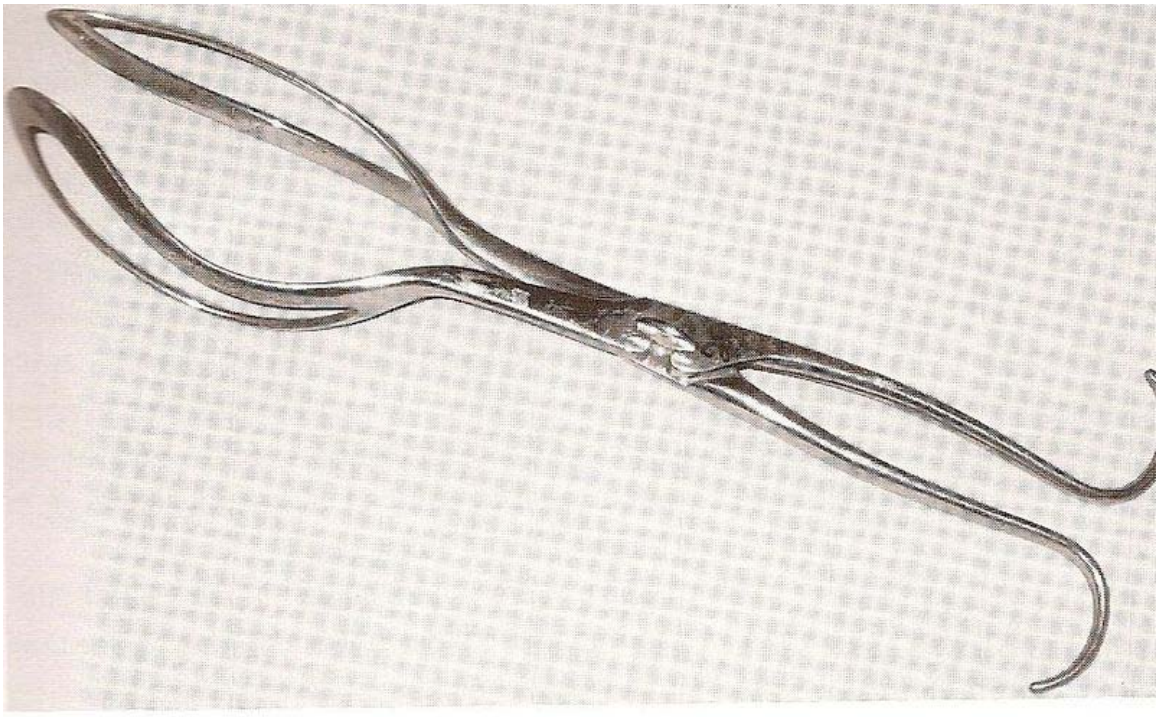


French forceps, Levret-Baudelocque type (1760-1860) with perforator and hook at the end of the handles

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

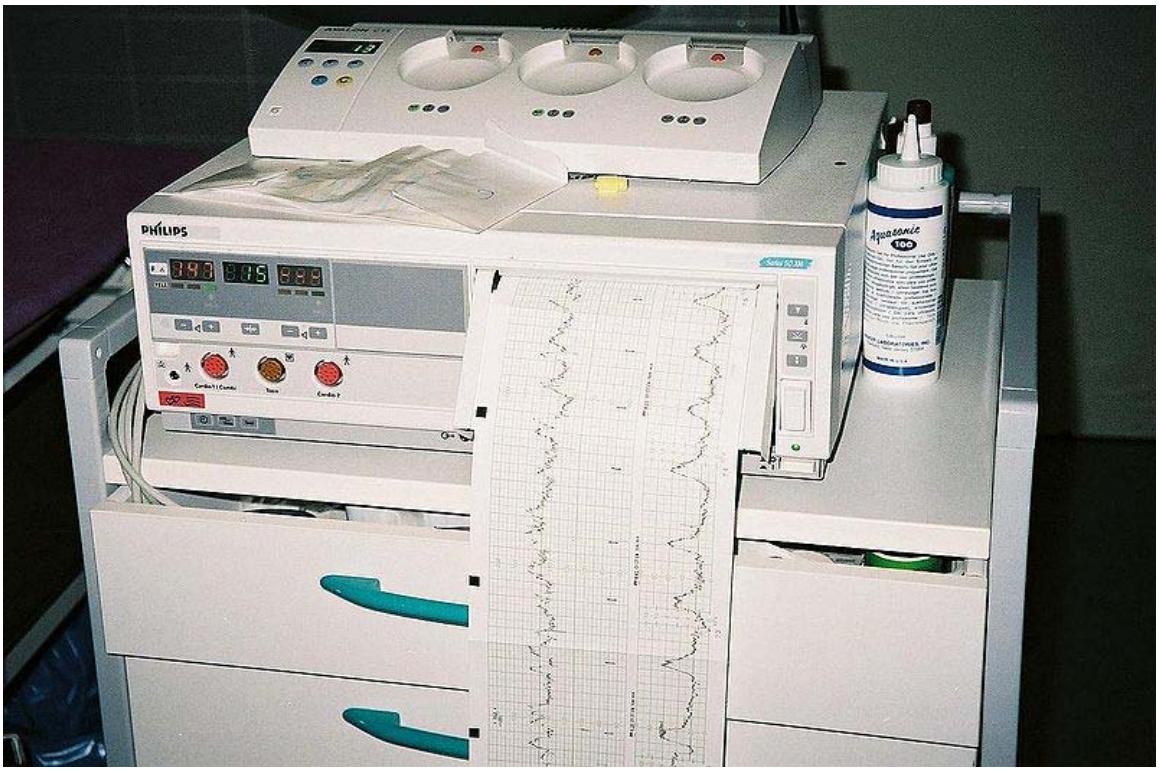
- An episiotomy is not usually required and there is little internal bruising.
- The mother still takes an active role in the birth.
- No special anesthesia required.
- The force applied to the baby can be less than that of a forceps delivery, leaving no marking on the face.
- There is less potential 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 15

Cardiotocography

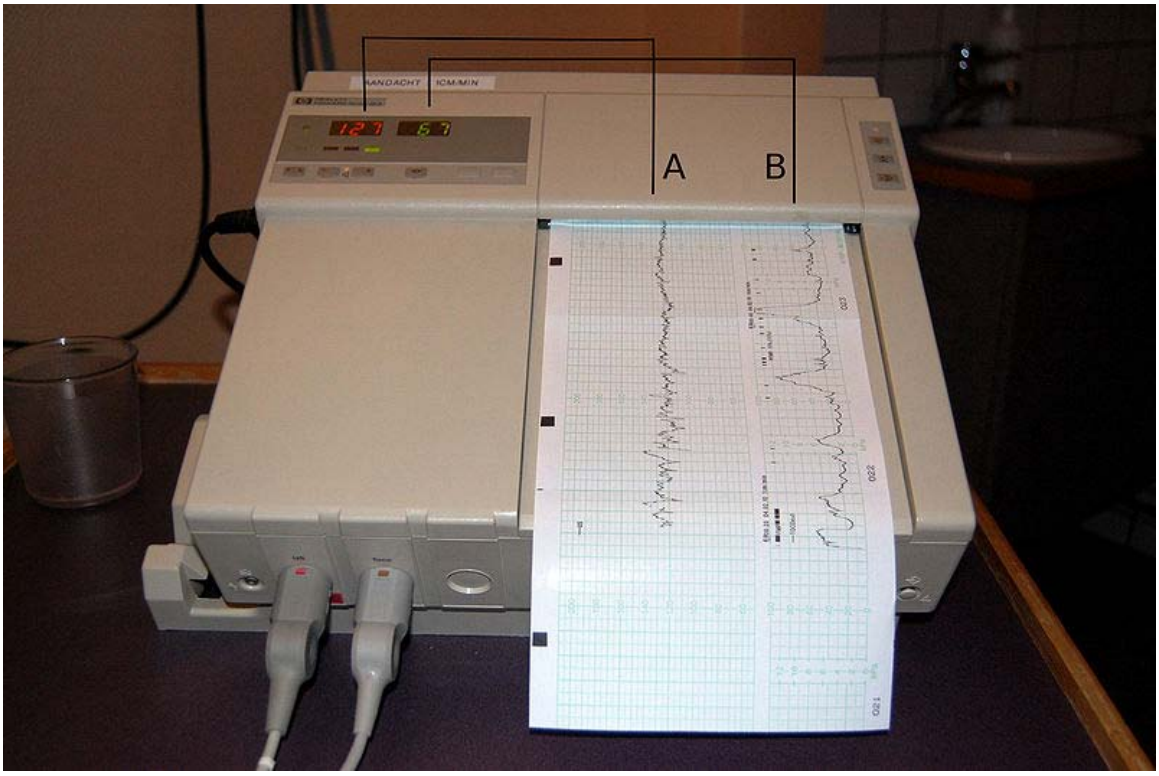


A cardiotocograph recording fetal heart rate and uterine contractions

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.

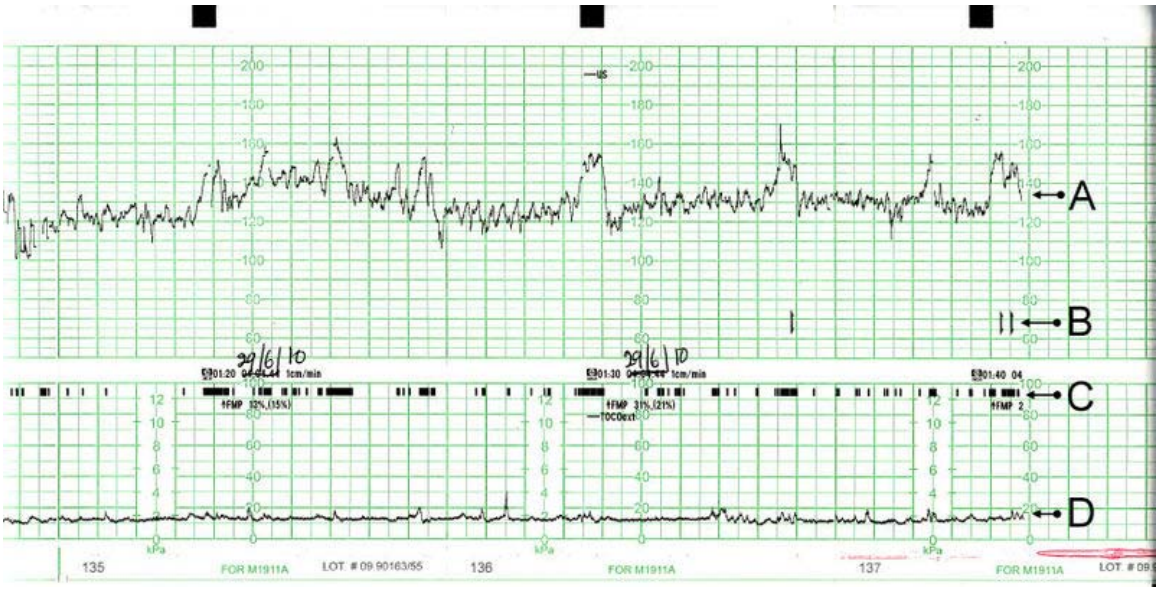
External measurement means taping or strapping the two sensors to the abdominal wall. The *heart* ultrasonic sensor, similar to a Doppler fetal monitor, detects motion of the fetal heart. The pressure-sensitive *contraction* transducer, called a tocodynamometer (toco), measures the tension of the maternal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

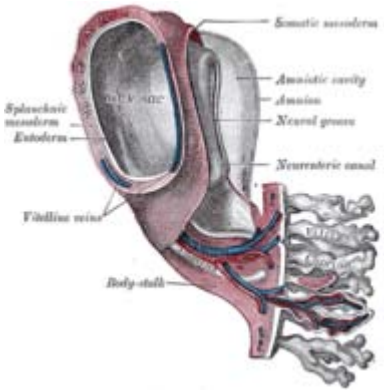
The popular manufacturers are GE(corometrics),Philips, Huntleigh(Sonicaid),Analogic, Toitu and Sunray.

Chapter 16

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 17

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 18

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.

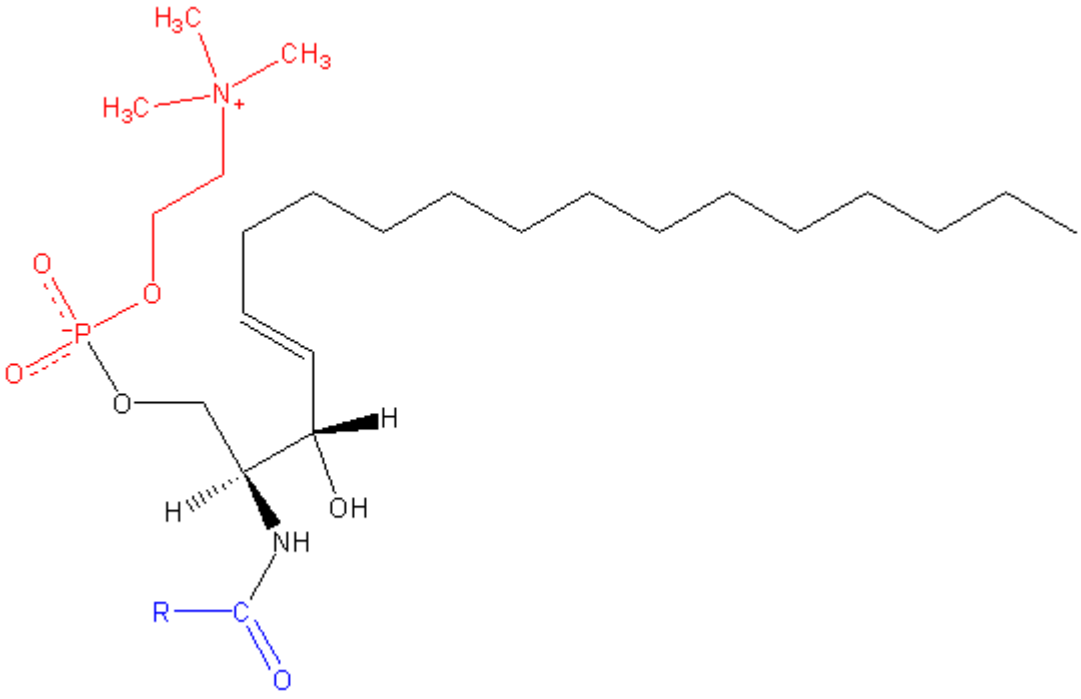
Lots of concern has been raised in the literature concerning false positives when sampling is done after delivery. In general this is not a problem. Delivery does result in higher frequency of detection of micro-hemorrhages but this should not confound interpretation of FMH as a possible cause of stillbirth. 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.

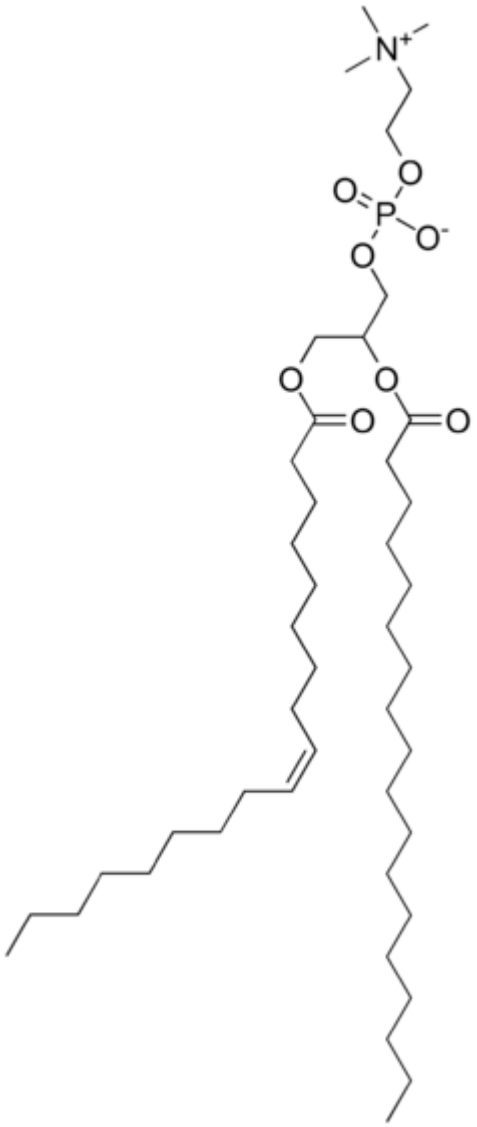
Chapter 19

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 20

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%.

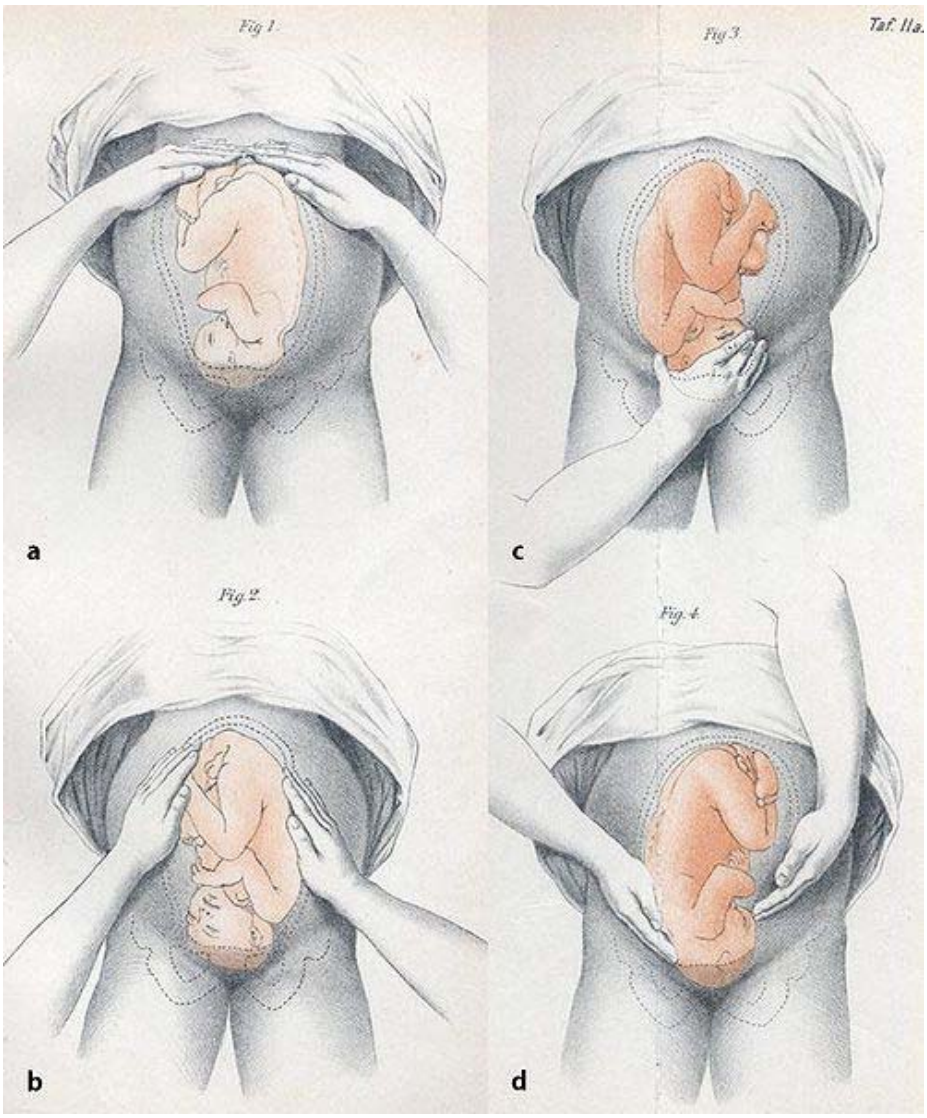
When screening is positive, amniocentesis testing is required to confirm the presence of a genetic abnormality. However this procedure carries a small risk of miscarriage so prior screening with low false positive rates are needed to minimize the chance of miscarrying.

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.