Epidemiology, Indications, and Surgical Techniques

2

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2.1 Epidemiology

The labour room is a multiprofessional environment; it is complex by definition. The woman and the fetus are the main players on the scene. The midwife, gynecologist, anaesthetist, neonatologist, nurse, and the assistant share critical decisions about two human beings' lives.

Until half a century ago, cesarean section was rare. It was a dangerous operation for at least three reasons: poor surgical technique, risk of sepsis, and no anesthesia. Many women died during or soon after a cesarean section. Evolution of medicine changed this practice.

The World Health Organization declared in 1985, in Fortaleza, Brazil, that '*there is no justification for any reason to have a cesarean section rate higher than 10–15%*' [1].

An appropriate cesarean section prevents maternal and perinatal complications. There is no benefit for women or infants who do not need the procedure. The complications have a negative effect on a woman's health.

In 2015, WHO published a systematic review of the studies in the scientific literature to analyse the association between cesarean section rates and maternal, perinatal, and infant outcomes. A panel of international experts agreed on this statement [2].

> Caesarean sections are effective in saving maternal and infant lives, but only when they are required for medically indicated reasons. At population level, caesarean section rates higher than 10% are not associated with reductions in maternal and newborn mortality rates.
>
> Caesarean sections can cause significant and sometimes permanent complications, disability or death particularly in settings that lack the facilities and/or capacity to properly conduct safe surgery and treat surgical complications.

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> Caesarean sections should ideally only be undertaken when medically necessary. Every effort should be made to provide caesarean sections to women in need, rather than striving to achieve a specific rate. The effects of caesarean section rates on other outcomes, such as maternal and perinatal morbidity, pediatric outcomes, and psychological or social well-being are still unclear. More research is needed to understand the health effects of caesarean section on immediate and future outcomes.

An historical study on graphic analysis of labour in 1954 included 100 women with spontaneous labour. Of these women, 64 had an operative vaginal birth with forceps and one had a cesarean section [3].

The rate of cesarean section increased steeply during last decades. Urbanization, childbirth in hospital, reduction of homebirths, consultant-led maternity and the exclusion of midwives from clinical decisions, and induction of labour are possible causes of the increase of this operation [4, 5].

The obstetric population has changed. Many women live their pregnancy later in life. Average body mass index of the mother and fetal weight have increased [6].

The proportion of births by cesarean section has been proposed as an indicator for measuring access, availability, or appropriateness of medical care, as well as for monitoring changes in maternal mortality. A study of births by cesarean section estimated in 2007 at national, regional, and global levels with data from 126 countries, 89% of world live births. The global rate of cesarean section was 15%. In more developed countries, it was 21.1%, in less developed countries 14.3%, and in least developed countries 2% [7].

Repeat cesarean deliveries in the United States account for one third of the cesarean sections.

The most common indications for primary cesarean delivery, in a recent population study, were labour dystocia, abnormal or indeterminate fetal heart rate tracing, fetal malpresentation, multiple gestation, and suspected fetal macrosomia [8].

WHO proposed in 2014 the Robson classification system as a global standard for assessing, monitoring and comparing cesarean section rates within healthcare facilities over time, and between facilities [9].

2.2 Indications

2.2.1 Introduction

During pregnancy every woman is eager to know whether natural childbirth is possible for her. The obstetrician, midwife or doctor, has the duty to plan childbirth with her.

There are situations in which natural childbirth is contraindicated but most of the time the decision is difficult. Often it is necessary to wait for labour to decide.

The childbirth is natural or operative (Fig. 2.1). Natural is vaginal. Operative is both vaginal or abdominal. Operative vaginal childbirth is performed with forceps or with vacuum. There are more devices but these are universal. Operative abdominal childbirth is cesarean.

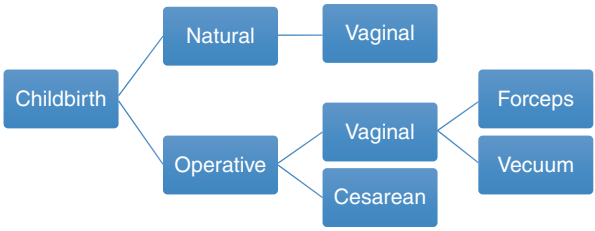

Fig. 2.1 Childbirth option

2.2.2 Classification

Classification of the indications for cesarean section is not simple. There are lots of categories. The most used is emergency or elective cesarean section. Using temporal criteria, cesarean section is prelabour or intrapartum.

A recent concept is planned or unplanned [9]. Planned cesarean section is at all times a prelabour decision. The indication is maternal, fetal, or both. A planned cesarean section sometimes becomes an emergency operation.

Unplanned is always urgent. It often regards obstetric care in labour. Fetal distress, maternal complications, and failure to progress in labour are indications that open a discussion among professionals in labour room. Cardiotocography and partogram are tools to be used wisely to agree on the indication of an emergency cesarean section.

Indications for a planned cesarean section have evolved over the last decades. Some indications are absolute, others are relative. Evidence-based medicine is a method to counsel women. Maternal request is a crisis between a woman's auto determination and midwifery which would suggest a natural childbirth.

2.2.3 Planned Cesarean Section

The indications for a planned cesarean section are seldom absolute and need to be discussed with the woman and her expectations (Fig. 2.2) [9].

2.2.3.1 Breech Presentation

Breech presentation is not purely coincidental [10]. It is frequent in preterm births. Some malformations prevent proper rotation of the fetus to the cephalic presentation. Uterine anomalies, such as bicornate uterus, may prevent cephalic presentation of the fetus. It is good practice to search for a cause. Breech presentation at term is an indication for one out of ten cesarean sections [11, 12]. External cephalic version, moxibustion, and posture are interventions that promote cephalic version [11, 13–16]. External cephalic version has recognized complications: transient bradycardia and other fetal heart rate abnormalities, placental abruption, vaginal bleeding, induction of labour.

Evidence-based medicine [9]

Women who have an uncomplicated singleton breech pregnancy at 36 weeks gestation should be offered external cephalic version. Exceptions include women in labour and women with a uterine scar or abnormality, fetal compromise, ruptured membranes, vaginal bleeding, or medical conditions.

Pregnant women with a singleton breech presentation at term, for whom external cephalic version is contraindicated or has been unsuccessful, should be offered CS because it reduces perinatal mortality and neonatal morbidity.

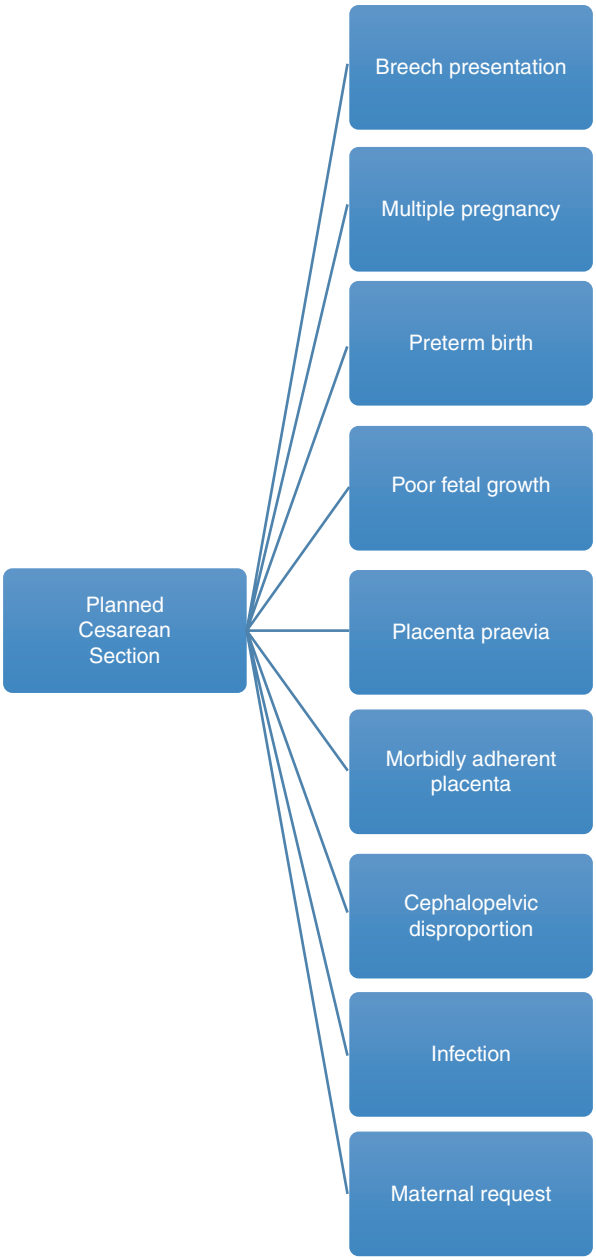

Fig. 2.2 Planned cesarean section

2.2.3.2 Multiple Pregnancy

In the last decades, artificial reproductive technology has increased the incidence of multiple pregnancy [17, 18]. Multiple pregnancy is associated with preterm birth and low birth weight [19–23]. The complexity of placental circulation in monochorionic twin pregnancy is a risk for a discordant growth. Second-born twin has a specific risk of complications during childbirth.

The management of the complications of multiple pregnancy, such as pre-eclampsia, influences the mode of delivery. Cephalic presentation of the first twin is a possible indication for a trial of labour [24]. The evidence is not conclusive.

Evidence-based medicine [9]

In otherwise uncomplicated twin pregnancies at term where the presentation of the first twin is cephalic, perinatal morbidity and mortality is increased for the second twin. However, the effect of planned CS in improving outcome for the second twin remains uncertain and therefore CS should not routinely be offered outside a research context.

In twin pregnancies where the first twin is not cephalic, the effect of CS in improving outcome is uncertain, but current practice is to offer a planned CS.

2.2.3.3 Preterm Birth

The premature prelabour rupture of membranes determines preterm birth. The decision on the mode of delivery is not straightforward [25–27]. Pre-eclampsia, HELLP syndrome, and other maternal complications are an indication to expedite birth. Fetal compromise may induce a decision for preterm birth. There is no evidence that planned cesarean section changes the outcome of birth [28].

Evidence-based medicine

Preterm birth is associated with higher neonatal morbidity and mortality. However, the effect of planned CS in improving these outcomes remains uncertain and therefore CS should not routinely be offered outside a research context.

2.2.3.4 Poor Fetal Growth

Poor fetal growth is not always pathologic. It may be constitutional and there is no specific risk to anticipate childbirth [29–32]. Fetal growth restriction is pathologic. There is discordant growth with a significant difference between cephalic and abdominal circumference. The fetus is small for gestational age.

Evidence-based medicine [9]

The risk of neonatal morbidity and mortality is higher with ‘small-for-gestational-age’ babies. However, the effect of planned CS in improving these outcomes remains uncertain and therefore CS should not routinely be offered outside a research context.

2.2.3.5 Placenta Previa

The diagnosis of low-lying placenta changes with gestational age. It is necessary to repeat serial ultrasound scans to study the position of the placenta with respect to internal cervical os [19, 33]. Pulsed and Colour Doppler ultrasound give a detailed view of placental circulation. The major placenta previa, covering internal cervical os, is an absolute indication for cesarean section after the 36th week of pregnancy.

Evidence-based medicine [9]

Women with a placenta that partly or completely covers the internal cervical os (minor or major placenta previa) should be offered CS.

2.2.3.6 Morbidly Adherent Placenta

The risk of morbidly adherent placenta is increased after a previous cesarean section. Women with three or more previous cesarean sections have a risk of placenta previa of 1.8–3.7% and high risk of morbidly adherent placenta [34]. The most frequent complications are major obstetric hemorrhage, transfusion of large quantities of blood products, hysterectomy and admission to intensive care unit [35, 36]. Ultrasound, Colour flow mapping and MRI have increased early prenatal diagnosis [37].

Evidence-based medicine [9]

If low-lying placenta is confirmed at 32–34 weeks in women who have had a previous CS, offer colour-flow Doppler ultrasound as the first diagnostic test for morbidly adherent placenta.

If a colour-flow Doppler ultrasound scan result suggests morbidly adherent placenta, discuss with the woman the improved accuracy of magnetic resonance imaging (MRI) in addition to ultrasound to help diagnose morbidly adherent placenta and clarify the degree of invasion. Explain what to expect during an MRI procedure, inform the woman that current experience suggests that MRI is safe, but then there is a lack of evidence about any long-term risks to the baby; offer MRI if acceptable to the woman.

Discuss the interventions available for delivery with women suspected to have morbidly adherent placenta including cross-matching of blood and planned CS with a consultant obstetrician present.

When performing a CS for women suspected of having a morbidly adherent placenta, ensure that a consultant obstetrician and a consultant anaesthetist are present, an experienced paediatrician is present, a senior haematologist is available for advice, a critical care bed is available, and sufficient cross-matched blood and blood products are readily available.

2.2.4 Predicting Cesarean Section for Cephalopelvic Disproportion

The role of pelvimetry, shoe size, maternal height, and clinical and ultrasound estimation of fetal size to predict cephalopelvic disproportion is controversial [38, 39, 42].

Evidence-based medicine [9]

Pelvimetry is not useful in predicting ‘failure to progress’ in labour and should not be used in decision-making about mode of birth.

Shoe size, maternal height, and estimations of fetal size (ultrasound or clinical examination) do not accurately predict cephalopelvic disproportion and should not be used to predict ‘failure to progress’ during labour.

2.2.4.1 Mother to Child Transmission of Maternal Infections

The prevention of vertical transmission of maternal infections to the fetus influences the mode of delivery. The passage through the birth canal and direct contact with maternal vaginal and perineal secretions are a recognized cause of transmission of a maternal infection to the fetus. Cesarean section has been considered a preventive measure for some infections but evidence has a continuous evolution. There is new

evidence for HIV [40–44], hepatitis B [45, 46], hepatitis C [47], and herpes virus infection [48–50].

Evidence-based medicine [9]

As early as possible give women with HIV information about the risks and benefits for them and their child of the HIV treatment options and mode of birth so that they can make an informed decision.

Do not offer a CS on the grounds of HIV status to prevent mother-to-child transmission of HIV to: women on highly active anti-retroviral therapy (HAART) with a viral load of less than 400 copies per ml or women on any anti-retroviral therapy with a viral load of less than 50 copies per ml. Inform women that in these circumstances the risk of HIV transmission is the same for a CS and a vaginal birth.

Consider either a vaginal birth or a CS for women on anti-retroviral therapy (ART) with a viral load of 50–400 copies per ml because there is insufficient evidence that a CS prevents mother-to-child transmission of HIV.

Offer a CS to women with HIV who are not receiving any anti-retroviral therapy or are receiving any anti-retroviral therapy and have a viral load of 400 copies per ml or more. Mother-to-child transmission of hepatitis B can be reduced if the baby receives immunoglobulin and vaccination. In these situations, pregnant women with hepatitis B should not be offered a planned CS because there is insufficient evidence that this reduces mother-to-child transmission of hepatitis B virus.

Women who are infected with hepatitis C should not be offered a planned CS because this does not reduce mother-to-child transmission of the virus.

Women with primary genital herpes simplex virus (HSV) infection occurring in the third trimester of pregnancy should be offered planned CS because it decreases the risk of neonatal HSV infection.

2.2.4.2 Maternal Request for Cesarean Section

To ask for a cesarean section without an obstetric indication is not a natural option for a woman close to term [19, 51]. Many women experience a preference for cesarean section. If they had a previous cesarean section or a previous negative outcome, or a complication in the current pregnancy or fear of childbirth, they think cesarean section is the safest way to give birth [52–54]. Respect to the woman's feelings is a duty for all those who attend her. The indication for a cesarean section on maternal request becomes effective after multidisciplinary counselling. Gynecologist, midwife, and anesthetist discuss the risks and benefits of cesarean section with her, comparing vaginal birth [55]. They offer referral to a specialist in mental health, who supports and certifies the maternal request and gives the alternative choice for a natural childbirth with active support.

Evidence-based medicine [9]

When a woman requests a CS, explore, discuss, and record the specific reasons for the request.

If a woman requests a CS when there is no other indication, discuss the overall risks and benefits of CS compared with vaginal birth and record that this discussion has taken place. Include a discussion with other members of the obstetric team (including the obstetrician, midwife, and anesthetist) if necessary to explore the reasons for the request, and to ensure the woman has accurate information.

When a woman requests a CS because she has anxiety about childbirth, offer referral to a healthcare professional with expertise in providing perinatal mental health support to help her address her anxiety in a supportive manner.

For women requesting a CS, if after discussion and offer of support (including perinatal mental health support for women with anxiety about childbirth), a vaginal birth is still not an acceptable option, offer a planned CS.

2.2.5 Unplanned Cesarean Section

Healthcare professionals in the labour room frequently assist a woman, who has no indication for a planned cesarean section.

Labour room is a teamwork. Decisions are shared among the members of the team. The midwife has the most important role. She is empathic with the woman and is her connection with the rest of the team. She is the team leader during natural childbirth.

The number of cesarean sections during labour is a quality index of the labour room performance. A third-level hospital has a greater number of unplanned cesarean sections than a less-equipped hospital.

The indications for unplanned cesarean section are often related to failure to progress in labour and fetal distress. There are maternal conditions, such as severe pre-eclampsia, in which a cesarean section comes after a trial of labour. Some factors reduce the likelihood of cesarean section.

2.2.5.1 Factors that Reduce the Likelihood of Cesarean Section

One-to-one support in labour room, induction of labour after 41 weeks, use of partogram during labour, consultant obstetrician who decides on cesarean section, and fetal blood sampling for abnormal heart rate pattern reduce the likelihood of cesarean section [56–64, 68].

Evidence-based medicine [9]

Women should be informed that continuous support during labour with or without prior training reduces the likelihood of CS.

Women with an uncomplicated pregnancy should be offered induction of labour beyond 41 weeks because this reduces the risk of perinatal mortality and the likelihood of CS.

A partogram with a four-hour action line should be used to monitor progress of labour of women in spontaneous labour with an uncomplicated singleton pregnancy at term because it reduces the likelihood of CS.

Consultant obstetricians should be involved in the decision-making for CS because this reduces the likelihood of CS.

Electronic fetal monitoring is associated with an increased likelihood of CS. When CS is contemplated because of an abnormal fetal heart rate pattern, in cases of suspected fetal acidosis, fetal blood sampling should be offered, if it is technically possible and there are no contraindications.

2.2.5.2 Failure to Progress in Labour

The partogram allows a graphic analysis of labour [61, 65, 66]. Failure to progress in labour is an indication for an unplanned cesarean section. The disorders of dilatation are prolonged latent phase, protracted active phase and arrest of cervical dilatation. The disorders of descent are failure to descent, protracted descent, and arrest of cervical dilatation (Table 2.1) (Fig. 2.3).

The three key words are failure, delay, and arrest [67]. Labour abnormalities derive from complex interaction between maternal body and fetal characteristics.

Table 2.1 Failure to progress in labour

Disorder	Dilatation	Descent
Failure	Prolonged latent phase	Failure of descent
Protraction	Protracted active phase	Protracted descent
Arrest	Arrest of dilatation	Arrest of descent

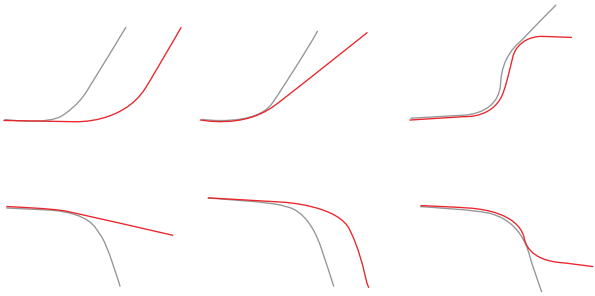

Fig. 2.3 The disorders of dilatation and descent

The decision for a cesarean section is clinical. A four-hour action line on the partogram is the standard to diagnose labour protraction [66, 67]. The most recent evidence is that dilatation progress takes up to six hours between 4 and 5 cm and up to three hours between 5 and 6 cm [5, 8] . After 6 cm labour accelerates and multiparous women are faster than nulliparous parturients. In many cases, active phase has no consistent pattern, but still a vaginal delivery is achieved with active phase not starting before 6 cm of dilatation. Labour protraction should not be based on an average starting point of active phase of labour or average duration of labour. In the presence of reassuring maternal and fetal conditions, a woman should be allowed to continue her labour.

It would be advisable to do a study that compares a partogram with and without an action line and its effect on maternal and neonatal well-being.

Evidence-based medicine [8]

Slow but progressive labor in the first stage of labor should not be indication for cesarean delivery.

Cervical dilatation of 6 cm should be considered threshold for active phase of most women in labor. Thus, before 6 cm of dilation is achieved, standards of active-phase progress should not be applied.

Cesarean delivery for active-phase arrest in first stage of labor should be reserved for women with >6 cm of dilatation with ruptured membranes who fail to progress despite four hours of adequate uterine activity, or at least six hours of oxytocin administration with inadequate uterine activity and no cervical change.

2.2.5.3 Fetal Distress

Fetal distress is not a specific notion. In clinical practice it means a not-reassuring fetal heart rate pattern recorded with cardiotocography in which a state of hypoxia and metabolic acidosis would be present [68].

There are transitory factors such as cord compression, maternal hypotension, maternal supine position, and uterine hyperstimulation. There are also permanent factors such as cord prolapse, complete placental abruption, and uterine rupture.

Cardiotocography only records two parameters: the fetal heart rate and contractions.

The four features of fetal heart rate that are scrutinized in a cardiotocograph are baseline heart activity, baseline variability, presence or absence of decelerations and presence of accelerations.

Cardiotocography is a screening test for perinatal asphyxia, not a diagnostic test or treatment [69–73]. There is a clear discrepancy between abnormalities in cardiotocographs and severe perinatal asphyxia, causing death or severe neurological impairment.

Cardiotocography has a good negative likelihood ratio; when normal the chance of hypoxia is low. It is moderately useful in predicting poor neonatal outcomes.

Some features of cardiotocographs may predict neonatal outcome or the surrogate measure of low umbilical cord blood pH: prolonged or severe bradycardia, decreased variability, decreased variability with no accelerations, decreased variability associated with variable or late decelerations or no accelerations, recurrent late decelerations with decreased variability, late decelerations, and variable decelerations [74–78].

The decision to change a woman's care in labour is delicate. The midwife and the doctor integrate the information of cardiotocographs with fetal blood sampling and fetal response to scalp stimulation. The care is empathic with the woman, her partner, and her family.

Evidence-based medicine [69]

Electronic fetal monitoring is associated with an increased likelihood of CS. When CS is contemplated because of an abnormal fetal heart rate pattern, in cases of suspected fetal acidosis, fetal blood sampling should be offered if it is technically possible and there are no contraindications.

If fetal scalp stimulation leads to an acceleration in fetal heart rate, regard this as a reassuring feature. Take this into account when reviewing the whole clinical picture.

Use the fetal heart rate response after fetal scalp stimulation during a vaginal examination to elicit information about fetal well-being if fetal blood sampling is unsuccessful or contraindicated.

2.2.5.4 Classification of Urgency

The classification of urgent cesarean section prevents any misunderstanding between healthcare professionals (Table 2.2). There are four grades of urgent cesarean section [9]. Some clinical conditions which determine **grade 1** cesarean sections are acute fetal bradycardia, cord prolapse, uterine rupture, or fetal blood sampling pH less than 7.2; **grade 2** cesarean section are antepartum hemorrhage or failure to progress in labor with maternal or fetal compromise; **grade 3** are failure to progress in labor with no maternal or fetal compromise or a woman booked for a planned cesarean section who is admitted with a prelabour rupture of membranes; **grade 4** are all cesarean sections carried out electively at a planned time to suit the mother and the clinicians.

The urgent cesarean section was measured with a three-colour code: red, orange, and green [79, 80]. The ideal decision-to-delivery time was 15 min for a red code, 30 min for an orange code, and 60 min for a green code. After six months of observation, mean decision-to-delivery interval was 31.7 min. Previously, it was 39.6 min.

Table 2.2 Urgency of cesarean section

Grade	Condition
1	Immediate threat to the life of the woman or fetus
2	Maternal or fetal compromise which was not immediately life-threatening
3	No maternal or fetal compromise but needs early delivery
4	Delivery timed to suit woman or staff

The NICE stated in 2011 that grade 1 and 2 cesarean sections must be performed as quickly as possible, grade 3, in most situations, within 75 min [9].

The decision to deliver in an interval of less than 15 min is often harmful for the woman and her fetus for an iatrogenic injury. This a treatment paradox.

2.3 Technique

2.3.1 Prerequisites

There are some evidence-based medicine prerequisites for cesarean section: agreement of the woman on the indication, informed consent; WHO surgical safety checklist; if appropriate, blood available for surgery; antacids and antiemetics available; achievement of anesthesia; prevention of aortocaval compression; neonatal resuscitation available; bladder empty with an indwelling catheter; operator appropriately experienced and skilled; prophylactic antibiotic and thrombo-prophylaxis [81].

2.3.2 WHO Surgical Safety Checklist

The three steps of WHO surgical safety checklist are: Sign In, Time out, Sign out [82] . It was the result of a prospective study in eight hospitals representing a variety of economic circumstances and diverse populations of patients participating in World Health Organization's Safe Surgery Saves Lives Program.

2.3.2.1 Sign In (for Cesarean Section)

Before induction of anesthesia, members of the team orally confirm that the patient has verified her identity, the surgical procedure and consent; the pulse oximeter is on the patient and functioning; all members of the team are aware of whether the patient has a known allergy; the patient's airway and risk of aspiration have been evaluated and appropriate equipment and assistance is available; if there is a risk of blood loss of at least 500 ml appropriate access and fluids are available.

2.3.2.2 Time Out (for Cesarean Section)

Before skin incision the entire team orally confirms that all team members have been introduced by name and role; confirms the patient's identity and procedure; reviews the anticipated critical events; surgeon reviews critical and unexpected

steps, operative duration and anticipated blood loss; anesthesia staff review concerns specific to the patient; nursing staff review confirmation of sterility, equipment availability and other concerns; confirms that prophylactic antibiotics have been administered 60 min before incision is made or the antibiotics are not indicated; confirms that all imaging results for the correct patients are displayed in the operating room.

2.3.2.3 Sign Out (for Cesarean Section)

Before the patient leaves the operating room: nurse reviews items aloud with the team; name of the procedure as recorded; that the needle, sponge, and instrument counts are complete; whether there are any issues with equipment to be addressed; the surgeon, nurse, and anesthesia professionals review aloud the key concerns for the recovery and care of the patient.

2.3.3 Skin Incision

Surgical incisions for cesarean section are vertical and transverse [83–85]. The length must be adequate to perform a safe procedure. The incision should be approximately 15 cm long, as an 'Allis' clamp, laid on the skin.

2.3.3.1 Vertical Incision

This is a midline incision on the umbilical-pubic axis [84]. A vertical incision is a direct access to abdomen and pelvis. It is indicated for urgent cesarean section. A typical indication is a massive hemorrhage. The surgeon could practice a vertical incision for a perimortem cesarean section or when a patient is high risk for a coagulopathy or if she refuses a much-needed blood transfusion.

2.3.3.2 Pfannestiel's Incision

This is a lower transverse abdominal incision. It is slightly curved above the symphysis pubis. It involves dissection of subcutaneous layer and of anterior rectus sheath. This incision does not follow Langer's line, the natural orientation of collagen fibres in the dermis, parallel to the orientation of the underlying muscle fibres. It was introduced by Pfannestiel in 1896 and published in 1900 [86] . The extension of the incision into external and oblique muscles could damage ilioinguinal and iliohypogastric nerves. It may slow down an emergency cesarean section. It reduces the incidence of wound dehiscence. Wound hernias are uncommon. Instead postoperative haematomas and wound infections are possible [87–90].

2.3.3.3 Joel Cohen's Incision

It is a transverse incision, 3 cm below the line between the iliac anterior superior spines. It is higher than Pfannestiel's incision. It was introduced in 1954 for abdominal hysterectomy [87, 91, 92]. The opening of the subcutaneous tissue is not sharp. The surgeon incises the anterior rectus sheath in the midline for about 3 cm but does

not separate rectus muscle from the sheath. The opening of the peritoneum is blunt and traction is in a transverse direction.

2.3.3.4 Maylard Incision

It is a high transverse incision with section of rectal muscles with cautery or surgical scalpel and ligature of inferior epigastric vessels [93, 94]. It is advisable to not separate rectus muscles from anterior rectus sheath. This incision is used for radical pelvic surgery.

Evidence-based Medicine [9]

CS should be performed using a transverse abdominal incision because this is associated with less postoperative pain and an improved cosmetic effect compared with a midline incision.

The transverse incision of choice should be the Joel Cohen incision (a straight skin incision, 3 cm above the symphysis pubis; subsequent tissue layers are opened bluntly and, if necessary, extended with scissors and not a knife), because it is associated with shorter operating times and reduced postoperative febrile morbidity.

The use of separate surgical knives to incise the skin and the deeper tissues at CS is not recommended because it does not decrease wound infection.

2.3.4 Uterine Incision

2.3.4.1 Low Transverse Incision

It is a transverse incision through the lower uterine segment. It was introduced in 1926 [95]. The loose fold of the peritoneum is incised, and the bladder is pushed down with care. The doyen's retractor exposes the uterine lower segment. Sometimes the uterus is rotated on the right side and its position is corrected before delivery of the fetus. The surgeon incises 2–3 cm in the middle to expose fetal membranes. Then he enlarges the depth and the width of opening with the blunt end of the scalpel or with fingers [96, 97]. The lateral extension of the incision may reach uterine vessels with a massive hemorrhage. The surgical extension on the upper segment usually is J-shaped or reverse T-shaped. In these cases, the scar is weaker than the incision limited to lower segment.

2.3.4.2 Low Vertical Incision

It is a vertical incision on the lower uterine segment [84]. It was introduced in 1922 [98]. It spares uterine vessels but is a real threat for the bladder. This incision needs a careful dissection of the bladder. It is an alternative when transverse incision is contraindicated by a medical reason, such as a fibroid.

2.3.4.3 Classical Incision

Classical incision is a vertical incision which involves upper uterine segment. The thickness of the myometrium poses a great risk for blood loss, infection and poor healing. Some conditions are a possible indication for a classical incision: preterm delivery before the formation of lower uterine segment [99]; premature rupture of

membranes and transverse lie; transverse lie with back inferior; large cervical fibroid; severe adhesions in lower uterine segment; postmortem cesarean section; placenta previa with large vessels in lower segment.

Evidence-based medicine [9]

When there is a well-formed lower uterine segment, blunt rather than sharp extension of the uterine incision should be used because it reduces blood loss, incidence of postpartum hemorrhage, and the need for transfusion at CS.

2.3.5 Delivery of the Fetus

2.3.5.1 Cephalic Presentation

After uterine incision the operator tears fetal membranes with care. He introduces his hand into lower uterine cavity and elevates fetal head until it becomes visible through the incision. The active flexion of fetal head reduces its diameter. In transverse and posterior position, the operator must rotate fetal head as much as possible, in anterior position. The assistant applies fundal pressure. The collaboration between surgeon and assistant allows a minimal traction to deliver fetal head. The head comes out with an extension movement. Delivery of shoulders needs special care. A brachial plexus damage or palsy is possible as in normal childbirth. This a consequence of a reckless maneuver.

When fetal head is high in the uterus there is risk for excessive blood loss. A forceps or vacuum delivery is the solution. In literature there are specific vacuum cups for cesarean section.

Cesarean at full dilatation with a deeply engaged fetal head is a challenge. A third assistant raises fetal head from vagina to meet operator's hand. A pillow is an alternative device.

2.3.5.2 Face or Brow Cephalic Presentation

The head is deflexed. The operator places intrauterine hand behind occiput, flexes the head, rotates it to anterior or transverse position, and delivers it as usual (Table 2.3).

2.3.5.3 Frank Breech

The operator cups his hand around the bottom and delivers the breech by lateral flexion. When trunk is visible, leg is flexed rotating the femur laterally on fetal abdomen with index finger parallel to the femur. Then the conduct should be the same as in total breech extraction.

Table 2.3 Breech presentation

Breech	Legs and hip
Frank	Legs flexed at the hip extended at the knee
Complete	Legs flexed at the hip flexed at the knee
Footing	Legs extended at the hip extended at the knee
Kneeling	Legs extended at the hip flexed at the knee

2.3.5.4 Footling and Complete Breech

The operator holds one foot or both feet and so legs come first. He keeps the sacrum as anterior, as possible, to facilitate delivery.

2.3.5.5 Transverse Lie

The operator plans surgical approach according to the position of the fetus, location of the feet and of the placenta. The appraisal is both clinical and sonographic. A prolapse of shoulder is possible with a fetal hand coming first through uterine incision. Fetal extraction is not possible. The operator facilitates the hand inside the uterus.

2.3.5.6 Back Down Transverse Lie

The feet are in uterine fundus. It is important to follow the body of the fetus, finding the bottom and the legs. The delivery of posterior leg first keeps the back of the fetus in anterior position. Afterwards the operator may start a breech extraction as in footling breech presentation.

2.3.5.7 Back-up Transverse Lie

The operator follows the fetal body until the bottom and the legs. He grasps both feet and extracts them. Afterwards the operator may start a breech extraction as in footling breech presentation.

2.3.6 Delivery of the Placenta

The operator delivers the placenta with the help of uterine massage, 5 IU of oxytocin, intravenous or intramuscular, and gentle traction on the umbilical cord. This is Active Management of Third Stage of Labour [100–103]. Manual removal of the placenta is an alternative in the presence of heavy bleeding [104]. It has higher rate of postpartum endometritis and heavy bleeding than spontaneous delivery [105, 106].

Evidence-based medicine [9]

Oxytocin 5 IU by slow intravenous injection should be used at CS to encourage contraction of the uterus and to decrease blood loss.

At CS, the placenta should be removed using controlled cord traction and not manual removal as this reduces the risk of endometritis.

2.3.7 Exteriorization of the Uterus

Exteriorization of the uterus during cesarean section may cause nausea and vomiting. Some women have strong postoperative pain. Venous air embolism is a rare complication. Exteriorization of the uterus does not reduce incidence of hemorrhage and infection [96, 107–109].

Evidence-based medicine [9]

Intraperitoneal repair of the uterus at CS should be undertaken. Exteriorization of the uterus is not recommended because it is associated with more pain and does not improve operative outcomes such as hemorrhage and infection.

2.3.8 Suturing of the Uterus

Kerr in 1926 recommended uterine closure in two layers [96] . Theoretically single-layer closure should cause less tissue damage and should take less operative time. Suture is either locking or non-locking. There are concerns about the integrity of the scar after a single layer suture of the uterus. Evidence is not conclusive [97, 110–115]. The closure of a classical incision is in three layers because of its thickness and vascularity [116].

Evidence-based medicine [9]

The effectiveness and safety of a single-layer closure of the uterine incision is uncertain. Except within a research context, the uterine incision should be sutured with two layers.

2.3.9 Peritoneal Closure

Non-closure of the visceral and parietal layer of the peritoneum is associated with less postoperative morbidity [117–120]. It reduces operative time and wound pain.

Evidence-based medicine [9]

Neither the visceral nor the parietal peritoneum should be sutured at CS because this reduces operating time and the need for postoperative analgesia, and improves maternal satisfaction.

2.3.10 Closure of the Skin

The suture of skin edges of the incision is either intracutaneous or subcuticular [84, 121, 122]. Subcuticular suture has a good cosmetic result. Cyanoacrylate, skin glue, is an alternative [123].

Evidence-based medicine [9]

Routine closure of the subcutaneous tissue space should not be used, unless the woman has more than 2 cm subcutaneous fat, because it does not reduce the incidence of wound infection.

Superficial wound drains should not be used at CS because they do not decrease the incidence of wound infection or wound haematoma.

Obstetricians should be aware that the effects of different suture materials or methods of skin closure at CS are not certain.

2.3.11 Misgav Ladach Technique

Misgav Ladach is a Jerusalem hospital. The technique for cesarean section is a combination of procedures. The result of non-randomized trials and randomized have demonstrated quicker postoperative recovery; reduction of febrile reactions, need

for antibiotics, peritoneal adhesions, bleeding, and of postoperative pain, and shorter period before normal bowel function [84, 87, 92, 127].

There are important procedural aspects as follow:

1. Stretching of the skin to respect Langer's lines
2. Joel Cohen incision 17 cm long without involvement of the subcutaneous tissue
3. Short transverse incision about 2–3 cm through the fat down to the rectus sheath
4. Small transverse incision in the sheath
5. Transverse bilateral incision of the sheath with scissors, one blade under and one blade above, underneath the fat and subcutaneous tissue
6. Gentle cranio-caudal separation of the rectus sheath and rectus muscles
7. Stretching in a transverse way to open parietal peritoneum, using index fingers in a cranio-caudal direction to make a small hole
8. Identification of the lower uterine segment and of the bladder
9. Transverse incision of visceral peritoneum 10–12 cm in total and 1 cm above the bladder
10. Fritsch or doyen retractor
11. Small transverse incision in lower uterine segment
12. Transverse stretching of the hole with right thumb and left index finger
13. Two fingers below to release the head
14. Fundal pressure to bring the baby down
15. The fingers guide the head out of the uterine opening
16. Delivery of the baby
17. Manual removal of the placenta
18. Exteriorization of the upper uterus out of abdominal wound
19. Massage of the uterus
20. Cleaning of the inside of the uterus with a towel to remove remnants of membranes and to stimulate contraction and retraction of the uterus
21. Repair of uterine wall with one layer of continuous locked stitch
22. In special circumstances second layer with cross stitches
23. Visceral and parietal peritoneum unstitched
24. Artery forceps to grasp the fascia
25. Continuous running unlocking suture
26. Closure of the skin with two or three maximum mattress suture.

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