Caesarean Delivery and Peripartum Hysterectomy

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Learning Objectives

After studying this chapter, you should be able to:

- Discuss the different indications for caesarean section.
- Describe the management of caesarean section in labour.
- Explain the surgical techniques of caesarean section.
- Understand the management of common complications of caesarean section.
- Define peripartum (caesarean/postpartum) hysterectomy and discuss its indication.
- List the risk management issues in caesarean section.

18.1 History of Caesarean Section

Caesarean section is the most commonly performed surgical operation in the world [1]. It is an operative technique by which a foetus is delivered through an incision in the uterus. It is performed for foetal or maternal benefit and is as old as modern obstetrics. Legend has it that Julius Caesar (100 BC) was born in this manner, and this may explain the origin of the name. However, there is no supporting evidence for this claim. Trolle's monograph provides a more comprehensive historical background. Caesarean section was popularised in the pre–World War II Britain following a paper published in 1931 by St George Wilson. Its use was associated with a high maternal mortality, with a rate of 3.5 per 1000 births in the UK in 1962. This was ten times that of the overall maternal mortality [2]. Caesarean section is now deemed a safe operation worldwide and this has led to substantial increase in its use. Improved operative techniques, thromboprophylaxis, availability of antibiotics and blood have resulted in a fall in maternal deaths associated with caesarean sections and maternal death is now quite rare. From 1988 to 1990, women undergoing elective caesarean sections were more than eight times likely to die than women having a vaginal delivery; from 1994 to 1996, they were approximately three times as likely to die; and by 1997 to 1999, the relative risk of death had decreased to slightly more than two. In Brazil, 'a middle income country with high caesarean section rate', caesarean section compared to vaginal delivery was associated with a significantly increased risk of postpartum maternal mortality, adjusted OR 2.9 [3].

18.2 The Incidence of Caesarean Section

There has been unprecedented increase in the use of caesarean section. Using the latest data from 150 countries, Betrán et al. calculated the incidence of caesarean to be 18.6%, ranging from 6% to 27.2% in the least and most developed regions, respectively. Latin America and the Caribbean region have the highest caesarean section (CS) rates (40.5%), followed by Northern America (32.3%), Oceania (31.1%), Europe (25%), Asia (19.2%) and Africa (7.3%). Based on the data from 121 countries, the trend analysis showed that between 1990 and 2014, the global average CS rate increased by 12.4% (from 6.7% to 19.1%) with an average annual rate of increase of 4.4%. The largest

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absolute increases occurred in Latin America and the Caribbean (19.4%, from 22.8% to 42.2%), followed by Asia (15.1%, from 4.4% to 19.5%), Oceania (14.1%, from 18.5% to 32.6%), Europe (13.8%, from 11.2% to 25%), Northern America (10%, from 22.3% to 32.3%) and Africa (4.5%, from 2.9% to 7.4%) [4]. Asia and Northern America were the regions with the highest and lowest average annual rate of increase (6.4% and 1.6% respectively). The gap between higher- and lower-resource settings remains despite an increase worldwide [4].

The increase in caesarean section rates is largely driven by a variety of factors. These include societal demands for improved foetal outcome and protection of the maternal pelvic floor, the aspirations of obstetricians to meet these demands and protect themselves himself from a highly litigating society. Potential difficult forceps delivery is a thing of the past, and similarly, the diagnosis of dystocia is more often managed by caesarean section. The advent of electronic foetal monitoring leads to the over-diagnosis of foetal distress and delivery of the foetus by caesarean section. Improved anaesthetic techniques, thromboprophylaxis and a wider choice of antibiotics for treatment of infection have made maternal deaths from caesarean section rare.

Unlike the developed nations, the caesarean section rate is low in low resource nations, as low as 1.4% in Niger; howbeit, the overall average has increased slightly to an average rate of 5.2% [5]. This is as a result of the poor access to the available facilities, lack of facilities and personnel. The high maternal and perinatal morbidity and mortality rate in this region is a reflection of the low caesarean section rate. This is a result of poor access to caesarean sections. There is suggestive evidence that a caesarean section rate of 3.6–6.5% is needed to address obstetric complications in West Africa, and that a rate of 2% is the required minimum [6]. J Ye et al. showed that the least developed countries in his study had the greatest relative changes of caesarean section rate (caesarean section rates increased 160% compared with the baseline), and this led to a phenomenal decline in maternal and neonatal mortality rate [5].

Conversely, the rising trend of caesarean section rates is gradually becoming the practice in some low resource nations and this has been shown to be driven by the private sector. A caesarean section rate of 55.6% was reported in Brazil [3]. There can be no medical justification for this and one hopes that medical needs and not financial gains will be the driving force for caesarean sections.

Studies suggesting that caesarean birth improved the outcomes of various complications of pregnancy led to use of caesarean delivery for certain conditions. As the primary caesarean rate rose due to more frequent increase in surgical intervention for these complications, the long-held tenets stating ‘once a Caesarean, always a Caesarean’ led to a rapid increase in the number of repeat caesarean births, as these women delivered subsequent pregnancies. The decision to perform a caesarean should involve calculating the trade-offs between risk and benefit to both the mother and foetus simultaneously. While caesarean delivery may be more morbid for the mother, it is often perceived as being the safest route of delivery for the infant [7]. Ideally, information about risks and benefits to both mother and infant, at least in the most common clinical situations, would be available to assist decision-making. However, in many cases such information does not exist [8].

Recent studies have shown that high caesarean section rates were associated with lower maternal and infant mortality until it gets to a specific point, at which caesarean section above these rates were not significantly associated with improved foetal outcomes. Hence this inflection point was considered as a necessary caesarean section rate from a medical viewpoint to minimise mortality. The significant and negative relationship between caesarean section rates and mortality was only found when the caesarean section rate was below 5–10%; hence, the study suggested that the aforementioned advantage of caesarean section reducing both maternal and neonatal mortality was lost once the caesarean section rate was greater than 10% [5].

The big question then is this, ‘Is there really an optimal caesarean section rate’? Recently, a global online survey of medical doctors who had performed at least one caesarean in the last 5 years was conducted and respondents were asked to report their opinion of the optimal caesarean rate (defined as the caesarean rate that would minimise poor maternal and perinatal outcomes); there was sizeable disparity in their responses, and this further highlights a lack of consensus around which women are in need of a caesarean among obstetric care providers worldwide [9].

The WHO in 1985 suggested that a rate between 10% and 15% was ideal, however, in their most recent statement WHO concluded that:

1. Caesarean sections are effective in saving maternal and infant lives, but only when they are required for medically indicated reasons.
2. At population level, caesarean section rates higher than 10% are not associated with reductions in maternal and new-born mortality rates.
3. 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. Caesarean sections should ideally only be undertaken when medically necessary.
4. Every effort should be made to provide caesarean sections to women in need, rather than to achieve a specific rate.
5. The effects of caesarean section rates on other outcomes, such as maternal and perinatal morbidity, paediatric 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.

The WHO has also proposed that the Robson classification system be used as a global standard for assessing, monitoring and comparing caesarean section rates within and between healthcare facilities over time. The WHO plans to develop guidelines for the use, implementation and interpretation, including standardisation of terms and definitions of the Robson classification in order to assist healthcare facilities [10]. Further, JP Souza et al. using the WHO Multi-Country Survey on Maternal and Newborn Health created a mathematical model, the 'C-Model', a tool designed to guide obstetric teams, health managers and other stakeholders in the complex task of optimising the use of CS. They built their model including comparison of caesarean rates across different populations and institutions, they applied dynamic econometric models to assess aggregate level determinants of caesarean section rates in developed countries, and made adjustments for Robson's Ten-Group Classification System, as well as clinical and socio-demographic variables of the mother and the foetus for inter-hospital comparisons of CS rates. Through a customised estimate of CS rates, the C-Model may provide a locally relevant reference of what would be an optimal CS rate. Nevertheless, this should not be used to prevent a woman that needs a caesarean from having one or vice versa [1].

18.3 The Indications of Caesarean Section

The most common indications for caesarean section in the United States are previous caesarean section, failure to progress in labour and foetal distress, accounting for 35%, 30% and 8% of caesarean sections respectively [11]. The rising rates of caesarean section have led to questions being raised about the appropriate use of caesarean sections for many indications. These questions are motivated by several observations. First, the United States has higher rates of infant mortality than many developed countries in which caesarean rates are less than half of those in the United States [12]. Second, there is considerable variation in the use of caesareans between regions of the United States, and from hospital to hospital [13]. This variation does not appear to be explained by differences in clinical risk factors, since non-clinical factors such as hospital ownership, hospital teaching status, payment source and volume of deliveries have also been shown to influence the rate of caesarean births [14, 15]. All of these observations suggest that factors other than the health benefits to mother or infant may influence the decision to perform caesarean delivery [16].

We continue to witness a rise in caesarean section rate due to factors as maternal request for social reasons and perceived medical reasons such as the protection of the pelvic floor muscles. Some observers have suggested that the caesarean rate has been affected by other factors, such as defensive medicine and financial rewards in the private sector. Further research is required into these emerging indications.

18.4 Cephalopelvic Disproportion (CPD)

Failure to progress in labour or dystocia is a leading indication for primary caesarean section and has a major impact on escalating caesarean section rate (CSR) especially in the United States [17]. Studies have shown that the diagnosis of CPD has no prognostic value from one pregnancy to the next and generally should not exclude a patient from a trial of labour. In women with a cephalic presentation who had an arrest of descent in the second stage of labour during their first delivery, the chances of vaginal delivery in their next pregnancy are high, even after a failed instrumental vagina delivery, and a trial of labour can usually be pursued with success [18]. In the study of 132 women in their second pregnancy and who had a caesarean section in the first pregnancy, 29 (22%) underwent planned repeat caesarean section. Of the 103 women who were allowed a trial of labour, 82 (80%) were successful in having vaginal delivery, and 21 (20%) had a second caesarean section. Of the 74 women with failed trial of instrumental delivery during the previous labour, 19 had a planned repeat caesarean section while 41 of the remaining 55 (75%) had successful trial of labour.

18.5 Foetal Distress in Labour

This is an acceptable indication for caesarean section. Peter et al. [19] found that foetal distress was the indication for 25% of caesarean sections in their study. The diagnosis of 'fetal distress' is open to different interpretations. Initially, Apgar scores were used to determine the presence or absence of 'true' distress, but they have been shown to correlate poorly with other morbidity measures and with long term outcomes [20]. The development of procedures such as electronic foetal monitoring (EFM) for the diagnosis of foetal distress has been made difficult by the fact that they were introduced into clinical practice without being subjected to clinical trials and the lack of a 'gold standard' against which they can be assessed. Inter and intra-observer reliability of cardiotocography (CTG) interpretation is poor. In one study, four obstetricians were asked to read 50 different CTG tracings. Only 11 of the 50 tracings were assessed in the same way 'need for immediate delivery' by all four physicians. 21% of the tracings were interpreted differently by individual obstetricians when re-assessed 2 months later [21]. The diagnosis of hypoxia based on cardiotocography (CTG) alone has led to an increase in caesarean section rate (CSR). The use of foetal scalp pH to confirm the diagnosis of foetal distress in labour is recommended. Ayromlooi and Garfinkel

[23] found that foetal blood sampling has helped reduce the CSR. MacDonald et al. [24], however, have shown that electronic foetal monitoring did not influence the number of caesarean sections in low-risk pregnancies at the National Maternity Hospital, Dublin. Electronic foetal heart monitoring is indicated in high-risk women.

18.6 Breech Presentation

Breech babies are often prone to birth injuries and intrauterine hypoxia during vaginal deliveries. Kubli et al. [24], found that foetal acidosis was much more common in breech than cephalic presentations and concluded that all breeches should be delivered by caesarean section. The management dilemma of best mode of delivery persisted for years until when the term breech trial, a randomised control trial, recommended caesarean section as the safer option of delivery. The trial involved 2088 women from 121 centres in 26 countries, all of whom were at least 37 weeks pregnant with a single live foetus in a breech position between January 1997 and April 2000. The women were randomly assigned to have either a planned caesarean delivery or a planned vaginal birth. The trial showed that in pregnant women with breech presentation, planned caesarean section had a lower risk for perinatal mortality and serious morbidity than did planned vaginal birth [25]. This has changed the management of breech foetuses and has contributed to the rising rate of caesarean section. The trend in the UK in line with the RCOG guideline is to offer women who have an uncomplicated singleton breech pregnancy at 36 weeks' gestation external cephalic version with the exceptions of women in advanced labour and women with a uterine scar or major uterine abnormality, foetal compromise, ruptured membranes, recent vaginal bleeding, multiple pregnancy or medical conditions (Royal College of Obstetricians and Gynaecologists. The Management of Breech Presentation. Guideline No. 20. London: RCOG Press; 2001). This is aimed at reducing the need for caesarean section. If external cephalic version is contraindicated or unsuccessful, the women are offered caesarean section because it reduces perinatal mortality and neonatal morbidity [26].

Paul et al. [27], examined 72 patients with breech presentation and found that vaginal delivery was achieved in 46%, and 18% allowed a trial of labour. Access to a delivery suite with facilities for performing a caesarean section is not always possible in developing nations and the inevitability of carrying out vaginal breech deliveries exists. Schutte et al. [29] and O'Driscoll and Foley [28] showed that breeches could be safely delivered vaginally. However, certain criteria have to be met to improve the likelihood of a safe delivery. These criteria include the following:

(i) Anticipated foetal weight is 3.5 kg or less by ultrasound examination (or clinical estimation where ultrasound is not available)
(ii) Frank breech presentation with flexed head
(iii) The presence of an experienced obstetrician to conduct the delivery

Planned caesarean section compared with planned vaginal birth has been shown to reduce perinatal or neonatal death as well as the composite outcome death or serious neonatal morbidity, but this is at the expense of slightly increased maternal morbidity. Remarkably, a 2-year follow up, has identified that there were increased infant medical problems following planned caesarean section and there were no differences in long-term neurodevelopmental delay or the outcome of 'death although the numbers were too small to exclude the possibility of an important difference in either direction' [30]. Thus, the benefits need to be weighed against factors like the mother's access to a safe hospital for her future trial of labour (especially in a resource poor country with limited hospitals and obstetricians), her preference for vaginal birth, and the risks to her future pregnancy complications in the woman's specific healthcare setting.

18.7 Multiple Pregnancy

There is little evidence regarding the best mode or type of delivery for women with multiple pregnancy [31]. There is ongoing debate as to the optimum mode of delivery for multiple pregnancy. This has been due to the increasing recourse to caesarean section for the delivery of the second twin. One limited trial found no advantage of caesarean section for a second twin presenting other than as a vertex [32]. There is a place for advocating an elective caesarean section in high order multiple pregnancy in order to prevent birth trauma in the small foetuses.

It would be logical to think that the abdominal distension associated with multiple pregnancy may predispose to dehiscence or rupture of a previous caesarean section scar. Gilbert et al. [32], in a retrospective study showed that a transverse low uterine segment scar does not present a risk because of uterine distension secondary to a twin pregnancy. Strong et al. [33], studied the pregnancy outcome of 56 women with twin gestation and a previous section birth. In these patients, 31 (55%) underwent an elective repeat caesarean delivery and 25(45%) attempted a vaginal delivery. In the latter, 18 (72%) were vaginally delivered of both infants. The dehiscence rate among women with twin pregnancies who attempted a trial of labour was 4%, compared with 2% in women with a singleton pregnancy.

'The Twin Birth Study', a Randomised Trial of Planned Caesarean or Vaginal Delivery for Twin Pregnancy, as well as a Cochrane review have concluded that in twin pregnancy

between 32 weeks 0 days and 38 weeks 6 days of gestation, with the first twin in the cephalic presentation, planned caesarean delivery did not significantly decrease or increase the risk of foetal or neonatal death or serious neonatal morbidity, as compared with planned vaginal delivery. Hence, there is insufficient evidence to support the routine use of planned caesarean section for term twin pregnancy with leading cephalic presentation [34, 35].

18.8 Very Low Birth Weight Babies (500–1499 g)

Increasing numbers of very low birth weight (VLBW) infants are being delivered by caesarean section in order to reduce the incidence of birth trauma. However, population-based data do not support the view that caesarean section enhances the neonatal survival of VLBW babies when obstetric complications are absent [36]. Caesarean section has been shown to be beneficial to LBWB with breech presentation [37]

18.9 Prevention of Mother-to-Child Transmission of Maternal Infections

Women with viral blood borne infections need to be given information as early as possible about the risks and benefits for them and their child as well as of the treatment options and mode of birth so that they can make an informed decision. They should not be routinely offered a caesarean section on the grounds of their infection. To prevent mother-to-child transmission of HIV offer vaginal birth to women on highly active anti-retroviral therapy (HAART) that have a viral load of less than 400 copies per mL or if on any anti-retroviral therapy with a viral load of less than 50 copies per mL as the risk of HIV transmission is the same for a CS and a vaginal birth [26].

They can either have a vaginal birth or a CS for women on anti-retroviral therapy (ART) if their viral load is between 50 and 400 copies per mL because there is insufficient evidence that a caesarean section prevents mother-to-child transmission of HIV. However, 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 should be advised to have a caesarean section [26].

Mother-to-child transmission of hepatitis B can be reduced if the baby receives immunoglobulin and vaccination. Hence, pregnant women with hepatitis B should not be offered an elective caesarean birth as there is insufficient evidence that this reduces mother-to-child transmission of hepatitis B virus [26]. Additionally, 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. Though, pregnant women who are co-infected with hepatitis C virus and HIV should be offered planned CS because it reduces mother-to-child transmission of both hepatitis C virus and HIV [26].

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. Conversely, if it is a recurrence of HSV the risk of transmission is less. Therefore, CS should not routinely be offered [26].

18.10 Maternal Request

A new trend is arising with women requesting caesarean section, where some women have a genuine fear of labour 'Tocophobia', others cannot be bothered to push for various reasons, 'the too posh to push group'. These women who request a caesarean section (when there is no clinical indication) need to have a documented discussion with members of the maternity team about the overall risks and benefits of a caesarean section compared with vaginal birth [38]. Those who request a caesarean section because of anxiety about childbirth should be referred to a healthcare professional with expertise in perinatal mental health support [38]. Two small randomised trials suggested that a nurse-led relaxation training programme for women with a fear or anxiety of childbirth as well as birth preparation sessions were effective in reducing caesarean section rates [39].

Sydsjö G et al. investigated the prevalence of psychiatric illness amongst women who requested for caesarean section and found psychiatric illnesses was significantly higher in women giving birth by caesarean section on maternal request. The most common diagnoses were 'Neurotic disorders, stress-related disorders and somatoform disorders' and 'Mood disorders'. Further, in his study, women giving birth by caesarean section on maternal request were older, smoked more, had a lower educational level, higher body mass index, were more often married, unemployed and their parents were more often born outside of Scandinavia [40]. It is imperative that patient-centred care is offered and patients provided with full information to aid them in decision-making about their care.

18.11 Classification of Caesarean Section

The National Institute of Health and Care Excellence (NICE) guidelines in the UK advised that the urgency of caesarean section should be documented using a standardised scheme in order to aid clear communication between healthcare professionals about the urgency of a CS. They classify caesarean section from category 1–4 [26].

1. Immediate threat to the life of the woman or foetus
2. Maternal or foetal compromise which is not immediately life-threatening
3. No maternal or foetal compromise but needs early delivery
4. Delivery timed to suit woman or staff

Obstetricians are advised to perform category 1 caesarean section as quickly as possible after making the decision, that is, the decision-to-delivery intervals should be within 30 min. Category 2 caesarean section in most situations should be performed within 75 min of making the decision. Nonetheless, care should be taken to consider the condition of the woman and the unborn baby when making decisions about rapid delivery, because rapid delivery may be harmful in certain circumstances. This is not a tool to measure the overall performance of an obstetric unit, or to judge multidisciplinary team performance for any individual caesarean section. It is to communicate urgency to the multidisciplinary, and it could also be used as a tool for audit standards [26].

In the developing countries, the recommendation of decision delivery interval of 30 min is not currently feasible; several studies have shown that in only between 0% and 6% of cases were the caesarean done within 30 min. Anaesthetic delay was the major cause of delay in carrying out emergency caesarean sections. The average interval in the studies were between 100 and 400 min, although the decision delivery interval was not deemed to correlate with perinatal outcome. The perinatal outcomes used were Apgar scores, admission to neonatal unit as well as perinatal death, but there is a great spectrum between a healthy baby and a dead one [41–43]. Nonetheless, effort should be made to expedite caesarean section when it is life threatening to either the mother or the foetus.

18.12 Elective Caesarean Section

The indications for an elective operation are often relative rather than absolute. Factors such as maternal age, relative infertility, past obstetric history, as well as foetal age and estimated weight are taken into consideration. Maternal request is increasingly becoming an acceptable indication for elective and emergency caesarean sections. In the developing world, cephalopelvic disproportion is fairly common due to the small underdeveloped pelvis in teenage brides. In Europe and other developed parts of the world, cephalopelvic disproportion is not common and not a usual indication for primary elective caesarean section. Elective caesarean section is usually performed following a previous caesarean section due to suspected cephalopelvic disproportion. However, a repeat caesarean section may not be necessary if the babies in subsequent pregnancies are much smaller than the baby born previously by caesarean section.

An elective caesarean section is justified whenever it is deemed that the uterus or foetus could be damaged during labour. Previous uterine surgery or injury normally constitute a real hazard though the degree of potential danger will often depend on the site of the scar, the clinical conditions influencing previous healing, for example, infection, and the site of the placenta in the current pregnancy.

If there is a uterine anomaly or anomaly of the lower genital tract, which precludes vaginal delivery or endangers nearby structures, for example, a successful vesico-vaginal fistula repair, or surgically treated stress incontinence, elective caesarean section may be preferable. Both minor and major degrees of placenta praevia or fulminating pre-eclampsia are special indications for elective caesarean section.

The usual time for an elective caesarean section for such reasons like cephalopelvic disproportion, breech presentation, placenta praevia, or previous caesarean section is after 37 completed weeks and not beyond 40 weeks gestation, preferably after the 39 weeks to reduce the risk of admission to neonatal unit. It is good clinical practice to ascertain foetal maturity by referring to the gestational age as calculated from a dating ultrasound scan to avoid the delivery of a premature baby.

In situations such as foetal growth restriction, the timing of the operation will require a careful judgment. One needs to balance the risks of prematurity and continued intrauterine existence. Antenatal cardiotocography with the addition of foetal umbilical artery Doppler studies, where available, will help to determine the optimum time for delivery. The administration of antenatal corticosteroids to the mother will help promote foetal lung maturation and is recommended.

18.13 Caesarean Section in Labour

It is sometimes necessary to abandon a proposed vaginal delivery in favour of an abdominal delivery. The indications for this change are usually fairly clear – obstructed labour occurring during labour or the appearance of foetal or maternal distress prior to full cervical dilatation. Before deciding to operate, it is important for the obstetrician to confirm that foetal distress is not being caused simply by the injudicious use of oxytocics over-stimulating uterine activity. Also, if maternal distress is being aggravated by pain, it may be sensible to consider introducing epidural analgesia before finally deciding upon the need for caesarean section.

Delay in the progress of labour, especially during the first stage, is probably the commonest reason for considering the need to deliver a baby abdominally. In this clinical situation, it is helpful to have partographic evidence of

delay, as the visual evidence of a partograph often helps the obstetrician to distinguish between any sudden onset of delay after normal progress and the slow latent or first stage of labour.

In addition to partography, it is helpful to have some reliable quantitative measure of uterine activity. Simple clinical assessments of uterine activity are rather unreliable. Many potential caesarean sections for uterine inertia can probably be avoided by recognising quantitatively that uterine activity is sub-optimal. The restoration of optimal uterine activity by oxytocic stimulation may then be attempted. If optimal activity according to quantitative criteria cannot be restored, or if delay continues despite optimal uterine activity, the indications for caesarean section become much clearer. A common example of the value of using quantitative assessments of uterine activity is the slow rotation of a foetal head from the occipito-posterior position. This will often result from uterine inertia rather than from any disadvantageous cephalopelvic relationships. If optimal uterine activity can be secured, abdominal delivery may well be averted. Conversely, if delayed progress continues despite the stimulation of uterine activity that is quantitatively satisfactory, there is a clear indication to proceed to caesarean section. Delay in labour in a multiparous woman is to be viewed with extreme suspicion. This clinical situation always necessitates prompt and careful evaluation. Uterine inertia is a most uncommon cause.

In the developing countries with inherent lack of maternity services and facilities, obstructed labour complicated by significant delay and impaction of presenting part, maternal and foetal distress or even intrauterine foetal death, are not uncommon especially among unbooked patients. This is a situation almost unknown in the developed world. When the situation does occur, the patient presents a serious operative risk. Despite the need for haste in proceeding with the operation, adequate time must be spent to properly resuscitate the patient. Dehydration must be corrected as well as any electrolyte deficit or acidosis. Central venous pressure monitoring will be required if the patient is in shock, and in the presence of septicaemia, broad-spectrum antibiotics are necessary and probably steroid therapy as well. De Lee incision (a low vertical instead of a low transverse) in the uterus is recommended when, because of thinning and distension of the lower segment, there is a danger that any transverse incision may extend laterally and compromise major vessels or the uterus. A particularly dangerous circumstance is a neglected shoulder presentation with a prolapsed arm. In obstructed labour, the bladder is usually bruised and friable and may extend much higher into the abdomen than is usual. To avoid damage to the bladder, the parietal peritoneum must be entered higher than usual and the bladder must be reflected downwards with extreme caution.

18.14 Surgical Technique of Caesarean Section

Pre-operative preparations include haemoglobin estimation, blood group determination and saving for cross-match. The use of a lateral 15° wedge at caesarean section is now mandatory in order to reduce the effects of caval occlusion during surgery. Immediate pre-operative preparation also includes administration of sodium citrate by mouth or H_2 antagonist.

The commonest incision is a transverse incision on the lower segment of the uterus. The lower segment is approached through a Pfannenstiel incision, a transverse incision through the skin and external sheath of the recti muscles, about an inch above the pubes. It follows natural folds of the skin and curves over mons pubis in such a way that the pubic hairs cover the cicatrix.

More recently, the transverse incision of choice is 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), this is because it is associated with shorter operating times and reduced postoperative febrile morbidity [26]. A lower segment uterine incision is widely used, as it has a much lower risk of scar rupture than a classical incision (0.5% compared with 2.2%). Care must be taken to reflect the bladder downwards before incising the uterus; it is at this time that most bladder injuries occur. The classical incision that employs a midline uterine incision is rarely used today. It may be indicated in a few situations such as in the presence of cervical carcinoma, and with a transverse lie with a prolapsed arm [17]. It may also be indicated if the lower half of the patient's uterus is very vascular as may occur in placenta praevia, or inaccessible as the result of adhesions from a previous operation joining her lower segment to her abdominal wall. A classical incision may also be used in the delivery of pre-term infants at less than 28 weeks gestation when the lower segment is not sufficiently formed.

The De Lee incision is a modified classical incision. It is a vertical incision, two thirds of which are in the lower segment, and one-third in the upper one. It is thus a cross between the classical upper segment operation, and the ordinary lower segment one. It is advisable to make a De Lee incision if a lateral tear is likely, as can happen if the lower segment is very thin, or the baby is in an abnormal position, as in a transverse lie. It has the advantages of allowing easier access than the lower segment incision and causes less bleeding than a classical incision. Most studies of scar rupture do not differentiate between a classical and a De Lee incision but the risk of rupture of the latter incision is usually quoted as lying between that of the classical and lower segment incisions. Patients who have had a previous classical, low vertical incision or an inverted T-incision should be delivered by

an elective caesarean section in subsequent pregnancies in order to minimise the risk of uterine rupture.

The number of layers to repair the uterus has been contentious; however, a recent meta-analysis found that 'the risk of uterine rupture during trial of labour after a single-layer closure was not significantly different from that after a double-layer closure'. However, a sensitivity analysis indicated that the risk of uterine rupture was increased after a locked single-layer closure but not after an unlocked single-layer closure, compared with a double-layer closure [44].

18.15 Peritoneal Closure

The sutures used to close the peritoneum may cause more adhesions than if the peritoneal edges were left unsutured. The traditional practice until recently was to close the peritoneum at caesarean section. It has been shown that for gynaecological procedures, omitting peritoneal closure does not increase the length of hospital stay or the subsequent development of adhesions [45]. It would therefore seem logical to apply this to caesarean section.

The Royal College of Obstetricians and Gynaecologists as well as the NICE guidelines in the UK recommend non-closure of the peritoneum at caesarean section. Studies have shown that non-closure of the parietal peritoneum results in significantly shorter operating time and post-operative hospital stay. It is also associated with lower post-operative febrile morbidity and postoperative use of analgesics [26]. A recent Cochrane review concluded that there is insufficient evidence of benefit to justify the additional time and use of suture material necessary for peritoneal closure [46].

18.16 Anaesthesia for Caesarean Section

Factors to be taken into consideration when choosing an anaesthetic for caesarean section include the safety of the mother, the safety of the foetus, the experience of the anaesthetist and the ability to perform the surgery under that anaesthetic technique. Caesarean section can be performed under general or regional anaesthesia. Regional anaesthesia includes both spinal and epidural anaesthesia. Increasing numbers of caesarean sections are performed under regional anaesthesia for safety reasons, and it is the preferred method when time is not as much of a factor [26].

Regional anaesthesia includes both spinal and epidural techniques. Contraindications to the use of regional anaesthesia include patients with bleeding and clotting abnormalities, patients with neurological problems and patients with infections that might be spread to the spinal area if regional anaesthesia is done.

Spinal anaesthesia is faster and simpler to place, works slightly faster and is less technically complicated than an epidural anaesthesia. A combined spinal epidural has a single injection like a spinal anaesthesia, as well as, an epidural catheter placed in the back; this allows the anaesthetic, Marcain, to be given repeatedly or continuously. If an epidural catheter is already in place for labour analgesia, then it makes sense to utilise this, should a caesarean become necessary. An epidural may also be used for postoperative pain control. Music is increasingly being used in theatre, current studies indicate that music during planned caesarean section under regional anaesthesia may improve pulse rate and birth satisfaction score [47].

The main disadvantages of general anaesthesia include the fact that the mother is unconscious and, therefore, unable to participate in the process of birth or interact with the baby once it is delivered. General anaesthesia is performed when there is an urgent need to deliver the baby. The advantages of general anaesthesia are that it can be given very quickly and the blood pressure is more easily controlled. The disadvantages of general anaesthesia include the fact that it wears off quickly, resulting in greater post-operative pain and increasing the need for postoperative analgesia. The other disadvantage is that there are some significant risks associated with general anaesthesia. Anaesthetic complications at present account for 5% of all direct deaths associated with caesarean section. Almost all of these are associated with general anaesthesia. The primary causes are failure of endotracheal intubation and inhalation of acidic stomach contents resulting in Mendelson's syndrome. Failure of intubation may be due to anatomical variations in the patient's neck or jaw or an abnormally small larynx or trachea.

It is recommended that an anaesthetist of at least registrar grade should cover a labour ward and a fully trained assistant (operating department personnel) should be present. The complications of a failed intubation can be minimised by regularly carrying out a failed intubation drill. Mendelson's syndrome accounted for 32 maternal deaths in the first report on confidential enquiries into maternal deaths in 1952. Better understanding of the disease process has led to the use of important therapeutic strategies to minimise the risks of aspiration and has led to a progressive reduction in the maternal death rate from aspiration syndromes to the extent that no maternal deaths were reported in the confidential enquiries into maternal deaths (1988–1990). The therapeutic strategies that have been adopted include the use of cricoid pressure at induction in association with pre-oxygenation and the use of a cuffed endotracheal tube to protect the airway. The administration of ranitidine, an H2 antagonist is used to raise the gastric pH and is more effective than sodium citrate at raising gastric pH. If used prior to elective caesarean section, two oral doses of ranitidine (150 mg) should be given, one the night before surgery and one on the morning of the opera-

tion. For emergency caesarean section, ranitidine 50 mg can be given intravenously. Sodium citrate should also be used. H2 antagonists may have the additional advantage of reducing gastric volume. The combined use of ranitidine and sodium citrate will raise gastric pH above 2.5 in the great majority of women in labour [48]. Women are also given anti-emetics to reduce nausea and vomiting during CS. General anaesthesia for emergency caesarean delivery should include pre-oxygenation, cricoid pressure and rapid sequence induction to reduce the risk of aspiration [26].

18.17 Complications of Caesarean Section

As with other surgical operations, caesarean section is not without its risk. The risks of caesarean section include maternal death, haemorrhage, venous thrombosis, infection, and anaesthetic complications. The latter has been dealt with in the preceding paragraph. Intraoperative surgical complications include damage to adjacent organs, for example: bladder, ureter or bowel, as well as inadvertent damage to the uterus or cervix. The occurrence of one or more of these complications is reported to be approximately 12% [49]. Caesarean sections performed during labour have overall complication rates greater than during a planned procedure (24% compared with 16%). Further, complication rates are higher at 9–10 cm dilatation when compared with 0–1 cm (33% compared with 17%) [50].

18.18 Maternal Death

The estimated risk of a woman dying after a caesarean section is less than one in 2500 (the risk of death after a vaginal birth is less than one in 10,000). The absolute risk of death in childbirth is small. In 1997–1999, there were two million births in the UK, of which 400,000 were by caesarean section. Sixty-nine women died at or shortly after giving birth; 40 of these deaths were after caesarean section, giving a fatality rate for caesarean section around five times greater than vaginal birth [38]. It cannot necessarily be concluded that caesarean section is more dangerous than vaginal birth because pre-existing conditions may have influenced the decision to carry out the CS and the outcome. Complications from caesarean section including maternal mortality and sepsis are, however, much higher in the developing countries. Ojo et al. [51] in a retrospective analysis of 27 maternal deaths after caesarean section over 5 years in Nigeria, found that caesarean section was 4.1%. Maternal mortality rate (MMR) following caesarean section was 18.1 per 1000 (81.5% from sepsis) while 1.89 per 1000 MMR from Egypt was equally high at 5% of all maternal mortality [52]. Factors contributing to this high maternal mortality include sepsis, obstructed labour, poor access to facilities, lack of equipment and poorly trained personnel. The risk of postpartum maternal death was almost threefold higher with caesarean than vaginal delivery, mainly due to deaths from postpartum haemorrhage and complications of anaesthesia [3].

Due to very low maternal mortality in developed countries, significant maternal morbidity is often used as an indirect means for maternal mortality which is described as ‘near misses’. The overall incidence of near miss is about 7.1 per 1000 births and, irrespective of the mode of birth, advanced maternal age, high BMI and nulliparity were identified as significant risk factors. Any type of caesarean birth was associated with a five-times increased risk of near miss [53].

18.19 Haemorrhage

Blood loss at caesarean section is about twice as much as with vaginal delivery. However, the overall incidence of intra-operative blood transfusion for acute blood loss at caesarean section is between 0.6% and 1.0%. Haemorrhage accounts for 6% of deaths associated with caesarean section and an unknown proportion of postoperative morbidity. Risk factors include placenta praevia, placental abruption and uterine atony in multiple pregnancy or multiparous patients. Patients requiring a cross-match of blood prior to caesarean section include those with placenta praevia Grade IV and severe pre-eclampsia with evidence of coagulopathy. Disseminated intravascular coagulation is a rare cause but must be considered in cases of continuing haemorrhage.

Haemorrhage may be primary, delayed primary or secondary. Bleeding may come from the placental bed or may be due to a tear or extended uterine incision into major vessels. A rapid first line of uterine sutures must be placed to close the uterine incision taking care to include the angles in the suture. Delivering the uterus onto the abdomen may facilitate this. Bleeding tears should be repaired in two layers. Caution should be exercised to avoid injuring the ureter when repairing extended tears.

Uterine atony may be corrected by a bolus dose of 10 units of syntocinon given intravenously followed by a continuous infusion of 40 units of syntocinon in 500 mL of normal saline over 2 h. The use of Hemabate (carboprost tromethamine) should be considered if uterine atony and bleeding persists. Hemabate may be injected directly into the uterine muscle or given intra-muscularly. If haemorrhage continues, more radical surgical intervention is required. The B-Lynch suturing technique (brace suture) may be particularly useful because of its simplicity of application, life-saving potential, relative safety, and its capacity for preserving the uterus and, thus, fertility. Satisfactory haemostasis can be assessed immediately after application. The special advantage of this innovative technique is an alternative to major surgical procedures to control pelvic arterial pulse pressure or hysterectomy. This sutur-

ing technique has been successfully applied with no problems to date and no apparent complications documented [54].

If the B-Lynch suture fails, more radical surgical methods should be considered. These include tying off the uterine arteries and, if unsuccessful, ligating the internal iliac arteries. The long-term blood supply to the uterus is not compromised as an adequate collateral circulation is already present and takes effect immediately [55]. There is no compromise of the pelvic tissues following internal artery ligation, and subsequent normal pregnancies have been reported. If there is access to interventional radiologist, internal iliac catheters or embolisation could be used, this helps to reduce the bleeding and may completely stop the haemorrhage and prevent hysterectomy. The reader is referred to the treatment of the collapsed obstetric patients in other text.

18.20 Deep Venous Thrombosis and Pulmonary Thrombosis

Thrombosis and thromboembolism remains once again the leading cause of direct maternal death [56]. Pulmonary embolism is the major cause of maternal mortality following caesarean section accounting for 15% of direct deaths. Pregnant women and in particular those with a history of thromboembolic disease are at appreciable risk during pregnancy. The reported incidence of deep vein thrombosis (DVT) and non-fatal pulmonary embolism varies considerably because of the peculiar diagnostic difficulties in pregnancy. Real time ultrasound scanning combined with Doppler studies, being noninvasive, are the first line diagnostic techniques for DVT in pregnancy [57]. The majority of deaths from pulmonary embolism following caesarean section occur after the first week of the puerperium after discharge from hospital. All those involved with the care of women in the puerperium must be alert to this possibility. A clinically recognisable deep venous thrombosis precedes only 50% of cases of pulmonary embolus and, therefore, clinical suspicion must be high. The patient may present with a pyrexia, cough, shortness of breath, or acutely collapsed. It is essential that an accurate diagnosis be made, as inappropriate full anticoagulation carries risk to mother and foetus.

The Royal College of Obstetricians and Gynaecologists [57] recommend the following guidelines:

18.21 Prophylaxis Against Thromboembolic Disease in Patients Undergoing a Caesarean Section

- A risk assessment should be performed.
- Early mobilisation and adequate hydration are required.
- Patients at moderate risk should receive subcutaneous heparin or mechanical methods (Flowtrons).
- Patients at high risk should receive heparin prophylaxis and, in addition, leg stockings would be beneficial.
- Prophylaxis should be continued for 10 days or more depending on risk assessment.
- Subcutaneous heparin can be used after 4–6 h post operation in patients with an epidural or spinal block.

18.22 Caesarean Section and Chorioamnionitis

Chorioamnionitis is an overt intrauterine infection involving the amniotic fluid, placental membranes and the baby. The incidence of histologic chorioamnionitis (44%) is far larger than the incidence of culture positive amniotic fluid that is about 26% of clinical chorioamnionitis (9.6%) [58]. These are European figures and it would be expected to be much higher in the African setting in view of the general state of poor hygiene and sterility.

Premature rupture of the membranes is the commonest antecedent of significant intra-amniotic infection. Foetal and maternal tachycardia associated with low-grade pyrexia, and possibly offensive liquor, may be the earliest signs of developing infection. Broad-spectrum parental antibiotics should be commenced immediately. The mode of delivery will depend on the gestational age, state of the cervix and the foetal condition. Caesarean section should be considered if foetal maturity exceeds 26 weeks and the foetus is normal.

Extraperitoneal caesarean section is indicated if there is established chorioamnionitis. The presence of antibiotics, particularly metronidazole, has made the need for extraperitoneal approach unnecessary. Its use is recommended in the absence of antibiotics as it greatly reduces the incidence of life-threatening peritonitis. Excluding the incision in the uterus from the peritoneal cavity reduces the risk of peritonitis. To do this, the parietal peritoneum is reflected from the inside of the abdominal wall, the visceral peritoneum from the front of the lower uterine segment, and both tied together. This seals off the peritoneal cavity from the incision that is then made into the infected uterus. Suction evacuation of liquor following an incision into the uterus also minimises the risk of spreading infection by spillage. Irrigation of the extraperitoneal space should be performed post-operatively.

18.23 Peripartum (Caesarean/Postpartum) Hysterectomy

Postpartum hysterectomy (PH) refers to hysterectomy done either after vaginal delivery or skin closure after caesarean section, while caesarean hysterectomy is done in the same surgical case as caesarean delivery. Peripartum hysterectomies are largely unplanned and usually performed to control life-threatening haemorrhage and often done as an

emergency. The most common indication for peripartum hysterectomy is uncontrollable maternal haemorrhage especially associated with a morbidly adherent placenta. It may also be performed for co-existing cervical or uterine carcinoma, uterine rupture, or as a sterilising procedure [59]. Peripartum hysterectomy (PH) remains one of the obstetric catastrophes. It is associated with increased maternal mortality, considerable morbidity and it brings an abrupt, and usually unwelcome, end to a woman's reproductive potential [60–62].

PH complicates about 1 in 1000 deliveries [60]. The incidence, however, can vary from 1 in 442 in a Nigerian series compared with 1 in 1243 in a North American series, and 1 in 6967 in an Asian study [61–63]. The incidence varies over time, depends on the healthcare setting, and is strongly influenced by caesarean delivery rates [64]. The incidence of this procedure is lower in the United Kingdom than the United States as elective hysterectomy is usually postponed until after the puerperium when it is less hazardous. A study comparing outcomes of caesarean section showed that hysterectomy was uncommon in the vaginal birth reference group (0.05%) but was over 4 time more common among women who experienced both elective, and emergency caesarean delivery [65, 66].

18.24 Indications

Massive maternal haemorrhage is the commonest cause for postpartum hysterectomy. However, the underlying causes include uterine atony, uterine rupture and placental bed pathology [64]. There is a rising indication to undertake postpartum hysterectomy in cases of placenta accreta/percreta [67, 68]. An increase in PH for placenta accreta/percreta has also been reported and is associated with the rising caesarean delivery rate [69]. The risk of caesarean hysterectomy rises with the increasing number of prior caesareans [70].

Women with a prior caesarean should ideally have an ultrasound examination for placental localisation before the third trimester. The diagnosis of placental bed pathology and/or praevia may be suspected on ultrasound and, if the resources are available, other imaging technologies such as Doppler may be helpful diagnostically [71]. If the possibility of PH for placenta accreta/percreta is anticipated, the mother, her family and her medical team can prepare. The caesarean delivery should be performed under the supervision of an experienced obstetrician and anaesthetist. If a hysterectomy, particularly a total procedure, becomes necessary, assistance from a gynaecological oncologist should be considered if the obstetrician is not experienced in performing difficult hysterectomies. Total hysterectomies for placental bed pathology can be anticipated, whereas hysterectomy for atony usually cannot. An in-depth discussion about the management of patients with placenta accreta or percreta is beyond the scope of this chapter. Suffice to say that it requires multiprofessional management.

The rising rate of repeat elective caesarean delivery has conflicting effects on the incidence of PH. On the one hand, repeat elective caesarean delivery should, in the short-term, decrease the number of PHs for haemorrhage associated with either uterine rupture or traumatic intrapartum vaginal delivery because of the association between haemorrhage and caesarean in labour [69]. On the other hand, repeat caesareans are associated, in the long-term, with an increase in PH for pathological placental localisation, particularly as the number of repeat elective caesareans increases [70]. A woman with a prior caesarean whose family is complete may minimise her risk of hysterectomy by opting for a repeat elective caesarean [64].

The maternal death rate associated with caesarean hysterectomy from all causes is 0.7% [72] compared to 0.05% for all caesarean sections. Complication of caesarean hysterectomy is similar but higher than caesarean delivery. If hysterectomy is performed for uncontrolled uterine bleeding after delivery, the risk of the patient having disseminated intravascular coagulation (DIC) is high. Caesarean hysterectomy should not be left too late as the risk of uncontrollable haemorrhage is increased. Pelvic tissue in pregnancy is lax with increased oedema and vascularity, therefore, care is needed especially in tying pedicles, and the uterine side of the pedicle may also need to be ligated as back bleeding may be considerable [48]. There may be difficulty in identifying the lower margin of the cervix and a subtotal hysterectomy may be performed either deliberately or in error. This can be corrected either at the time of hysterectomy or as a second procedure. Prerequisites for peripartum hysterectomy are good understanding and anticipation of associated risks, focused and timely decision-making, experienced and confident surgical skill and a well-trained team, this decreases maternal morbidity and mortality and optimises patient outcome [73].

18.25 Infections

Recognised complications of the caesarean section are infections. These include endometritis, wound infection, urinary tract infections and postoperative chest infections. The infectious morbidity rates quoted vary from 18% to 83% [31]. The Royal College of Obstetricians and Gynaecologists has recommended the use of perioperative prophylactic antibiotics to reduce the risks of infections. A recent systematic review has shown that preoperative administration of antibiotics was associated with a significant 41% reduction in the rate of endometritis compared with intraoperative administration [74]. Similarly, a hospital in a developing country, compared the effect of antibiot-

ics prophylaxis within 1 h before skin incision and after skin incision on the incidence of postoperative infections in patients undergoing caesarean section and found the risk of overall postoperative infection was significantly lower when prophylaxis was given preoperatively as opposed to intraoperatively [75]. Contrastingly, a recent multi-centre RCT found no difference in maternal infectious morbidity pre incision or after umbilical cord clamping in patients undergoing elective caesarean section. Likewise, the timing of antibiotics did not have an impact on neonatal outcomes, including neonatal sepsis, sepsis workup and NICU admission [76]. We need to be careful to extrapolate their result to emergency caesarean delivery.

18.26 Urinary Tract Infection

Catheterisation is known to have a major effect on the risk of developing a urinary tract infection. Urinary tract infection is a risk of caesarean section, as most women are catheterised pre-operatively with indwelling catheters. The risk of infection from a single catheterisation has been quoted as less than 2% [77], although Cardozo et al. [78] found that in and out catheterisation did not significantly increase the incidence of postpartum urinary tract infection, provided the catheter is introduced under aseptic techniques. It is advisable that urinary catheters should be inserted immediately prior to caesarean section in the operating theatre, as this reduces the time a catheter remains in situ and the risk of infection. The catheter should be left in women with regional anaesthesia until the anaesthetic effect wears off.

18.27 Chest Infection

Postoperative chest infection occurs in up to 10% of patients following abdominal surgery. There are no figures for the risk of infection following caesarean section but it is probably considerably lower than this. Predisposing factors include obesity, smoking and pre-existing upper respiratory tract infection [79]. It is more common following general anaesthesia than epidural anaesthesia.

Postoperative pain may cause the patient to reduce inspiration and adequate postoperative analgesia should minimise this risk. Physiotherapy and breathing exercises should be encouraged in the postoperative period.

Patients with a chest infection usually present with a cough, pyrexia and purulent sputum. There may be localised chest signs and the disease process may progress to bronchopneumonia. Treatment of postoperative chest infection includes the use of antibiotics and chest physiotherapy.

18.28 Endometritis

Endometritis is an infection of the endometrium or decidua with extension into the myometrium and parametrial tissues. It is the most common cause of fever during the postpartum period. The incidence after a vaginal delivery is 1–3% and following caesarean delivery, the incidence ranges from 13% to 90% depending on the risk factors present and whether perioperative antibiotic prophylaxis had been given [80]. Endometritis is a polymicrobial disease involving on average 2–3 organisms with the commonest organisms being group B streptococcus, *Escherichia coli* and anaerobes. The risk of endometritis is increased with the length of labour, number of vaginal examinations performed in labour [81] and the presence of chorioamnionitis [82]. The diagnosis of endometritis is made on clinical history and examination. Ultrasound scan will exclude the presence of retained products and may show the presence of a phlegmon [83].

Management of endometritis is conservative with antibiotic therapy. Isolation of the infecting organisms is usually not possible as endometrial aspirates usually contain bacteria that are not relevant to the infection. Ampicillin and cephalosporins appear to have the same efficacy in reducing postoperative endometritis. Cefuroxime is commonly used because of its long half-life (1.7 h) and suitability as a single dose regime.

18.29 Wound Infection

The incidence of wound infection after caesarean section has been quoted from 1% to 9%. These are European figures; the figures from the developing world are expected to be a lot higher. The risk is higher with prolonged rupture of membranes, prolonged labour and inadequate aseptic techniques [84]. The risk is also directly proportional to the duration of ruptured membranes and the number of vaginal examinations performed in labour.

The use of prophylactic antibiotics is controversial [85]. The Cochrane database quotes a reduction in endometritis by 75% when prophylactic antibiotics are used. The most common organisms involved are *Staphylococcus aureus*, anaerobes and gram-negative organisms such as *Streptococcus faecalis*. Staphylococci are sensitive to cloxacillin or flucloxacillin. The most appropriate antibiotics to use are broad-spectrum penicillin or cephalosporins. There is no evidence of a reduced infection rate with metronidazole. Short courses are less effective than long courses of antibiotics [86]. The extra cost of antibiotic prophylaxis may be a hindrance in poor and developing countries. However, a study showed that the cost was balanced by a reduction of length of admission with wound infections [85]. It has been said that infection increases the possibility of uterine scar rupture in future

pregnancies [87]. However, there is no evidence to support this unless the uterine wound is involved and a history of a wound infection is not an indication for a repeat caesarean section [88].

18.30 Urinary Complications

The risk of bladder or ureteric injury at caesarean section is less than 1% [89]. The bladder is most commonly injured during downward dissection before entry to the uterus particularly in a repeat caesarean section. The ureters may be damaged if the uterine excision extends laterally. This is particularly likely if uterine closure is difficult and entails blind suturing. Ectopic ureters are rare; about 1:1900, and 80% of cases are associated with duplex collecting systems. They are more likely to be damaged because of their abnormal position. Pressure necrosis of the bladder following obstructed labour is rare in the developed but common in developing countries.

Management of damage to the urinary tract depends on the type of injury and when recognised. If the bladder is noted to be injured at the time of operation, it should be repaired in two layers with a suture such as Vicryl sutures and the bladder should be drained continuously with a catheter for 7–10 days. Ureteric injuries are usually best managed with the assistance of a urologist and treatment depends on the site and type of the injury. If the ureter has been tied but not cut, it is usually sufficient to remove the ligature, pass a ureteric catheter and drain the site of injury. Ureteric anastomosis is required if the ureter has been cut or crushed. A low ureteric injury may require reimplantation. A psoas hitch or Boari-Ockerblad flap is required to obtain more ureteric length and prevent tension on the repair sites [90].

A bladder or ureteric injury that is not recognised at the time of operation may present as urine draining vaginally or through the incision. Any case of unexplained fever, loin pain or haematuria occurring postoperatively should alert the obstetrician to the possibility of damage to the urinary tract. Any suspected case of injury should have intravenous urograms, micturating cystograms or cystoscopy with retrograde pyelograms done to determine the exact site and type of injury. Once this is suspected, the bladder should be drained continuously with a catheter. Surgical repair is usually needed and is performed immediately for ureteric injuries. As bladder injuries usually arise after an obstructed labour, it is necessary to allow tissue oedema to settle prior to undertaking a repair of a vesico-vaginal fistula. This repair may take place up to 3 months of the birth injury. A successful repair is usually an indication for subsequent elective caesarean section.

18.31 Impact on Future Fertility

In recent times, studies are observing the effect of caesarean section on a woman's future reproductive life. A meta-analysis suggests that patients who had undergone a caesarean section had a 9% lower subsequent pregnancy rate and 11% lower birth rate compared with patients who had delivered vaginally [91]. Further, Gurol-Urganci et al. in their study among low-risk primigravidae who were delivered by caesarean section, their subsequent birth rates compared to those who had vaginal birth were marginally lower after elective caesarean for breech with larger effects observed after elective caesarean for other indications and emergency caesarean delivery. However, the effect was smallest for elective caesarean for breech, and this was not statistically significant in women younger than 30 years of age. More studies are needed to know the full impact on fertility as well as the possible cause for this, so that we can prevent effect [92].

18.32 Management of a Previous Caesarean Section Scar

The management of a patient with a previous caesarean section scar is primarily a decision on the mode of delivery. This depends to a great extent on whether the reason for the previous caesarean section is recurrent or not. For example, pelvic contracture is a recurrent cause but some situations such as cervical dystocia are not as clear-cut. A management plan must be decided in women with a previous caesarean section. It used to be said that 'once a caesarean section always a caesarean section'. This adage has been challenged and women with a caesarean section scar are now considered for vaginal births. Absolute exceptions to this include women with a previous classical uterine incision, as this is associated with a uterine rupture rate of up to 12%. Low transverse uterine incisions with vertical T-extensions are also associated with a greater risk of uterine rupture. Relative contraindications for vaginal births after caesarean (VBAC) include multiple gestation and breech presentation. However, insufficient data exists to determine the efficacy and risks of VBAC in this group. In Britain, the majority of patients are allowed a trial of labour in the absence of cephalopelvic disproportion.

18.33 The Role of Pelvimetry

It was common practice to perform X-ray pelvimetry in women who had undergone a caesarean section. Lateral X-ray pelvimetry was used in the diagnosis of cephalopelvic disproportion, although its validity in a primigravid vertex

presentation is disputed [93]. Current evidence suggests that pelvimetry should not be used after a caesarean section to decide on the mode of delivery in the next pregnancy, as it is a poor predictor of future obstetric outcome [94]. Similarly, there is no need for computerised axial tomography (CAT scanning) or magnetic resonance scanning (MRI) as alternatives to conventional X-ray pelvimetry. Shoe size, maternal height and estimations of foetal size (ultrasound or clinical examination) do not accurately predict cephalopelvic disproportion and must not be used to predict 'failure to progress' during labour [26].

18.34 Management of a Trial of Scar

Ideally the onset of labour should be spontaneous as the use of prostaglandin for induction of labour may entail a higher risk of uterine rupture and spontaneous onset of labour is associated with a higher incidence of vaginal delivery. Personnel and facilities for performing an emergency caesarean section should be readily available for women undergoing a trial of scar and as such should always be looked after in a fully equipped labour ward with facilities for caesarean section. Intrapartum electronic foetal heart surveillance is recommended because a non-reassuring foetal heart rate pattern is the most common presenting sign of uterine rupture. The only reported predictable feature of foetal heart rate patterns in response to uterine rupture is the sudden onset of foetal bradycardia.

Epidural analgesia is not contraindicated in trial of scar patients as the block does not mask the signs of uterine rupture [95, 96]. The use of syntocinon in trial of scars is also controversial and, in the past, has been discouraged both to induce and augment labour. Recent studies have found no increased risk of uterine scar rupture with the judicious use of syntocinon [97]. Syntocinon may, however, be used with more confidence in the presence of intrauterine pressure catheters and these are advocated to allow augmentation of labour to achieve optimum uterine activity [69].

The major risk associated with labouring subsequent to caesarean section is uterine rupture. Benign dehiscence, asymptomatic separation of uterine scar is considered to be 1.5% [98], many of which are only discovered after the birth and which do not influence the course of event or require any treatment. However, in those rare occurrences of catastrophic rupture, the major complication is profound foetal distress resulting in neurological damage or foetal death. It must be kept in mind that unpredictable uterine rupture can occur and that uterine rupture necessitates emergency intervention. Most women with one previous lower segment caesarean delivery can be safely offered a trial of labour and should be adequately counselled. In developed countries women who have had up to four caesarean section could be offered a trial of labour [26].

In developing countries, trial of scar could be safe if the patients are well selected, counselled, monitored and deliver in a hospital able to perform a caesarean section if indicated. Gupta et al. noted a vaginal birth (VBAC) success rate of 59% in an Indian hospital; the incidence of uterine rupture was 0.7% and that of uterine dehiscence was 10%. However, the incidence of birth asphyxia was 4%. Repeat CS rate was high (61%) because 87% of patient were from rural area and 65% of their patient were unbooked and came to hospital in labour, hence attending obstetrician felt more comfortable performing a repeat CS rather than attempting trial of labour [99].

18.35 Risks of Scar Rupture

The risk of scar rupture varies with the type of uterine scar. The commonest used estimated risk is of an overall risk of 2.2% for a classical scar and 0.5% for a lower uterine scar [100]. Studies that are more recent show similar risks [101]. The maternal mortality associated with classical scar rupture is in the order of 5% with a foetal mortality of 73%. There is no significant maternal mortality associated with a lower segment scar but there is a foetal mortality of 12.5%. The risk of scar rupture with a de Lee's incision (low vertical incision) is estimated to lie somewhere between the two, but with the increasing use of this incision to deliver pre-term infants, further evaluation is needed of the exact risks [27].

18.36 Recognition of the Ruptured Uterus

Scar rupture is classically associated with an acute onset of abdominal pain that is continuous and does not remit between contractions. However, this may not be the case with lower uterine scars, which, as they are fibrous, usually rupture painlessly. Scar rupture may also present as acute foetal distress as shown on the cardiotocograph or as an acute cessation of labour. Once the diagnosis is made, resuscitation of the mother must be commenced and preparation must be made for immediate laparotomy and delivery of the foetus. Full resuscitation may not be possible until the foetus is delivered and the bleeding margins of the tear can be sutured or damped.

Following the delivery of the baby, a decision is made as to whether repair of the rupture or a caesarean hysterectomy is more appropriate. This choice depends upon the type and extent of the rupture, the patient's general condition, in particular the presence of uncontrollable haemorrhage, and to some extent on a woman's previous obstetric history. If the patient is in a poor condition, repair of the tear has been advocated as less traumatic to the patient than hysterectomy [83]. Tears in the upper part of the uterus are more difficult to

repair and hysterectomy is usually the operation of choice. Repair of the tear, if possible, along with tubal ligation has been proposed for women with large families who for cultural reasons wish to retain a uterus [102]. It would be expected that the risk of rupture in a subsequent pregnancy following repair of a tear would be high. However, no maternal morbidity was associated with this in patients delivered by elective caesarean section at 38 weeks [103]. A previous ruptured uterus is therefore an indication for an elective caesarean section. Some obstetricians advise examination of the uterine scar after delivery [105]. There is no clinical benefit in treating asymptomatic scars and scars may even be extended by the examining finger [22]. This practice is no longer carried out and must not.

18.37 Alternatives to Caesarean Section

This section takes into consideration the poor access to facilities that provide caesarean section in the developing countries. This dearth of facilities has contributed to the high incidence of perinatal and maternal morbidity and mortality. In such circumstances, delivery of the baby may have to be affected through symphysiotomy. Symphysiotomy is advocated as an alternative to caesarean section when there is mechanical difficulty during labour and the foetus is still alive [104]. This procedure is no longer practiced in the developing world and legal action is being pursued in Ireland where this practice has been branded as being barbaric [105]. However, there is a strong case for the continuation of this procedure in centres where facilities for caesarean section do not exist, as this may be the only available method of preventing a foetal and/or maternal death.

The method of delivery of a dead foetus following an obstructed labour creates a management dilemma. To deliver a dead baby by caesarean section creates potential problems. The need to have an alternative to caesarean section for delivering the dead foetus is discussed by Giwa-Osagie and Azzan [106]. The arguments in favour of destructive operations are the great dangers of caesarean section after prolonged and neglected labour in women who already have pelvic infection. The socio-cultural needs of women to have a vaginal delivery, often making the woman or her relatives refuse consent for caesarean section and the risks of scar rupture in an unattended subsequent pregnancy at home strengthens the case for embryotomy in such settings.

18.38 Court-Ordered Caesarean Section

Situations have arisen where women refuse to provide consent for a caesarean section when doctors think it is in the best interest of the foetus to do so. Compulsory surgical or invasive treatment of a male or female patient is illegal in Britain. Court rulings on these situations are that it is illegal to force a woman to submit to caesarean section. It is not just the courts that have warned against forcing medical treatment on a pregnant woman. The Royal College of Obstetricians and Gynaecologists [107] in 1994 issued ethical guidelines on the subject. These guidelines state as follows:

1. Although obligations to the foetus increase with its growth in utero, UK law does not grant it any legal status. This comes from the moment of birth.
2. The law does not limit a woman's freedom because she is pregnant. Her bodily integrity cannot be invaded on behalf of her foetus without her consent. The foetus has no remedy against injuries caused by her decision.
3. A doctor must respect the competent pregnant woman's right to choose or refuse any particular recommended course of action whilst optimising care for both mother and foetus to the best of his or her ability. A doctor would not then be culpable if these endeavours were unsuccessful.
4. The RCOG concludes that it is inappropriate and unlikely to be helpful or necessary to invoke judicial intervention to overrule an informed and competent woman's refusal of a proposed medical treatment, even though her refusal might place her life and that of her foetus at risk. A mentally competent pregnant woman cannot be forced to attend a hospital, or accept treatment, against her will and the Mental Health Act cannot be used to detain an individual against her will [107].

These legal representations should be taken on board in developing countries in the absence of any local judicial rulings.

18.39 Risk Management Issues in Caesarean Section

18.39.1 Timing of Elective Caesarean Section

The recommendation is that elective caesarean sections should take place between 39 and 40 weeks gestation unless there are obstetrics or medical reasons not to do so. It is essential to ascertain the correct gestational age before performing an elective caesarean section. Not to do so may result in an infant that is premature and that may suffer the accompanying sequelae of prematurity. It is good practice to use the first trimester dating scan for the determination of the expected date of delivery as this is the most accurate time with regard to gestational assessment.

18.39.2 Safety Practices

The WHO Surgical Safety Checklist was developed after extensive consultation aiming to decrease errors and adverse events, and increase teamwork and communication in surgery. The 19-item checklist has gone on to show significant reduction in both morbidity and mortality and is now used by a majority of surgical providers around the world [108]. It is essential that the WHO Surgical Safety checklist in performed in its true spirit. This will minimise errors such surgery on the wrong patient and the retention of swabs or surgical instruments within the patient.

18.39.3 Perimortem Caesarean Section (PMCS)

Perimortem Caesarean Section (PMCS) are not commonly done. However, when a pregnant mother arrives in the Emergency Department following cardiac arrest, PMCS is a resuscitative intervention for the mother and not for the baby as the aim is to save the mother first and foremost. Gestational age becomes irrelevant in these situations. The exception to a PMCS is during the first trimester as the uterus does not compress the inferior vena cava [109].

18.40 Conclusion

Caesarean section will always remain as an option of the mode of delivery for mothers. It is now a much safer operation than previously, hence the increase uptake will continue in developed nations despite all efforts to curtail it due to many factors, none the least the fear of litigation. Ironically, more caesarean sections need to be performed in developing countries to reduce the needless and avoidable maternal and perinatal death that occurs in these countries. There is need to provide trained personnel, facilities where caesarean delivery can safely take place as well as access to these facilities. This is necessary to lower the maternal and perinatal morbidity and mortality in low resource nations. A strong political will from the governments as well as help from charities will help see this happen.

Perioperative antibiotics, thromboprophylaxis and access to blood transfusion facilities are essential requirements in reducing the morbidity and mortality associated with caesarean sections. There is need to ensure that financial gains in the private sector do not drive the need for caesarean sections. Every age brings new challenges. The age of the rising caesarean delivery rate now brings obstetricians—with increasing frequency—the challenge of caesarean hysterectomy for placental accreta/percreta. When a decision is made to deliver a woman by caesarean, short-term considerations usually dominate. Obstetricians, however, also have a responsibility to take a woman's long-term reproductive outcomes into consideration when they are considering primary caesarean delivery in the absence of sound medical indications [64]. It is essential that adequate measures are put in place to ensure the delivery of a healthy baby and well-being of the mother.

18.41 Summary

Caesarean section is now a much safer operation than it has previously been. The increase in uptake will continue in developed nations despite all efforts to curtail it due to many factors, none the least the fear of litigation. There are needs for more uptake of caesarean section in developing countries to reduce the needless and avoidable maternal and perinatal death that occurs in these countries. There is need to provide trained personnel, facilities where caesarean delivery can safely take place as well as access to these facilities. This is a necessity to lower the maternal and perinatal morbidity and mortality in low resource nations. Perioperative antibiotics, thromboprophylaxis and access to blood transfusion facilities are essential requirements in reducing the morbidity and mortality associated with caesarean sections.

Rising caesarean delivery rate now brings obstetricians—with increasing frequency—the challenge of caesarean hysterectomy for placental accreta/percreta. When a decision is made to deliver a woman by caesarean, short-term considerations usually dominate. Obstetricians, however, also have a responsibility to take a woman's long-term reproductive outcomes into consideration when they are considering primary caesarean delivery in the absence of sound medical indications. It is essential that adequate measures are put in place to ensure the delivery of a healthy baby and well-being of the mother.

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