CAESAREAN SECTION

Introduction

The caesarean delivery is defined as the birth of a fetus through incisions in the abdominal wall (Laparotomy) and the uterine wall (Hysterotomy) ***(Berghella, 2011).***

The terms caesarean section, caesarean delivery, and caesarean birth may be used to describe the delivery of a fetus through a surgical incision of the anterior uterine wall.

Caesarean section is a tautology; both words connote incision, Therefore, caesarean birth or caesarean delivery, are preferable terms ***(Richard et al., 1996).***

Caesarean section is the most common laparotomy done in the world today. Thus any useful refinement in the operative technique, however minimal, is likely to yield substantial benefits ***(Dodd et al., 2014)***.

Historical Background

The exact origin of the term caesarean delivery is unclear. The popular beliefs that Julius Cesar was born in this manner with the result that the procedure became known as the caesarean operation.

Several circumstances weaken this explanation. First, the mother of Julius Cesar lived for many years after his birth in (100 BC) and as late as the 17^{th} century, the operation was almost invariably fatal. Second, the operation, whether done on living or dead women, it is not mentioned by any medical writer before the Middle Ages ***(Cunningham et al., 2002).***

Also it has been widely believed that the name of the operation is derived from a Roman law,

supposedly created by Numa Pompilius (8th century BC). Ordering that the procedure be done upon women dying in the last few weeks of later called lex caesarea and the operation itself became known as the caesarean operation ***(Percival et al., 1980).***

The term caesarean may have arisen in the Middle Ages from the Latin verb caedere (to cut), and the term section is delivered from the Latin verb seco (cut) ***(Sewell and Washington, 1993).***

The first authenticated caesarean delivery was performed by Trautmann of Wittenberg in 1610, with the mother succumbing to post-operative infection (25) days later ***(Larry et al., 2002).***

In 1769, a uterine incision in the lower uterine segment was suggested as early by Robert Wallace, but was not done until a century later ***(Sewell and Washington, 1993).***

Although, the caesarean births performed in Paris between 1787 and 1876 demonstrated that

100% of maternal mortality rate, mostly due to infection or haemorrhage ***(Sewell and Washington, 1993).***

In 1846, the introduction of diethyl ether anesthetic agent at Massachusetts General Hospital were increased the feasibility of major abdominal operations although, mortality rates for caesarean birth still high secondary to infections and bleeding ***(Richard et al., 1996).***

In 1876, Eduardo Porro, an Italian Professor recommended hysterectomy combined with caesarean birth to control uterine haemorrhage and prevent systemic infection. And it is considered the first major surgical advance in the technique of the caesarean section. Eduardo Porro technique resulted in a dramatic decline in the maternal mortality ***(Spreet et al., 1958).***

In 1882, Max Saenger introduced the technique of suturing the uterus. He advocated performing a vertical incision in the uterus that avoided the lower

uterine segment, and then he closed the uterus in two layers by using silver wire for the deep suture and fine silk for the superficial serosa ***(Sewell and Washington, 1993).***

In 1926, Munro Kerr recommended a semilunar uterine incision with the curve directed upward. The only objection to this incision was the danger of extending into the uterine vessels at the edges of the incision. However, Kerr argued that using careful technique, the vessels could be avoided ***(Larry et al., 2002),*** It was to reduce and contain the risk of sepsis. This was modified by ***Pfaneuf (1931)*** into the present day upward low transverse uterine incision ***(Cunningham et al., 2001).***

In the late of 1980s and 1990s, one layer suturing the uterus and pelvic peritoneal non closure were also advocated. The first evaluation of these modifications was described by Michael Stark and colleagues in 1995s, using a technique that took the name of the hospital that most contributed to its

development, The Misgav-Ladach ***(Xavier et al., 2005).***

Caesarean Birth Rates

There is an increase in the incidence of caesarean delivery (CD) and it is the most commonly performed major surgical procedure ***(Boyle and Reddy, 2012).*** Across Organization for Economic Co-operation and Development (OECD) countries, the average rate of CS is now at one in four births, an increase from one in five in 2010 ***(OECD Health Statistics, 2015).***

Before 1955, the caesarean birth rate remained relatively stable in the range of (2-5%). Data from the Chicago Lying-In Hospital had showed a five-fold increase in the caesarean birth rate from (0.6%) in 1910 to (3%) in 1928 ***(Richard et al., 1996).***

The rate of caesarean delivery has increased dramatically over the past decade. Medically elective caesareans are a major factor contributing to this rise ***(Miesnik and Reale, 2007).***

WHO advocates that CS is an essential treatment in pregnancy and is recommended at an ‘‘optimal’’ national rate of 5–15 % of all births ***(WHO, 2015)***. Epidemiologic studies have shown that CS is being provided at higher, and sometimes much higher, rates than recommended. A recent WHO publication reports that between 1990 and 2014 the global average CS rate increased to be 18.6 % with rates ranging, depending on region, between 6 and 27.2 %, and average annual rate of increase (AARI) of 4.4 % per year ***(Betran et al., 2016).***

Countries with the highest CS rates in each region are Brazil (55.6%) and Dominican Republic (56.4%) in Latin America and the Caribbean, Egypt (51.8%) in Africa, Iran and Turkey in Asia (47.9% and 47.5%, respectively), Italy (38.1%) in Europe, United States (32.8%) in Northern America, and New Zealand (33.4%) in Oceania ***(Betran et al., 2016).***

At country level, **Egypt** witnessed the largest rise in the African region. *CS rates in Egypt rose from 4.6% to 51.8% (47.2 points) over the 24 year period. Along with Morocco, these two countries had the largest worldwide AARI in CS rates (11.6%)* ***(Betran et al., 2016).***

In **Egypt**, according to the latest data, *more than half of all women give birth by CS without much difference between urban and rural areas* ***(Egypt Demographic and Health Survey, 2014)***.

In **Egypt**, *data on rates and indications of CS are variable based on the level of experience and on the whether the delivery was carried out at a private or a public setting* ***(Shaaban et al., 2012 and Khawaja et al., 2004)***. These highly rising rates of CS necessitate *the urgent need to put in place clinical pathways to promote evidence based practices which lower the CS practice and the need to develop risk adjusted CS rates* ***(Helal et al., 2013 and Ebrashy et al., 2011)***.

Some possible reasons for increasing CS rates are repeatedly reported in studies from many countries such as fear of pain; concerns about genital modifications after vaginal delivery; misconception that CS is safer for the baby; the convenience for health professionals and also for the mother and family; fear of medical litigation and lower tolerance to any complications or outcomes other than the perfect baby ***(Hellerstein et al., 2015; Abdel-Aleem et al., 2013 and Zwecker et al., 2011).***

Caesarean delivery on maternal request (CDMR) and women and physician's preferences are contributing to increasing rate of CS across the world ***(ACOG, 2013).*** The common misbelief that vaginal delivery may traumatize the delivering women's pelvic floor muscles resulting in stress urinary incontinence and postpartum pelvic organ descent was an important factor behind increased CDMR ***(Wilson et al., 2014 and Rogers et al., 2014)***. Moreover, the significant increase in

medicolegal litigations in obstetrics, the increased awareness of patients' rights, and the increased obstetricians' tendency to protective medical practice have resulted in more liberal CS decisions ***(Al-Kadri et al., 2015).***

The rate also varies based on the type of medical practice: a significant increase is observed when pregnant women are managed through private practice compared to governmental practice ***(Al-Kadri et al., 2015).***

Other cultural factors are more country-specific. For example, in China, choosing the date of the baby's delivery on the basis of luck and fate for the future of the baby by some people is one of the explanations for scheduling a CS ***(Hellerstein et al., 2015 and Mi and Liu, 2014)***.

The overall rate reflects a marked upswing in the frequency of primary CD and a sharp decline in the frequency of vaginal birth after CD ***(ACOG, 2014).***

Some case-studies have been published recently pointing to interventions such as high-quality midwifery-led unit for delivery as an effective way to reduce CS ***(Renfrew et al., 2014)*** and professional associations have released recommendations for the safe prevention of primary caesarean sections (**ACOG, 2014)**. However, considering solely medical factors in this complex scenario is likely to be a futile effort to reduce unnecessary CS. Factors associated to women's fears and lives and societal and cultural beliefs are contributing to the increase and need to be included in the equation ***(Betran et al., 2016).***

At a time when developed nations are beginning to examine critically this continued increase in surgical deliveries, women in many parts of the world do not even have access to the procedure. Approximately 12% of deliveries are estimated to occur via CD in the developing world as low as 8% if births in China are excluded ***(Stanton and Holtz,***

2006). Broad health systems deficiencies and lack of resources continue to be limiting factors to expand access and quality care. **The WHO Statement on Caesarean Section Rates published in 2015 emphasized that** *"Every effort should be made to provide caesarean sections to women in need, rather than striving to achieve a specific rate"* ***(WHO, 2015 and Betrán et al., 2015).***

Types of caesarean section:

Based on the time of C.S at time of decision making:

Emergency C.S: ideally the C.S should be done within the next 30 minutes. Some examples are: abruption placenta, cord prolapse, scar rupture, scalp pH less than 7.2 and prolonged FHR deceleration less than 80 bpm ***(Keith, 2007).***

Elective C.S: the main principle being to carry out C.S as late as possible in gestation without compromising the maternal or fetal health. It is generally done around 39 weeks as the incidence of tachypnea of the newborn is much less after this

gestation. These are cases where there is an indication for C.S but there is no urgency and examples include: placenta previa with no active bleeding, malpresentation, history of previous hysterotomy or vertical incision C.S, past history of repair of vesico-vaginal or recto-vaginal fistulae or stress incontinence, HIV infection ***(Keith, 2007).***

Classification of urgency:

Caesarean section has traditionally been classified as elective and emergency. The emergency category, however, does not differentiate between true emergencies where the life of the woman or fetus is threatened and situations in which there is no imminent threat to life ***(NICE, 2011).***

A four-point classification has been piloted, used in a national survey and shown to predict baby outcome ***(NICE, 2011).***

Its adoption is recommended to aid clear communication between healthcare professionals about the urgency of caesarean section.

Category 1: *Immediate threat to the life of the woman or fetus*. This includes caesarean section for acute severe fetal bradycardia, cord prolapse, uterine rupture, and fetal blood pH less than 7.2.

Category 2: *Maternal or fetal compromise that is not immediately life-threatening.* There is a degree of urgency to deliver the baby in order to prevent further deterioration of either the mother's or the baby's condition. Examples include antepartum haemorrhage and failure to progress in labour with maternal or fetal compromise.

Category 3: *No maternal or fetal compromise but needs early delivery.* Examples include a situation in which caesarean section is planned but the woman is admitted in early labour or with ruptured membranes.

Category 4: *Delivery timed to suit woman or staff.* This includes all planned elective caesarean sections ***(NICE, 2011)***.

Indications for Caesarean Delivery

Caesarean sections are performed for various fetal and maternal indications; these include labor and delivery abnormalities, placental and cord abnormalities, and repeated CS deliveries ***(Abenhaim and Benjamin, 2011).*** Recently, CS has been performed to satisfy women's desire; therefore, caesarean delivery on maternal request (CDMR) or caesarean section for non-medical reasons was added to the known common CS indications ***(Billard, 2011).***

The increasing requests by women for caesarean section (CDMR) in the absence of clear medical indications (caesarean section for non-medical reasons) , such as placenta praevia, HIV infection, contracted pelvis, and previous caesarean

section; contributed to the progressively rising Caesarean section rates in many parts of the world ***(Lavender et al., 2012)***.

The indications and proportions of caesarean delivery will vary from country to country and from hospital to hospital. Nonetheless, there are four main indications that account for 60-90% of all caesarean sections. These include: repeat caesarean section (35-40%), dystocia (20-35%), breech (10-15%) and fetal distress (10-15%) ***(Baskett and Arulkumaran, 2002).***

Caesarean section for previous caesarean section

One of the most common indications for caesarean section is previous caesarean section. When the most common caesarean section was the classical caesarean section clinicians feared scar rupture in attempting normal vaginal delivery and repeat caesarean section was considered mandatory

for all subsequent births. However, it rapidly became clear that lower segment caesarean section was not associated with disastrous rupture and the concept of trial of normal vaginal delivery became current ***(McMahon et al., 1996)***. So, Most women with one previous caesarean delivery with a low-transverse incision are candidates for and should be counseled about vaginal delivery after previous caesarean section (VBAC) and offered a trial of labor after caesarean (TOLAC) instead of elective repeat caesarean delivery (ERCD) as an attempt to reduce CS rates ***(ACOG, 2010).***

Approximately 75 percent of women who attempt TOLAC will be successful; this rate varies up or down depending upon the clinical situation that led to the first caesarean birth. VBAC is highest in women with a previous successful TOLAC, previous vaginal delivery, previous caesarean delivery for nonvertex presentation, and women with spontaneous onset of labor ***(ACOG, 2010).***

Timing of elective caesarean delivery:

While term pregnancy is defined as 37 weeks of gestation or later; elective caesarean delivery should not be performed prior to 39 weeks gestation unless there are medical indications for either the mother or fetus secondary to the risk of fetal lung non-maturity ***(NICE, 2011)***. Delivery prior to 39 weeks was associated with increased rates of respiratory problems, sepsis, hypoglycemia, and either prolonged hospitalization or requirement for increased level of care ***(Chiossi et al., 2013)***. However, if an elective caesarean delivery is performed prior to (39) weeks of gestation for patients with complicating factors (e.g. placenta praevia or prior classical uterine incision), risk of maintaining the pregnancy to 39 weeks may outweigh the risks to the mother and fetus if delivered prior to 39 weeks. In these situations, consideration should be given to obtaining an

amniocentesis for fetal lung maturity beginning at 36 weeks. Once fetal lungs are determined to be mature or the patient reaches 38 weeks of gestation, caesarean delivery should be performed ***(American Academy of Family Physicians, 2008).***

Surgical techniques of caesarean section:

The safety of the procedure has improved while surgical techniques do vary from surgeon to surgeon and from time to time, good adherence to basic surgical principles and an awareness of recognized methods of doing caesarean sections will minimize morbidity ***(Dodd et al., 2014).***

Caesarean birth remains the most common intra-peritoneal surgical procedure in obstetrical and gynecological practice. Frencois M. first reported its use in the 17th century, but perhaps the most significant technical evaluation occurred in the late 19th century when uterine wall suturing led to a

marked reduction in the mortality associated with procedure ***(Xavier et al., 2005).***

1- Pre-operative preparations:

The caesarean delivery will need the same pre-operative care as any major surgery plus additional consideration for the fetus. Determination of hemoglobin and hematocrit value is important prior to surgery and blood should be available for immediate transfusion if required.

- ***Prophylactic antibiotics:***

Prophylactic antibiotics reduce the incidence of fever, endometritis, wound, urinary tract and other infections ***(Smaill and Grivell, 2014).***

Intravenous prophylactic antibiotics for caesarean administered preoperatively significantly decreases the incidence of composite maternal postpartum infectious morbidity as compared with administration after cord clamp. There were no clear differences in adverse neonatal outcomes reported. So; all women undergoing caesarean delivery

should receive preincision antibiotic prophylaxis which is advantageous for the mother and not harmful to the neonate to reduce maternal infectious morbidities ***(Mackeen et al., 2014 and Dahlke et al., 2013)***.

There is no advantage in using multiple doses compared with a single dose ***(Hopkins and Smaill, 2009).***

Both ampicillin and first generation cephalosporins have similar efficacy in reducing postoperative endometritis. There does not appear to be added benefit in utilizing a broader spectrum agent or a multiple dose regimen ***(Gyte et al., 2014)***.

The guidelines of American College of Obstetricians and Gynecologists (ACOG) and Society of Obstetricians and Gynecologists of Canada (SOGC) recommend using a single dose of antibiotics half an hour before the caesarean section and adding another dose when

there are additional surgical risks. ***(ACOG, 2011 and SOGC, 2010)***.

The recently published World Health Organization (WHO) evidence-based guidance for preventing peripartum infections recommended routine antibiotic prophylaxis for women undergoing elective or emergency caesarean section ***(WHO, 2015)***. For caesarean section, prophylactic antibiotics should be given prior to skin incision. A single dose by intravenous route of first generation cephalosporin or penicillin should be used in preference to other classes of antibiotics ***(WHO, 2015 and Nabhan et al., 2015)***.

Patients with prolonged rupture of membrane must be given an appropriate antibiotic before operation which in this cases is not considered a prophylactic antibiotic, but actually treatment of present infection ***(WHO, 2015).***

2-Anaesthesia:

The gestational age and medical condition of the mother must be taken into consideration prior to the choice of an anaesthetic agent ***(Larry et al., 2002).*** For the safety of the patient, spinal or epidural anaesthesia is usually best for caesarean delivery if the clinical circumstances permit ***(NICE, 2011).***

All women were operated on under general type of anaesthesia using halothane with its known properties of uterine relaxation so; its use may have increase the importance of quick haemostasis ***(Magann et al., 1993).***

3- Position of the patient:

The woman's position may be supine or with a lateral tilt (Lateral tilt for caesarean section) ***(Wilkinson and Enkin, 2003a)***.

4- Catheterization:

Single catheterization before starting the procedure to avoid injury of the bladder is recommended. The use of an indwelling catheter

after caesarean section under spinal or epidural anaesthesia is thought to lessen risk of urine retention and the need for repeat catheterization because the anaesthetic block interferes with normal bladder function ***(NICE, 2011).***

Non-catheterization was suggested by some studies ***Nasr et al. (2009) and Li et al. (2011)*** as it seems to be associated with a reduced urinary tract infection rate, less discomfort at first voiding, less time until first voiding and ambulation, shorter hospital stay, reduced cost and no increase in either urinary retention or intra-operative difficulties but in current clinical practice, there is still a role for routine catheterization in caesarean section ***(Yong, 2011)***.

5- Preparations of the skin:

Before surgery, the skin of the abdomen must be scrubbed at the evening with a (4%) chlorhexidine sponge for at least two minutes. The same procedure was repeated the next morning. The

pubic hair must be removed from the operative field using a disposable razor, and the skin was scrubbed with a solution of (.5%) chlorhexidin in alcohol.

6- The incisions:

(1) Skin incisions:

Length of the skin incision: Whatever the chosen incision, the length of the incision should be adequate, with a minimum width of (15) cm. is recommended. This can be done by an Allis test, since the ease of delivery is related to the length of the incision ***(Ayers and Morley, 1987).***

A. ***Vertical Incision:*** A vertical midline incision allows a less vascular, rapid entry and good exposure of both the abdomen and pelvis. This incision may be indicated in cases of urgency ***(Ellis et al., 1984).***

B. ***Pfannenstiel Incision****:* Pfannenstiel introduced his incision in 1900. This incision is extensively used because of its excellent cosmetic results, along with the

benefits of early ambulation and a low incidence of wound disruption, wound dehiscence and hernia. The incision which is made in semilunar manner, should follow a curve of semilunar skin. The average incision begins and ends (2-3) cm. below and medial to the anterior superior iliac spines.

The *pfannenstiel* incision involves dissection of the sub-cutaneous layer and the anterior rectus sheath and, when extended into the external and oblique muscles may result in injury to the ilio-inguinal and ilio-hypogastric nerves in addition use of this incision limits views of the upper abdomen and may increase the blood loss and haematoma because of the increased dissection ***(Ellis et al., 1984).***

C. ***Maylard incision:*** The Maylard incision is made approximately (1) cm. higher than

the pfannenstiel incision and it involves cutting the rectus muscle transverse and ligating the inferior epigastric artery to provide good access to the pelvis ***(Helmkamp and Krebs, 1990).***

D. ***Joel-Cohen Incision****:* The 'Joel Cohen' abdominal incision is used. This is a straight transverse incision through skin only, 3 cm below the level of the anterior superior iliac spines (higher than the Pfannenstiel incision). The subcutaneous tissues are opened only in the middle 3 cm. The fascia is incised transversely in the midline then extended laterally with blunt finger dissection ***(Joel-Cohen, 1977 and Wallin, 1999).*** Finger dissection is used to separate the rectus muscles vertically and laterally and open the peritoneum. All the layers of the abdominal wall are stretched manually to the extent of the skin incision.

The bladder is reflected inferiorly. The myometrium is incised transversely in the midline but not to breach the amniotic sac, then opened and extended laterally with finger dissection. Interrupted sutures are used for the closure of the myometrium. Retrospective studies have suggested that these methods reduce operating time, blood loss and postoperative hospital stay ***(Song, 2006).*** Various modifications of the Joel-Cohen technique have been described ***(Franchi, 1998; Ferrari, 2001; Stark, 1995 and Wallin, 1999).***

A retrospective comparison found that the classical Joel-Cohen incision was associated with statistically less postoperative blood collection in the abdominal wall, pouch of Douglas and lower uterine segment than the modified incision, but the differences were small ***(Malvasi et al., 2007).***

A Cochrane review ***(Mathai et al., 2013)*** and metanalysis ***(Hofmeyr et al., 2009)*** of 14 trials (n = 2906) noted significantly improved short-term outcomes (less blood loss, less fever, less pain and analgesic requirements, shorter duration of surgery and hospital stay) in those techniques using Joel-Cohen based surgical methods. These advantages for the mother could be extrapolated to savings for the health system through less demand on resources.

(2) Uterine incision:

Before an incision is made, rotation of the uterus should be noted (it is usually dextro-rotated) and, if possible corrected, so that the incision will not be a symmetrical, risking extension on the opposite side.

The loose fold of peritoneum, where the bladder is attached, should be identified, then the visceral peritoneum should be incised and the bladder pushed down gently with care, mainly in the center in order to avoid disturbing the vascular plexus.

Most always uterine incisions is made in the lower uterine segment transversely ***(Kerr, 1926)*** or less often, vertically ***(Kroing, 1912).*** The lower segment transverse uterine incision is widely used in obstetric practice today. It should be made in the Centre for a length of (2-3) cm. and has the advantage of requiring only modest dissection of the bladder from underlying myometrium. If the incision extends laterally, a laceration may involve one or both of the uterine vessels.

This incision has been favored because the lower uterine segment is less vascular than the body of the uterus, and the incision is easier to repair. This leads to a reduction in operative complications, especially haemorrhage, and also a reduction in morbidity. Lower segment incisions are also associated with a lower incidence of uterine dehiscence or rupture in subsequent pregnancies ***(NICE, 2011).***

The use of a low vertical uterine incision has been recommended in certain clinical situations, particularly in delivery of the preterm infant, where the lower uterine segment may be poorly formed and the longitudinal incision may facilitate delivery and reduce birth trauma by improved surgical access ***(Chamberlain et al., 2001)***.

A ’classical’ uterine incision involves a vertical (up and down cut) in the upper body of the uterus, and is used more rarely. It may be used when the baby is in a transverse lie, when the infant is preterm, or if there is an anterior placenta praevia, but in practice, this incision is rarely used. Haemorrhage is potentially more severe when an upper uterine segment incision is used, and the repair often requires closure in three layers as the myometrium is thicker in this part of the uterus. Moreover, if the vertical incisions extend downward, it may tear through the cervix into the vagina and possibly involve the bladder. Importantly, during next

pregnancy a vertical incision that extends into the upper myometrium is more likely to rupture than a transverse incision, especially during labor ***(Chamberlain et al., 2001).***

When difficult circumstances are encountered, requiring an extension of the transverse incision to obtain better surgical access, or to facilitate delivery of the infant a **'' J-shaped''** extension into the upper segment, on the most accessible side is better than inverted **''T- shaped''** incision (which will form a weaker scar due to poor healing) ***(De Lee and Cornell, 1992)***.

Uterine rupture is a significant risk in a subsequent pregnancy or labour, with estimates of occurrence being 4% to 9% for classical (uterine body, midline) caesarean incision; 4% to 9% for inverted T-shaped incisions; 1% to 7% for lower uterine segment vertical incisions; and 0.2% to 1.5% for lower uterine segment transverse incisions (***ACOG, 1999).***

Patterson et al. (2002) observed a distribution of uterine incisions of 98.5% low transverse, 1.1% classical and 0.4% inverted T in 19.726 C.S.

7- The delivery:

(1) Delivery of the fetus:

Induction-Delivery intervals of more than (8) minutes under general anesthesia and Incision-Delivery intervals of more than (3) minutes under both general or spinal anesthesia were associated with increased number of low Apgar score and neonatal acidosis ***(Datta et al., 1981).***

In cephalic presentation a hand slipped into the uterine cavity between the symphysis pubis and fetal head , and fetal occiput is lifted toward the incision aided by modest transabdominal fundal pressure. If the fetal head is deeply engaged, delivery can be facilitated by an assistant who places a hand in the vagina and elevates the fetal head toward the surgeon's hand.

(2) Delivery of the placenta:

The placenta may be delivered by manual removal or spontaneously with gentle cord traction (CCT). A randomized controlled trials for comparison between these two methods showed that **"A decrease amount of bleeding and less infectious morbidity following spontaneous delivery"** ***(Anorlu et al., 2008).***

Current evidence recommended spontaneous expulsion with gentle controlled cord traction (CCT) for the delivery of the placenta ***(NICE, 2011 and Wilkinson and Enkin, 2003).***

8- The closure:

(1) Closure of the uterus:

Jacobs and Hofmery (2004) searched for randomized controlled trials involving a comparison of uterine exteriorization with intra-abdominal repair of uterine incision. 6 studies with 1221 women were included. There were no statistically significant differences between these groups in most

of the outcomes identified, except for febrile morbidity and length of hospital stay.

There is no significant difference between extra – abdominal and intra –abdominal repair of the uterine incision at caesarean delivery, but the number of sutures is lower and surgical time is shorter with extra-abdominal repair, although moderate and severe pain at 6 hours is less frequent with in situ uterine repair ***(Coutinho et al., 2008).***

The guidelines of Royal College of Obstetricians and Gynecologists recommend the intraperitoneal repair of the uterus at CS and exteriorization of the uterus is not recommended because it is associated with more pain and does not improve operative outcomes such as haemorrhage and infection ***(NICE, 2011)***.

Suturing of uterus:

Traditionally the uterine wound is closed in two layers, as was recommended by Kerr in 1926, The traditional two layers suturing technique was

borrowed directly from the initial vertical incision closure, the angles of the incision are identified and an absorbable chromic catgut No (0) or No (1) suture is begun just beyond one angle and runs along the length of the incision using a continuous locked or nonlocked suture technique ***(Hema and Johanson, 2001).***

However, when haemostasis is adequate with a single layer closure, a second layer is unnecessary ***(Cunningham et al., 2002).***

Recent evidence based on randomized controlled trials (RCTs) showed that **''Double layer closure of the uterine incision was not superior to single layer closure in terms of haemostasis or incidence of endometritis and single layer closure was recommended when anatomically feasible''** ***(Hauth et al., 1992).***

Regarding concerns about the integrity of the scar during a subsequent trial of normal labor after single layer closure, A randomized controlled trials

(RCTs) found no difference in the incidence of scar dehiscence and fetal outcome during a subsequent trial of normal labor after a single layer closure versus double layer closure, yet a recent observational cohort study from Canada came with worrying results. The study shows that **''A single layer closure of the uterine incision was associated with (4) fold increase in the risk of uterine rupture in attempting vaginal birth after cesarean section (VBAC) compared to double layer closure''** ***(Bujold et al., 2002).***

On the contrary, the meta-analysis published in 2011 revealed that locked but not unlocked single-layer closures were associated with a higher uterine rupture risk than double-layer closure in women attempting a trial of labor ***(Roberge et al., 2011)***. These findings support Jelsema's hypothesis that locked suture technique may develop ischemic necrosis of tissue due to the increased pressure ***(Jelsema et al., 1993)***. However, recently the locked

single-layer closure method of the lower uterine segment incision has been often preferred by surgeons to provide haemostasis (***Dodd et al., 2014).***

So uterine closure with single-layer; interrupted or continuous locking suture has short-term benefits. However, the evidence from observational studies of an increased risk of scar rupture may favor the use of double-layer closure pending evidence on this outcome from randomized trials ***(Dodd et al., 2014; NICE, 2011 and Gyamfi, 2006).***

(2) Peritoneal closure:

Bamigboye and Hofmeyr (2014) searched for controlled trials comparing leaving the visceral or parietal peritoneum, or both, unsutured at caesarean section with a technique which involves suturing the peritoneum. Sixteen trials involving 15,480 women were included and analyzed, when both parietal and visceral peritoneum was left unclosed versus when both peritoneal surfaces were closed. Postoperative adhesion formation was assessed in four trials with

282 women, and no difference was found between groups. Women of non-closure of the peritoneum reduced operating time whether both or either layer was not sutured. For both layers, the operating time was reduced by 5.81 minutes. There was significantly less postoperative fever and reduced postoperative stay in hospital and reduced number of postoperative analgesic dose. In a trial involving 112 women, reduced chronic pelvic pain was found in the peritoneal non-closure group. There was improved short time postoperative outcome if the peritoneum not closed.

Bivins and Galiup (2000) favor non closure of the peritoneum.

Non closure of peritoneum at primary C.S is associated with a significantly increased risk of visceral adhesions ***(Yiyang et al., 2006).***

(3) Rectus sheath closure:

The rectus sheath is commonly closed by using a synthetic suture. Wound healing is best if the

stitches are inserted (10) mm. from the edge and (10) mm. apart. This is because collagenolysis occurs over an area of (10) mm. from the edge of the wound, so any wound closed within the zone will be weaker ***(Rayburn and Schwartz, 1996).***

(4) Closure of subcutaneous tissue:

The subcutaneous tissue need not be closed separately if it is (2) cm. or less in thickness, as the subcutaneous sutures material may predispose to infection, if there is more adipose tissue than this, or if the subcuticular closure was chosen, a few interrupted (3/0) catgut sutures will obliterate the dead space and reduce tension on the skin edges ***(NICE, 2011 and Naumann et al., 1995).***

A randomized clinical trial evaluated subcutaneous closure, placement of a subcutaneous drain, or no closure for subsequent wound disruption risk in 964 women with subcutaneous depth >2 cm, there appears of no difference. Wound disruptions occurred in 9.7% other women with no closure,

10.4% of the women in the stitch closure group and 10.3% of the women in the closed drain group ***(Chelmow et al., 2004).***

(5) Skin closure:

Skin edges of the incision can be approximated either by interrupted sutures, staples or subcuticular sutures. *The most recent Cochrane review of skin closure techniques at cesarean delivery* ***(Mackeen et al., 2012)*** *commented on the lack of available evidence in this aspect .There is currently no conclusive evidence about how the skin should be closed after caesarean section. Staples are associated with similar outcomes in terms of wound infection, pain and cosmesis compared with sutures, and these two are the most commonly studied methods for skin closure after caesarean section. If staples are removed on day three, there is an increased incidence of skin separation and the need for reclosure compared with absorbable sutures.*

Despite of lack of data, the majority of obstetricians reported subcuticular skin closure as their routine 74% ***(Tully et al., 2002).***

Complications of Caesarean Delivery:

A-Intraoperative complication:

1- Hemorrhage: Bleeding during caesarean delivery has been estimated to range from (660 – 1000) ml, intra-operative bleeding is often secondary to uterine atony and has a good response to uterine massage. However, haemorrhage remains one of the most common causes of maternal mortality ***(Kauntiz et al., 1985).***

Prior to medical therapy for bleeding, the uterus should be inspected for retained products of conception. Initially, oxytocin is given, then methyl-ergometrine (Methergin) is also effective but it is contraindicated if the mother has hypertension. Finally, 15 methy1-$PGF_2\alpha$ (15-methyl-Prostaglandin F2α can be administered intramuscularly or directly into the myometrium)

and Misoprostol (400 mcg may be given sublingual in an awake alert patient or 800 mcg per rectum) may be used to promote uterine contractility ***(American Academy of Family Physicians, 2008).***

Failed medical management is an indication for surgical intervention including unilateral or bilateral ligation of the uterine arteries and uteri-ovarian arteries, uterine compression sutures (The B-Lynch suture), uterine packing, and hypo gastric artery ligation is the most effective way to control haemorrhage while still preserving the uterus. When these measures fail, caesarean hysterectomy becomes the life-saving measure of choice ***(Clark et al., 1985).***

2- Bladder injury: bladder injuries are the most common injuries to surrounding structure occurring at the time of caesarean delivery. Nevertheless, they are rare. Evaluating a series of nearly 15,000 caesarean deliveries, Phipps and colleagues reported that bladder injuries were encountered in 0.28% of

C.S. (0.14% for primary caesarean sections and 0.56% for repeat procedures) In the same study, ureteral injury occurred in 0.007 percent of all caesarean deliveries ***(Phipps et al., 2005).*** And this compared to a rate of three percent in caesarean hysterectomies ***(Shelhass et al., 2009).***

3- Ureteric injuries: The reported incidence ranging from (0.02 – 0.05%) the majority of ureteric injuries that occur are due to attempts to control bleeding from extension of the angle of the uterine incision into the broad ligament ***(Davies, 1999).***

4- Bowel injury: Bowel injuries occur in less than (0.1%) of all caesarean delivery. It occurs most often in the obese patient with excessive intraperitoneal fat, with poor anaesthesia that causes the patient to strain, or in the patient who has intra-abdominal adhesions as a result of a previous abdominal surgery ***(Cunningham et al., 2001).***

B- Post-operative complications:

1. Postoperative pain:

Pain is a subjective sensation and therefore difficult to measure. It is, however, important to quantify it for several reasons; one of the most compelling reasons is that assigning a measurement of pain gives patients some sense of control over their condition and has positive effects on their coping abilities. Pain measurements also provide a means of assessing the efficacy of response to treatment and prognosis**.**

The Visual Analog or Analogue Scale (VAS) is designed to present to the respondent a rating scale with minimum constraints. Respondents mark the location on the 10-centimeter line corresponding to the amount of pain they experienced. This gives them the greatest freedom to choose their pain's exact intensity. It also gives the maximum opportunity for each respondent to express a personal response style. VAS data of this type is

recorded as the number of millimeters from the left of the line with the range 0-100.

No pain	—————————— <-- 10 cm. -->	Pain as bad as possible

Figure (1): Visual Analogue Scales (VAS): **(*Aitken , 1969).***

The VAS score is determined by measuring in millimeters from the left hand end of the line to the point that the patient marks. After asking a question as the following, how severe is your pain today? Place a vertical mark on the line below to indicate how bad you feel your pain is today ***(Morano et al., 2006).***

Pain management has been established as one of the benchmarks of quality health care. Quality hospital care now must include the assessment of pain relief. In addition, the patient's perception of pain control has been established as a marker of

quality. Pain is to be labeled the "fifth vital sign" in hospitals ***(Miller, 2005).***

2- post-operative infections:

Caesarean section remains the single most important risk factor for puerperal infection. The incidence of post-caesarean infection varies widely worldwide, ranging from 2.5% to 20.5% ***(Conroy et al., 2012)***. Women undergoing caesarean section have a greater risk of developing infection compared with women who have a vaginal birth by 5 to 20 fold ***(Leth et al., 2009).***

Post-caesarean section infection includes wound infection and endometritis. Additionally, urinary tract infection may be associated with caesarean delivery. In rare cases, pelvic abscess, bacteraemia, septic shock, septic pelvic vein thrombophlebitis, necrotizing fasciitis, dehiscence of the wound or evisceration may occur. The impact of post-caesarean infections include additional cost, the use of therapeutic antibiotics, additional surgical

interventions, longer duration of hospital stay, and in some cases maternal death attributed to infection ***(Lamont et al., 2011).***

There are different interventions that aim to reduce the rate of infection after caesarean delivery including preoperative vaginal preparation with antiseptic solution ***(Haas et al., 2014)*** and prophylactic antibiotics ***(Smaill and Grivell, 2014; Doss et al., 2012 and Salim et al., 2011)***.

A- Post-operative endometritis:

Postpartum endometritis is one of the commonest complicating infections, which can follow an aggressive course, progressing into endomyometritis, up to pelvic abscess or even generalized peritonitis and septicaemia. Caesarean delivery is probably the most important single risk factor for postpartum endometritis, with reported odds ratios ranging between 5 and 20 ***(Olsen et al., 2010).***

One of the most common complications is endomyometritis, observed in (35-40%) of patients who undergo caesarean delivery.In general, preoperative antibiotics should be administrated in cases associated with a high risk of postoperative infection (e.g., long labor, multiple examination, premature rupture of membranes and chorioamnionitis) perioperative antibiotic serve to less the bacterial inoculums at the operative site, and so; use of an antibiotic as prophylactic in caesarean delivery has been shown to decrease endomyometritis by (50-60%) ***(Schwartz and Grolle, 1981).***

B- Post-operative febrile morbidity:

The mean causes of postoperative fever include wound infection, urinary tract infection and pulmonary infection. Endometritis, salpingitis, peritonitis, parametritis and wound infections are more liable to occur in infected or potentially infected cases (e.g., premature rupture of

membranes for more than (12) hours, long labor, multiple examinations, chorioamnionitis) ***(Gabert et al., 1992).***

C- Wound infections:

Surgical site infection (SSI) is a common complication of surgery. Infection has always been a feature of modern surgery and continues to be a significant problem for health-care practitioners across the world. SSI is a common and major cause of postoperative morbidity. Its morbidities range from delayed healing to systemic sepsis ***(Galal and El-Hindawy, 2011).***

A post-caesarean wound infection detected prior to hospital discharge will lead to prolongation of hospital stay and will increase the hospitalization costs and need readmission ***(Olsen et al., 2008).***

The risk of wound infection following a caesarean birth ranges from (2.5%) to higher than (15%). It is best treated by appropriate antibiotics if

swab can be cultured or by broad spectrum ones if they cannot. It usually responds well and there no need to intervene surgically. Should the infection be of the abdominal wall wound, local heat is helpful and secondary suture may be required if the skin and subcutaneous tissues gap ***(Chamberlain et al., 2001).***

Wound dehiscence is increased in vertical incision (2.49%) compared to low transverse incision (0.37%) giving further support to use the pfannenstiel incision whenever possible ***(Mowat and Bonnar, 1981).***

Wound dehiscence and wound evisceration are serious complications, being associated with a (12% and 30%) of maternal mortality rate, respectively ***(Mendolza et al., 1990).*** Avoidance of wound dehiscence is dependent on good surgical technique (sutures are placed at least (1) cm. from the fascial edge and then tied loosely) ***(Olsen et al., 2008)***.

D- Urinary tract infections:

The second most common etiology for post-operative febrile morbidity is urinary tract infections. The incidence ranges from (2-16%), and it is due to the presence an indwelling catheter. This initiates some trauma to the bladder ***(Ahern et al., 1982).***

3- Bowel Functions:

Postoperatively, some patients may complain of slow return of bowel function. Most of these patients respond to conservative therapy, but a small portion may require decompression ***(Gabert et al., 1992).***

4- Thrombo-embolic complications:

One of the leading causes of maternal mortality related to caesarean delivery is deep venous thrombosis resulting in pulmonary embolism. Rose and colleagues reviewed more than one million deliveries in Sweden from 1987 to 1995 and found that the relative risk of pulmonary embolism with caesarean delivery was approximately 7, after

excluding women with preeclampsia, the increase in risk was 4-fold relative to vaginal delivery ***(Rose et al., 2002).***

The American College of Chest Physicians practice guidelines recommends early mobilization in postpartum women with no risk factors for DVT other than the postpartum state and the operative delivery ***(Hirsh et al., 2008)***. For women with at least one additional risk factor, they suggest pharmacologic thromboprophylaxis (prophylactic low molecular weight heparin or unfractionated heparin) or mechanical prophylaxis while the patient is in the hospital. For women with multiple risk factors for thromboembolism, they suggest pharmacologic thromboprophylaxis combined with graduated compression stocking and/or intermittent pneumatic compression. ***Marik and Plante (2008)*** developed a risk stratification approach to venous thromboembolism prophylaxis (see table 1).

*Table (1): Risk Assessment for Thromboembolism in Patients Who Undergo Caesarean Section**

Low Risk: early ambulation

– Cesarean delivery for uncomplicated pregnancy with no other risk factors

Moderate risk: low-molecular-weight heparin or compression stockings

– Age > 35 yr
– Obesity (BMI > 30)
– Parity > 3
– Gross varicose veins
– Current infection
– Preeclampsia
– Immobility for > four days before operation
– Major current illness
– Emergency caesarean section during labor

High risk: low-molecular-weight heparin and compression stockings

– Presence of more than two risk factors from the moderate risk section
– Caesarean hysterectomy
– Previous deep-vein thrombosis or known thrombophilia

**BMI denotes body-mass index (the weight in kilograms divided by the square of the height in meters*

5- Fetal complications:

Iatrogenic prematurity; This might happen in elective caesarean delivery than those performed after onset of labor .This occurs occasionally even for babies thought to be full term, as was reported in a

study of more than 170.000 births in England. This resulted in increased neonatal respiratory problems and increased admission to neonatal units ***(Madar et al., 1999)***.

A recent literature review suggests that vaginal births involve important physiological changes that are absent or modified in babies born by caesarean section ***(Hyde et al., 2011).*** *Authors suggest that vaginal birth is an important life programming event for the infant, and that the differences in physiology that arise between vaginal and caesarean births have implications for the infant, with caesarean section increasing the risk of compromised health in both the short and the long term* ***(Hyde et al., 2011).***

6-Delayed Post-Operative Complications:

A-Placenta Accreta:

There is a significant increased risk of abnormal placentation such as placenta previa, placenta accreta, placenta previa with accreta, and

the need for gravid hysterectomy after a woman's second caesarean delivery ***(Silver et al., 2006)***. One in four patients who undergoes repeat caesarean delivery because of placenta previa will require caesarean hysterectomy for hemorrhage caused by placenta accreta. This complication increases with the number of prior uterine incisions ***(Downes et al., 2015 and Sholapurkar, 2013)***.

B-Uterine Dehiscence and/or Rupture:

Dehiscence and rupture of a uterine scar are uncommon complications that are diagnosed during a subsequent pregnancy.

The term uterine dehiscence is commonly applied to asymptomatic scar separation that does not penetrate the serosa and does not produce haemorrhage, presents as a "serosal window" and is often discovered unexpectedly during a repeat caesarean delivery ***(Rockville, 2003)***.

Preterm delivery and number of previous CDs were found to be independent risk factors for uterine scar dehiscence. In contrast, parity had a protective effect against dehiscence ***(Bashiri and Mazor, 2008).***

Rupture of lower segment scars usually occurs during labor, but may occur antepartum, particularly with classical uterine scars ***(Spong et al., 2007)***.

In contrast to dehiscence, uterine rupture is a through-and-through scar separation that is clinically symptomatic and requires surgical intervention. Uterine rupture occurs in about 0.7 percent of women with a prior caesarean delivery ***(Dodd et al., 2009)***.

Fetal bradycardia is the most common and characteristic clinical manifestation of uterine rupture, occurring in 33 to 70 percent of symptomatic cases. Variable or late decelerations

may precede the bradycardia ***(Ridgeway et al., 2004)***.

Maternal manifestations are variable. In women with known uterine scarring or trauma, uterine rupture should always be strongly considered if constant abdominal pain and signs of intra-abdominal haemorrhage are present. Vaginal bleeding is not a cardinal symptom, as it may be modest, despite major intra-abdominal haemorrhage. Other clinical manifestations include maternal tachycardia, hypotension ranging from subtle to severe (hypovolemic shock), cessation of uterine contractions, loss of station of the fetal presenting part, uterine tenderness, and change in uterine shape ***(Spong et al., 2007***).

Postpartum, uterine rupture is characterized by pain and persistent vaginal bleeding despite use of uterotonic agents. Haematuria may occur if the rupture extends into the bladder.

Women who have had a previous preterm caesarean delivery are at a minimally increased risk for uterine rupture in a subsequent pregnancy when compared with women who have had previous term caesarean deliveries ***(Sciscione et al., 2008).***

C-Caesarean Hysterectomy:

Indications for caesarean hysterectomy are uterine haemorrhage unresponsive to treatment, uterine laceration that would result in an unstable repair, placenta accreta, and advanced cervical dysplasia or carcinoma. Complications of caesarean hysterectomy are more common during emergent procedures and include increased blood loss and anesthesia time, plus infection, blood transfusion, and unanticipated sterility ***(American Academy of Family Physicians, 2008)***.

D-Repeat Caesarean Delivery:

A major complication of caesarean delivery is that nearly most of patients will undergo caesarean delivery with subsequent pregnancies. Repeated surgeries may also involve adhesions and subfertility, chronic pain syndromes and keloid formation ***(American Academy of Family Physicians, 2008)***.

NB: Other rare complications include adhesive disease leading to bowel obstruction, pelvic pain and infertility ***(Pietrantoni et al., 1991).***

Substantial proportions of mothers reported problems with postpartum pain. Women experiencing a caesarean section or an assisted vaginal delivery were most likely to report that the pain persisted for an extended period ***(Declercq et al., 2008).***

Ectopic pregnancy in a caesarean scar is an important diagnosis to consider in a woman who has had a history of caesarean delivery and whose early ultrasonography shows a thin, lower uterine segment or a low implantation site. Once recognized, patients with this complication may be treated either surgically or medically as indicated by the clinical situation ***(Holland and Bienstock, 2008).***

Although short-term occurrence of any degree of postpartum stress urinary incontinence is reduced with caesarean section, severe symptoms are equivalent by mode of birth. Risk of postpartum stress urinary incontinence must be considered in the context of associated maternal and newborn morbidity and mortality ***(Press et al., 2007).***

Antenatal incontinence increases the risk of postpartum incontinence, which in turn increases the risk of long-term persistent incontinence. After the first delivery, women delivered vaginally have two – fold more incontinence than those delivered by

caesarean. The protective effect of caesarean on urinary incontinence may dissipate after further deliveries, decreases with age, and is not present in older women ***(Nygaard, 2006).***

Elective caesarean section does not appear to cause infertility. What we need now, however, are more qualitative studies to determine the contribution of caesarean section per se on fecundity ***(Oral and Elter, 2007).***

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