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# Microsurgical Cesarean Section

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## Abstract

Worldwide, not only is cesarean section (CS) the most commonly performed major surgery, but it is also the commonest obstetric operation. CD is associated with some chronic maternal morbidities including pelvic pain, adhesions and adverse reproductive effects. CS carries long-term sequelae which can adversely affect subsequent pregnancies. Why do some women develop bad sequelae of CS-like adhesions, and infertility is well demonstrated in this chapter. Fertility-oriented step-by-step description of CS techniques is extensively described. Some recent controversial issues related to CS like the development of uterine niche (isthmocoele) at the CS scar site, placenta accrete and the role of cesarean myomectomy are discussed in details. At the end of this chapter, the reader will conceive enjoy fertility-oriented concept of CS.

**Keywords:** cesarean section, fertility, infertility, adhesions, isthmocoele, adhesions, cesarean myomectomy

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## 1. Introduction

While cesarean section (CS) is sometimes mandatory and even maternal and fetal lifesaving, in most situations, spontaneous vaginal birth is still safer for both woman and her baby. Worldwide, cesarean delivery (CD) is the most frequent major operation performed, and of course, the commonest surgery performed in obstetrics. For instance, in the US, nearly one in three women gives birth by CS. According to The American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine [1], CD is too common in the US and has markedly increased up to the extent that about 1.3 million children each year are now delivered by CS.

## 2. Epidemiology of CS

Of no doubt, all obstetricians and even the public community notice dramatic increase of CS rate. The rate of CD (calculated by dividing the number of CS over the total number of live births) has increased dramatically since the 1990s, reaching a peak of 32.9% in 2009 [2]. In 1985, the international healthcare community has considered the ideal rate for CS to be between 10 and 15%. Since then, CS has become increasingly performed in both developed and developing countries [3].

In one study [4], the latest CS rates and trends over the last 24 years were presented. According to data from 150 countries, they found that 18.6% of all births occur by CS, ranging from 6 to 27.2% in the least and most developed regions, respectively. Latin America and the Caribbean region had the highest CS rates (40.5%), followed by Northern America (32.3%), Oceania (31.1%), Europe (25%), Asia (19.2%) and Africa (7.3%). It was concluded that the use of CS worldwide has increased to unprecedented levels although the gap between higher- and lower-resource settings remains. Practically speaking, CS rates show every day increase thanks to improved safety issues, refinement of the surgical techniques and maternal preference.

The increased rate of CS can be seen among women of all ages and race/ethnicities, in every country, and across all gestational ages. Because the primary CD rate has increased and the rate of trial of labor after CD has decreased, the primary CS rate has become a major driver in the total CD rate. Moreover, contributing to the high CD rate is increased subjective indications, for example, fetal distress or nonreassuring fetal heart rate (FHR) tracing and failure of progress in addition to elective CS [2].

### 2.1. CS and female fertility

A lot of women subjected to CD can easily get pregnant even within 2 months after the operation. There is a general consensus among obstetricians and women that CS has little compromise of future fertility. Unfortunately, this consensus is not based on respectable studies. Personal impression or experience even of scientific committees is class IV evidence.

### 2.2. Why CS is less likely to induce pelvic adhesions compared to gynecologic operations?

Regarding the risk of fertility-related adhesions, the nearer the surgery to the pelvis, the higher risk of adhesion formation. Any gynecologic or nongynecologic pelvic surgery is considered as a potential risk factor for pelvic adhesion induction.

Nevertheless, adhesion formation after CS is less likely than gynecologic operations which may be attributed to one or more of the following [5]:

- Less tissue hypoxia due to greater tissue perfusion associated with physiological changes in pregnancy.
- The injured site at rest: the lower segment (LS) is subjected to fewer movements than upper segment (US). LSCS site is the least susceptible site for adhesion formation. That is why

we recommend performing myomectomy of the anterior uterine wall or even some fundal myomata via a LSCS-like incision to minimize adhesion formation. The same concept applies for cervical myoma after proper dissection of the bladder.

- LS is covered by UB which is constantly being filled and emptied during the healing process disrupting any fibrinous band between the uterus and the bladder, and between the LS and the anterior abdominal wall, thus decreasing adhesion development at this location.
- Anatomic effects of uterine involution postpartum would help disruption of newly formed adhesions.
- Always single incision (unlike myomectomy where more than one incision may be required).
- Rare hematoma formation.

#### *2.2.1. Minimal adhesion risk peculiar to pregnancy*

- Pregnancy is associated with increased fibrinolytic activity in amniotic fluid beyond 37 weeks.
- During pregnancy, there is increased plasminogen activator activity which is associated with fewer adhesion formation risks.
- Unique hormonal changes of pregnancy with increased steroid secretion.

#### *2.2.2. Clinical evidence of lower adhesion formation rate following CS*

Since CD incision is away from the tubes and hidden by the bladder flap, it is expected to develop fewer adhesions than posterior or fundal uterine incisions [6]. A second-look laparoscopy assessed adhesions between the abdominal wall and the underlying omentum and bowel following a previous laparotomy [7]. Patients with midline incisions performed for gynecologic indications had significantly more adhesions than all types of incisions performed for obstetric indications (OR, 1.65; CI, 0.97–2.83,  $P = .054$ ). The presence of adhesions in patients with previous obstetric surgery was not affected by the type of incision in this study. Similarly, women with midline or Pfannenstiel incision for gynecologic surgery had more adhesions than those with incisions for obstetric surgery [8].

However, adhesions continue to occur despite lower uterine incisions, albeit less to the anterior abdominal wall compared to classical upper segment CD or gynecologic incisions.

### **2.3. Deleterious impact of CS on subsequent fertility**

Sometimes, CD is associated with some chronic maternal morbidities including pelvic pain, adhesions and adverse reproductive effects like decreased fertility and increased risk of spontaneous abortion and ectopic pregnancy [9]. Pelvic adhesions may cause pelvic pain, dyspareunia, intestinal obstruction or infertility. CS carries long-term sequelae which can adversely affect subsequent pregnancies. Women with previous CS may present with frequent intermenstrual spotting due to retention of blood inside a reservoir-like defect of

the scar (isthmocele). Generally, women who have had a CS are less likely to have further children than those who have had a vaginal delivery. This can be attributed to voluntary family planning, patient fear from repeated surgical intervention, consequences of the indications for the cesarean and due to the operation itself.

On evaluation of 18 cohort studies [10], it has been found the CS is associated with 9% reduction of subsequent pregnancy rate [risk ratio (RR) 0.91, 95% confidence interval (CI) (0.87, 0.95)] and 11% reduction of birth rate [RR 0.89, 95%CI (0.87, 0.92)] compared with patients who had delivered vaginally.

However, these studies were heterogeneous with failure to assess some contributing factors like increasing maternal age (which is the most important independent fertility factor), changes in accepted indications for elective CS and changes in women's choices (increased CS on demand rate). **CS on demand (maternal request)** is primary prelabor CS on maternal request in the absence of any maternal or fetal indications.

## 2.4. How does CS induce adhesions?

Surgery may cause tissue ischemia which is a predisposing factor for adhesion formation. Subsequently, suppression of fibrinolysis and persistence of fibrin follow. Immunosuppression may have a role. Additive rough surgical techniques would aggravate adhesion formation like aggressive tissue manipulations, use of excessive electrocoagulation, leaving FB particles or blood during surgery, infection and any factor damaging the normal healing process [11].

### 2.4.1. Impact of post-CD adhesions on the operative course of repeat CS

All obstetricians face some difficulties with variable degrees due to adhesions induced by a previous CD. The incidence of adhesion development increases with the number of CDs performed. A significantly higher risk of intraperitoneal adhesions was detected in patients undergoing their 4th to 10th CD compared to those having their 1st, 2nd or 3rd CD (OR, 8.1; CI, 2.7–23.8) [12]. One study [13] was constructed to estimate the incidence of adhesions after CS and to determine their impact on delivery and infant well-being.

They evaluated reports of 542 women who had undergone primary CS (265 women) or repeat CS (277 women). The incidence, severity, and locations of adhesions, delivery time, cord blood pH, and Apgar scores were analyzed. After the first CD, 100 of 217 women (46%) had pelvic adhesive disease; 48 of 64 women (75%) who underwent a third CD and 5 of 6 women (83%) who underwent a fourth CD had formed pelvic adhesive disease. Compared with primary CD, delivery of the infant was delayed 5.6 min (52%) with 1 previous CD, 8.5 min (79%) after 2 CD, and 18.1 min (169%) during the fourth CD ( $P < 0.001$  for all comparisons). It had been concluded that the high percentage of CDs results in adhesive disease, which delays repeat CD of the fetus. The potential for adhesive disease should be included in counseling regarding primary elective CD. Actually, I find the last conclusion very valuable as women are not familiar with long-term sequelae of CD particularly surgical difficulties and possibility of additional surgical procedures like adhesiolysis, repair of bladder injury or surgical steps required for prompt management of placenta accreta which may end by cesarean hysterectomy.

## 2.5. Impact of CD on the endometrium

CD induces a delay in endometrial maturation at the scar site which might have been a result of disruption in steroid receptor expression, leading to abnormal response to estrogen and progesterone [14]. Endometrium at LSCS scar site may not cycle in synchrony with the rest of endometrium in the uterine cavity. Endometrial samples were taken from both cesarean scar site and posterior uterine wall and were compared to similar samples obtained from women who had spontaneous vaginal delivery (SVD). Fewer leukocytes and less vascularization at the scar site were seen less than in the endometrium of the unscarred uterus.

## 2.6. Other CD-associated abnormal uterine factors

CD may be associated with abnormal scar healing, abnormal signaling, disturbed endometrial receptivity as well as uterine contractility.

## 2.7. How does CS affect future fertility?

CS can affect fertility by different ways. Principally, CS can cause fertility-compromising induction of intraperitoneal or intrauterine adhesions. Formation of adhesions is common after cesarean delivery; rates of 11–70% have been reported [15].

## 2.8. Possible sites of adhesions following CS

Post-CS adhesions can be seen at different parts of the pelvis and abdomen. Commonly, we notice a thick central band attracting the uterus upward to the anterior abdominal wall as seen by laparoscopy (**Figure 1**). The exact mechanism of formation of this thick band can be attributed to leaving row sites of the scar that adhere to the peritoneum particularly if nonclosure technique is used. This position is fertility-compromising as both tubes will be elevated and fimbriae will not reach the pouch of Douglas for ovum pick-up. In many cases, despite no adhesion detection in the pouch of Douglas at laparoscopy, yet infertility is supposed to be due to abnormal position of the tubes.



**Figure 1.** A thick central band of post-CS adhesions.



Another commonly seen form of adhesions is lateral position of one or both adnexae with dense adhesions to the lateral pelvic wall (**Figure 2**) or even anterior abdominal wall. These adhesions entrap the ovum and hinder the motility of the tube. Occurrence of such adhesions can be attributed to leaving blood clots or meconium behind in flanks or using dry towels in flanks. The last procedure is practiced by many obstetricians aiming at prevention of soiling the peritoneal cavity with blood, meconium, amniotic fluid or debris. However, serosal trauma induced by towels especially dry towels would be more harmful to the patient from fertility point of view. A very rare but very serious complication of inserting tools in flanks is missing one or both towels which had been seen at least once by some senior obstetricians.



**Figure 2.** Dense adnexal adhesions to lateral pelvic wall.

We may diagnose dense omental (**Figure 3**) and even intestinal adhesions to the anterior abdominal wall, uterovesical pouch, or adnexae. These forms of adhesions result from peritoneal soiling, uterine exteriorization or rough manipulations of pelvic organs or intestine.



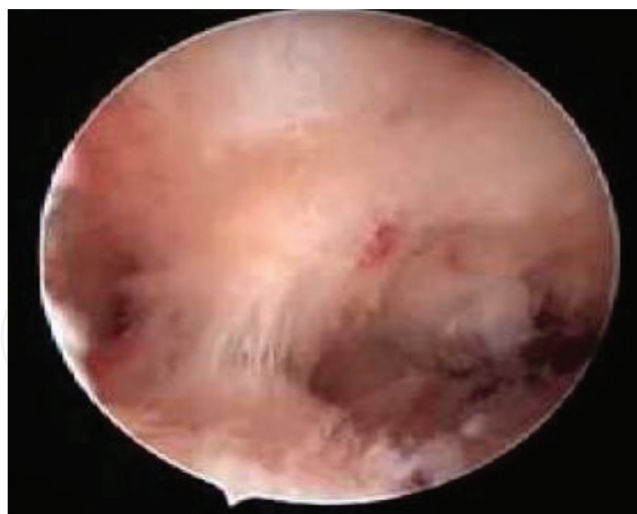
**Figure 3.** Dense omental adhesions.

Fine thin adhesions of the pouch of Douglas (**Figure 4**) can be noticed due to retained blood clots. Excision of these filmy adhesions would increase the chance of pregnancy by facilitating easy ovum pickup.



**Figure 4.** Fine adhesions of the pouch of Douglas.

Adhesions can occur in utero. The most difficult and aggressive form of adhesions is class IV intrauterine adhesions (IUAs) (**Figure 5**), which may result from suturing of the anterior and posterior uterine walls, leaving intrauterine remnants (part of placenta or membranous tissues) or post-CS intrauterine infection.



**Figure 5.** Dense IUAs.

## 2.9. Steps of fertility-oriented CS

Some procedures related to CS would affect future fertility including preoperative, intraoperative and postoperative issues. In the following section, stress on impact of every CS step on future fertility will be addressed.



### 2.9.1. *Strict asepsis*

The concept of asepsis all through CS should be conceived by all members of the team concerned in delivery process. Every now and then, senior obstetricians should check steps of asepsis by different members of the delivery team. They should inform juniors and nurses that infection is a real enemy to delivery whether vaginal or abdominal. They should teach juniors that washing hands even with antiseptic solutions is not sterilization. Principles of hand cleaning, disinfection and sterilization should be highlighted all the time. Scrubbing hands and forearms even with antiseptic solutions make them “surgically clean.” The purpose of scrubbing is to minimize the possibility of infection whenever unintentional cut of sterile gloves occurs and to minimize the risk of infecting the surgeon himself. Senior should check how the team wears gloves and gowns without touching the external surfaces.

Preoperatively, repeated vaginal examination may carry a risk of introduction of ascending infection to the upper genital tract with subsequent fertility compromise. I think that routine use of partograph during labor would minimize the need for repeated vaginal examination. Of course, if PV is highly required, complete aseptic conditions are mandatory.

Some obstetricians routinely clean the vagina with an antiseptic solution which looks a good safety step to guard against ascending infection. Preoperative vaginal cleansing with povidone iodine has reduced post-cesarean infectious morbidities [16].

Prolonged premature rupture of fetal membranes (PROM) is an important factor that would increase the risk of upper genital tract infections and subsequent fertility compromise.

If CS is decided, proper skin disinfection from the lower border of the breasts to the knees is mandatory. Sterilization should be unidirectional using copious amount of the disinfectant. The incision site should be repeatedly disinfected. Whether to use povidone-iodine or chlorhexidine-alcohol is equally effective [17].

**Prophylactic antibiotics:** pre-skin IV BS antibiotic would help reduce maternal infectious morbidity [18].

### 2.9.2. *Fertility-oriented skin incision*

Vertical incision allows good access to the pelvis, lower and upper abdomen. However, in addition to being noncosmetic and not accepted by many women, it may affect future fertility. It may attract more adhesions due to longer row space of the peritoneum putting in mind that the row peritoneal surface is not masked unlike transverse incision. The uterus can easily adhere to the peritoneal defect that causes a commonly seen thick central band of adhesions attracting the uterus upward. If the patient became infertile, laparoscopic access to the abdomen will be more dangerous than transverse incision with a possibility of intestinal adhesions to the peritoneal surface. So, it is better to perform transverse incision whenever possible.

Two common transverse incisions for cesarean delivery are performed [6]. The Pfannenstiel skin incision is slightly curved, 2–3 cm above the symphysis pubis, with the midportion of the incision within the shaved area of the pubic hair. The Joel-Cohen type incision is straight, 3 cm

below the line that joins the anterior superior iliac spines, and slightly more cephalad than Pfannenstiel [19]. The former incision is usually completed utilizing sharp dissection while the latter using blunt dissection. In a Cochrane meta-analysis of randomized trials of surgical incisions for cesarean delivery, the Joel-Cohen type incision had significant short-term advantages compared with the Pfannenstiel incision, including lower rates of fever, postoperative pain, and use of analgesia, less blood loss and shorter operating time (overall and incision-to-delivery) and hospital stay [20, 21]. In two trials (411 women) that compared the Joel-Cohen incision with the Pfannenstiel incision, the Joel-Cohen incision resulted in a 65% reduction in reported postoperative febrile morbidity (RR 0.35, 95% CI 0.14–0.87); one trial reported reduced postoperative analgesic requirements (RR 0.55, 95% CI 0.40–0.76), operating time (mean difference [MD] -11.40, 95% CI -16.55 to -6.25 min), delivery time (MD -1.90, 95% CI -2.53 to -1.27 min), total dose of analgesia in the first 24 h (MD -0.89, 95% CI -1.19 to -0.59), estimated blood loss (MD -58.00, 95% CI -108.51 to -7.49 mL), postoperative hospital stay for the mother (MD -1.50, 95% CI -2.16 to -0.84 days), and increased time to the first dose of analgesia (MD 0.80, 95% CI 0.12–1.48 h) [20]. No other significant differences were found in either trial.

From fertility-enhancing point of view, transverse incisions are more fertility-enhancing due to direct access to the lower segment with minimal manipulations of the genital organs. Moreover, sutures are confined to the lower segment of the anterior aspect of the uterus away from the adnexae.

### 2.9.3. *Opening the peritoneum*

It seems that both sharp and blunt opening of the peritoneum have little impact on fertility. Despite no supportive studies on the effect of peritoneal opening on fertility, blunt opening minimizes the risk of inadvertent injury to bowel, bladder or other organs that may be adherent to the underlying surface. This peculiar advantage avoids extra procedures and suturing which may compromise subsequent fertility.

An extraperitoneal approach is another option. Most obstetricians are not familiar with this technique since it was used primarily in the pre-antibiotic era to decrease the risk of intraperitoneal infection. It requires a detailed knowledge of the relationship between the fascial planes the bladder and lower uterine segment. Theoretically, avoiding exposure of the peritoneal cavity to blood, amniotic fluid, vernix, and mechanical irritation can potentially reduce nausea and vomiting, postoperative pain, voiding disturbances, and other side effects and complications of cesarean delivery [6]. This hypothesis is supported by a small randomized trial that compared the transperitoneal and extraperitoneal techniques and found the latter resulted in less intraoperative nausea and vomiting and less postoperative pain [22].

### 2.9.4. *Prior dense intraperitoneal adhesions*

If there are dense adhesions between the anterior abdominal wall and the anterior surface of the uterus, please enter the peritoneum as lateral as possible bluntly and as close as possible to the upper abdomen to avoid areas of dense scar tissue in the lower abdomen (pelvis). Sharp dissection of the peritoneum also may be needed and should be performed cautiously using

shallow incisions under direct vision. If pelvic adhesions are dense and organs are sealed, bladder injury would be inevitable. In such situation, a higher hysterotomy incision albeit more bloody would be obligatory. After delivery of the baby, uterine exteriorization may be needed to perform proper adhesiolysis and meticulous hemostasis.

#### 2.9.5. *Bladder flap*

It is not clearly cited whether undergoing or omitting development of a bladder flap would affect future fertility. Omitting this procedure reduced the incision-to-delivery interval by an average of one to two minutes and was not associated with an increase in adverse short-term outcome [23, 24]. However, there is no available data to definitively assess morbidity, such risk of bladder injury, or the long-term consequences of not creating a bladder flap.

#### 2.9.6. *Fertility-oriented hysterotomy incision*

Of no doubt, transverse incision along the lower uterine segment (i.e., Monro Kerr or Kerr incision) is much more fertility-enhancing than longitudinal incision in different ways including less subsequent adhesion formation, stronger scar with less liability to weakness complications, and less bloody. The problem of the transverse incision is failure to extract the presenting part easily particularly if it is big or the lower segment is not well formed. In such cases, wound extension with subsequent uterine arteries tear is expected. This would require additional rescue procedures that may compromise fertility by induction of adhesions due to excessive bleeding or additional suturing.

A practical trick to minimize the possibility of uterine artery injury is widening of the hysterotomy incision by simultaneous cephalad and caudal traction of the edges using two fingers on the upper and two fingers on the lower end. Never extend the incision right and left as vessel injury would be expected. However, if the presenting part is still not easily extracted, a modification of the wound would be a rescue additional step by doing unilateral or even bilateral curved incisions (J-shaped or U-shaped incisions) with care not to cut the uterine arteries.

Do not perform inverted T-shaped incision whenever possible as it is an ugly scar with poor healing and subsequent high possibility of uterine rupture in subsequent pregnancy. In all situations, transverse hysterotomy incision is much better than low vertical or classical vertical incisions simply due to less liability of adhesion formation or compromise the course of subsequent pregnancy.

#### 2.9.7. *Exteriorizing the uterus*

It allows more access to the hysterotomy site and adnexae. However, it encourages the surgeon to overmanipulate adnexae with prolonged exposure, congestion and dryness. These factors would increase the possibility of adhesion formation.

A meta-analysis of randomized trials of extraabdominal (exteriorized) versus intraabdominal (in situ) repair found no clinically significant differences in blood loss, intraoperative nausea,

vomiting or pain between the two approaches [25]. Unfortunately, it was a short-term study and missed evaluation of future fertility.

#### *2.9.8. Finger or instrumental dilatation of cervix*

It aims to improve drainage of blood and lochia. Personally, I routinely perform cervical dilatation in elective CS particularly primigravida where the cervix is tightly closed. We noticed that omission of this step is associated with frequent women complaints of no or trivial vaginal bleeding, and they consider all postoperative complaints due to retained blood inside the uterine cavity. However, risk of ascending infection from the cervix should be considered. The surgeon should change his gloves or discard the used curved artery forceps after cervical dilatation. So far, there are no bacteriological studies on bacterial colonies on the forceps or the gloves after dilatation.

#### *2.9.9. Fertility-oriented hysterotomy suturing*

**Choice of suture material:** A plethora of suturing materials is available like chromic catgut or delayed absorbable synthetic, for example, polyglactin 910, poliglecaprone 25. We commonly use 0-delayed absorbable synthetic monofilament (e.g., Monocryl) or braided (e.g., Vicryl) in modern practice. Despite no available studies on the direct relation of suturing material to future fertility, yet we have to select the least tissue-irritant material with minimal tissue reaction.

**Myometrial closure:** Several studies compared single- versus double-layer closure of hysterotomy incision. For fertility enhancement, we usually perform a two-layer, continuous closure with delayed absorbable synthetic suture incorporating all of the muscle to avoid bleeding from the incision edges. Care should be considered to avoid leaving raw surface of the scar which is a potential site for further adhesion formation.

**Endometrial suturing:** Previously, it was recommended that the endometrium should be spared from suturing for fear of induction of intrauterine synechiae. However, with frequent sonographic follow-up, it was found that better to include the endometrial layer in the full thickness myometrial closure to avoid scar defect. This opinion is based on a randomized trial that assigned 78 term pregnant patients delivered by cesarean to one layer myometrial closure either including or excluding the endometrial layer [26]. The frequency of a wedge-type healing defect on ultrasound 6 weeks postpartum (isthmocoele) was significantly lower in the group that had full thickness suturing (45 versus 69%). It is conceived that isthmocoele would negatively affect future fertility (see section on isthmocoele and fertility).

**Blunt (rounded tip) versus sharp (tapered point) needles:** Despite performing faster particularly in repeat CS, sharp needles are associated with minute bleeding after traction on the continuous sutures with a possibility of diathermy use. Theoretically, this would increase the likelihood of adhesion invitation. There are no available studies on adhesion formation according to the type of needle so far.

**Single- versus double-layer closure:** It is a controversial issue. From fertility point of view, better to do meticulous two layers without leaving raw points. If fertility future is not important,

the obstetrician is free to do single- or double-layer closure according to the myometrial thickness and control of bleeding. In a 2014 systematic review and meta-analysis of comparative studies, single- and double-layer hysterotomy closure resulted in similar rates of overall maternal infectious morbidity, endometritis, wound infection, and blood transfusion, but operative time was 6 min shorter with the single-layer closure (20 studies including almost 15,000 patients) [27]. Over the long term, however, uterine rupture in the next pregnancy is a potential risk of single-layer closure [6]. Available data are limited and do not provide convincing evidence of safety or harm. In the 2014 meta-analysis described above, single-layer closure resulted in a nonstatistical increase in “uterine rupture or dehiscence” in the next pregnancy (4.8 versus 2.9%; RR 2.38, 95% CI 0.63–8.96; two studies, n = 187 participants) [27]. The technique used for the single-layer closure may be a contributing factor. Compared with an unlocked closure, locked closure has been associated with higher occurrence of surrogate markers of scar weakness (thinner myometrial thickness, bell-shaped uterine wall defects) [28, 29] and dehiscence or rupture [30]. However, available data are limited by heterogeneity in criteria for diagnosis of uterine scar defects, length of follow-up, method of follow-up, and closure technique, as well as lack of randomization for the primary outcome and the low number of uterine ruptures. Further study of possible adverse consequences of single-layer closure is warranted [6].

**Peritoneal closure and future fertility:** Nonclosure of the visceral or parietal peritoneum saves time with rare liability to postoperative ilius.

Theoretically, nonclosure might allow the enlarged uterus to adhere to the anterior abdominal wall or impede spontaneous closure of the peritoneum, while closure might cause a foreign body reaction to sutures and tissue damage [6].

A systematic review of prospective observational studies of peritoneal nonclosure at CS, nonclosure was associated with greater adhesion formation than closure of the parietal layer or both visceral and parietal layers (OR 2.6, 95% CI 1.48–4.56; three studies, n = 249) [31]. Moreover, a 2011 systematic review that included many of the excluded observational studies in the systematic review [32] also found that nonclosure was associated with greater adhesion formation [33]. On the other hand, some studies found that closure or nonclosure of the peritoneum at CS did not lead to large differences in the adhesion rate [31] using adhesion scoring system.

**Use of drains:** Despite not recommended by many studies, again if the obstetrician is fertility-oriented, intraperitoneal or subrectal tube drains may have a role particularly in repeat cases with concomitant adhesiolysis, ovarian cystectomy or myomectomy. Drain is of peculiar importance if the surgeon closes the abdomen on trivial serosal oozing. In a 2013 meta-analysis of randomized trials of wound drainage at cesarean delivery, routine use of wound drains was not beneficial [34]. Compared with no drain, routine use of drains does not reduce the odds of seroma, hematoma, infection or wound disruption. Additionally, restricted use of subrectus sheath drains offers no benefit in maternal infectious morbidity compared with liberal use [35]. These findings also apply to obese women [36]. All these studies omitted evaluation of further fertility particularly in repeat cases and didn't include laparoscopic findings in infertile cases.



## 2.10. Postpartum care and future fertility

It seems logic that a woman delivered by abdominal approach is more liable to infection than those delivered vaginally. This can be attributed to tissue manipulations, hematoma formation, seroma formation, or leaving behind intraperitoneal blood, AF, meconium or vernix. All these contributing factors are actually added to possible risk factors after vaginal delivery that may help introduce infection to the upper genital tract with subsequent adhesion formation. An additional risk factor is wound infection which may be aggressive to the extent of necrotizing fasciitis. Prompt and condensed treatment of these factors would minimize the risk of adhesion formation.

## 2.11. Bad surgical technique and nonmicrosurgical approach: how to avoid?

- **Think fertility:** To perform microsurgical CS, the surgeon should think fertility all the time. He has to develop the skill of fine manipulations and gentle tissue handling aiming at preservation of future fertility potential of the genital organs. Every effort should be exerted to avoid development of postoperative adhesions which would affect future fertility. Surgeons should adopt a routine adhesion reduction strategy with good surgical practice to reduce adhesion formation [37].
- **Avoid predisposing factors for adhesion formation:** Many factors can contribute for adhesion formations like excessive tissue ischemia, dryness of surfaces, excessive suturing, omental patches or infection. Moreover, technical problems may help adhesions like excessive traction on the peritoneum, retained blood clots inside the peritoneal cavity, prolonged operative time, and adnexal trauma by rough manipulations, dry towels or talc powder. Of peculiar occurrence during CD, leaving meconium and amniotic fluid behind particularly in the Douglas pouch and flanks represents an evident factor as these foreign materials may induce peritoneal and serosal irritation with subsequent inflammation.
- **Microsurgical principles:** An obstetrician should think microsurgery during CS. He should follow fertility-preserving reconstructive surgical principles which are as follows:
  - Avoidance of serosal insults: tissue trauma, ischemia, hemorrhage, infection, foreign-body reaction, and leaving raw surfaces.
  - Minimizing tissue trauma by using atraumatic techniques, meticulous hemostasis, complete excision of abnormal tissues and precise alignment and approximation of tissue planes. Since a long time, there is some evidence of superiority of reconstructive surgery over nonreconstructive surgery. For instance, performing reconstructive surgical correction of distal tubal occlusion achieved double pregnancy rate if compared to nonreconstructive technique surgical [38].

## 2.12. Safety guidelines against adhesion formation during CS

Despite principally described for gynecologic operations [39], most of the following six safety guidelines (with some modifications to suite CS) can properly apply for CS.

1. The risk of postoperative adhesions should be systematically discussed with any patient scheduled for open or laparoscopic abdominal surgery prior to obtaining his/her informed consent.
2. Surgeons need to act to reduce postoperative adhesions in order to fulfill their duty of care toward patients undergoing abdominal surgery.
3. Surgeons should adopt a routine adhesion reduction strategy (especially for women more prone liable to adhesions like those with prolonged PROM, or those with a history of postoperative adhesions or laparoscopic adhesiolysis due to previous CS).
4. Good surgical technique is fundamental to any adhesion reduction strategy.
  - a. Carefully handle tissue with field enhancement (magnification) techniques (in CS good illumination is sufficient).
  - b. Focus on planned surgery and, if any secondary pathology is identified, question the risk: benefit ratio of surgical treatment before proceeding (like performing cesarean myomectomy or ovarian cystectomy during CS).
  - c. Perform diligent hemostasis and ensure diligent use of cautery (better bipolar with minimal secondary coagulation effect).
  - d. Reduce diathermy time and frequency and aspirate aerosolized tissue following diathermy.
  - e. Excise tissue—reduce fulguration.
  - f. Reduce duration of surgery (whenever possible to minimize tissue dryness).
  - g. Reduce risk of infection.
  - h. Reduce drying of tissues.
  - i. Limit use of sutures and choose fine nonreactive sutures.
  - j. Avoid foreign bodies when possible—such as materials with loose fibers.
  - k. Avoid nonperitonized implants and meshes.
  - l. Minimal use of dry towels or sponges in laparotomy.
  - m. Use starch- and latex-free gloves in laparotomy.
5. Surgeons should consider the use of adhesion reduction agents as part of the adhesion reduction strategy.
  - i. Give special consideration to agents with data supporting safety in routine surgery and efficacy in adhesion prevention
  - ii. Practicality, ease of use, and cost of agents should influence their selection for routine practice

- iii. Good medical practice implies that any serious or frequently occurring risks be discussed before obtaining the patient's informed consent prior to surgery.

## 2.13. How to fight against infertility induced by CD?

### 2.13.1. Increase patient and doctor awareness about fertility compromising sequelae of CS

**Back to normal delivery:** Obstetricians should be very clear when counseling women for CS. We should emphasize that CS is a major operation with a lot of complications up to maternal death. Counseling regarding future fertility should include studies which documented decreased pregnancy rate after CS especially repeat CS. The risk of placenta accreta and the possibility of hysterectomy in subsequent pregnancies should be addressed.

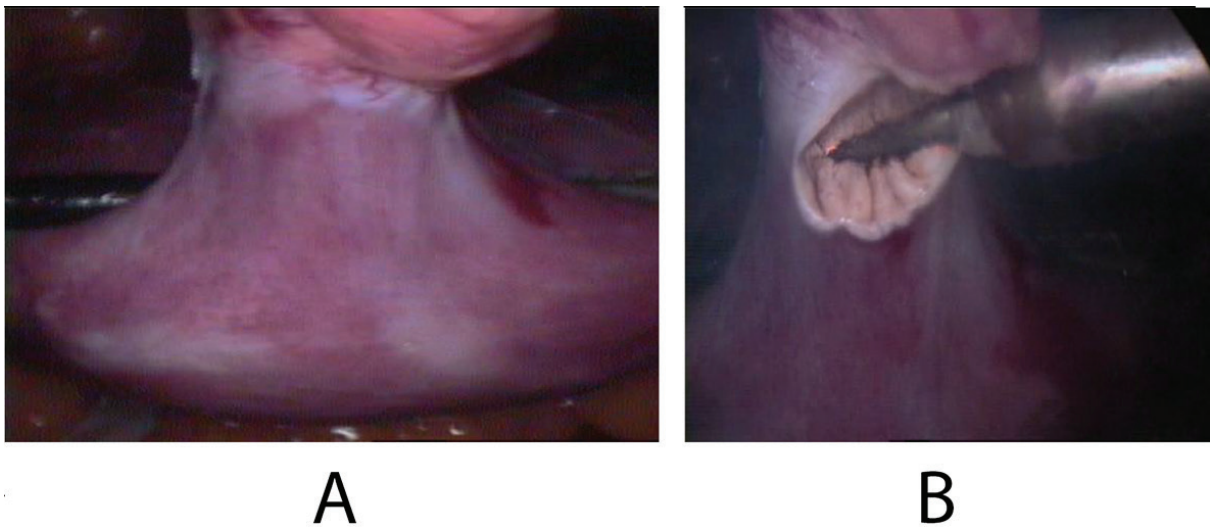
**Discourage CS on demand and unnecessary CD:** A good number of CS is done in situations when babies could be safely delivered vaginally instead. Sometimes, performing CS when it is not necessary poses avoidable risks to the mother and her child and needlessly raises costs, research shows [40].

Potential risks of CS on maternal request include a longer maternal hospital stay, an increased risk of respiratory problems for the infant, and greater complications in subsequent pregnancies, including uterine rupture, placental implantation problems, and the need for hysterectomy. Potential short-term benefits of planned CS compared with a planned vaginal delivery which may end in selective CS include a decreased risk of hemorrhage and transfusion, fewer surgical complications, and a decrease in urinary incontinence during the first year after delivery. CS on maternal request particularly is not recommended for women desiring several children, given that the risks of placenta previa, placenta accreta, and gravid hysterectomy increase with each CS [40].

### 2.13.2. Endoscopic (laparoscopic and hysteroscopic) management of CS-induced infertility

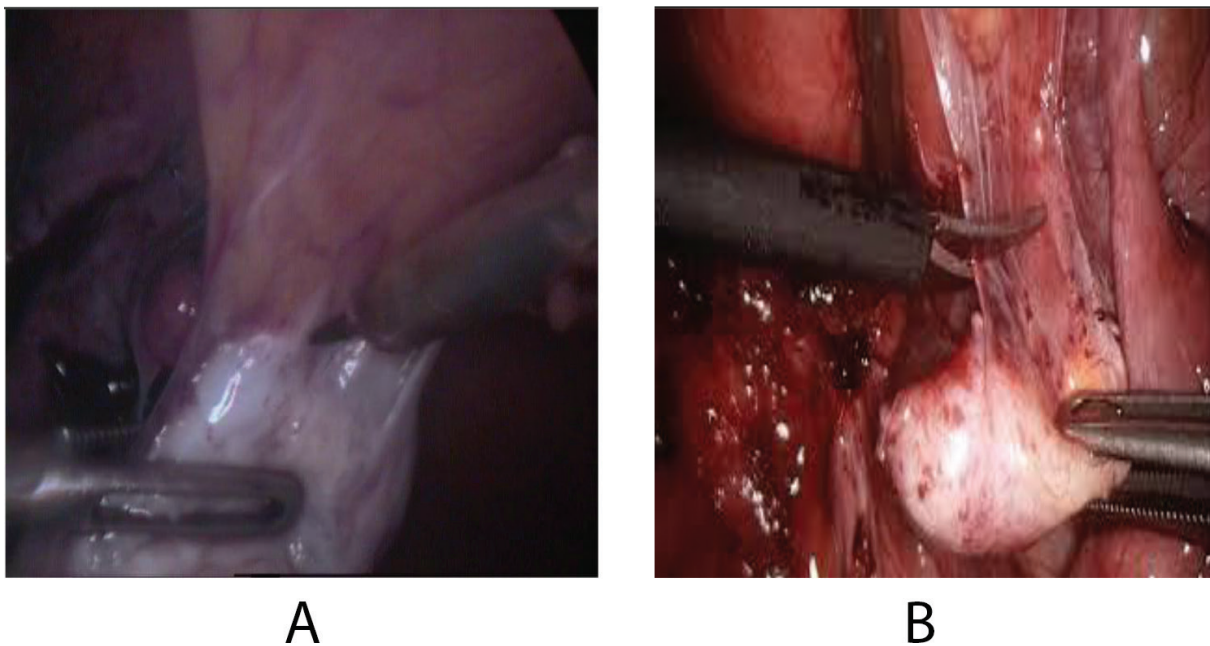
**(A) Laparoscopic uterolysis (Figure 6):** Thick central band between the uterus and the anterior abdominal wall can be expected on clinical examination where the cervix is high or inaccessible at all in addition to restricted mobility on vaginal examination. At laparoscopy, the uterus may be seen densely adherent and attracted to the anterior abdominal wall. In some cases, we found the uterus very near to the umbilicus. After proper evaluation of the pelvis and sometimes extensive adhesiolysis of omental adhesions, access to the uterovesical pouch is confirmed. If the cervix is vaginally accessible even with some traction, the assistant should insert a uterine manipulator to push on aiming at finding a space for work. Trial of uterolysis should start by cutting the thick central band of adhesions using a scissors or a microneedle which will help lateral dissection. In the same time, lateral counter pressure on the uterus should be done by a blunt instrument to facilitate adhesiolysis. Sometimes, this band is thin but may not be identifiable due to sealing of the uterus in the anterior abdominal wall. In such cases, using a microneedle, sharp dissection of the uterus is done with control of bleeding points using a coagulating probe.

Care should be taken whenever the base of the band is reached to avoid bladder injury. Of good clinical importance is the frequent insertion of a metal catheter into the bladder to ensure intact wall. Lysis should be stopped after completion of uterine freeing and easy access to the cervix vaginally. Secure hemostasis and peritoneal toilet are essential.



**Figure 6.** Adhesiolysis of the central thick band: (A) before cutting and (B) during cutting.

**(B) Laparoscopic adnexolysis:** Sometimes, the adnexa are densely adherent to the lateral pelvic wall (**Figure 7**). Firstly, the relationship of the adnexa to the vital iliac vessels should be identified. Unlike uterolysis, dissection would rely mainly on blunt dissection and counter traction to avoid vessel injury. If sharp dissection is required, it should be done ontracted adnexa to the other side and the tips of the scissors directed medially toward the adnexa.



**Figure 7.** Adnexolysis: (A) counter traction to the opposite side and (B) cutting against attracted adnexa.

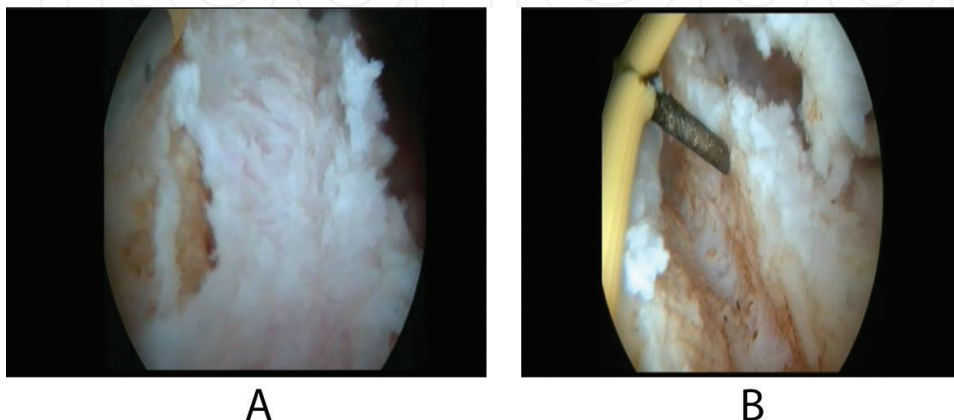


**(C) Microsurgical adhesiolysis** of any other fertility-related adhesions is usually done using a sharp scissors (**Figure 8**).



**Figure 8.** Adhesiolysis.

**(D) Hysteroscopic adhesiolysis (HA)** essentially should be preceded by grading of adhesions either by hysterosalpingography or better by office hysteroscopy. The hysteroscopist plans the procedure according to the grade. Sometimes more than one session is required. Different tools can be used according to the availability and expertise. A 5-mm office operative hysteroscopy or the standard 9-mm conventional hysteroscope may be used (**Figure 9**). Flexible or rigid scissor can be used by experienced hysteroscopists (**Figure 9**). Bipolar electrode is a good option for adhesiolysis as well. The main goal of adhesiolysis is to restore a uterine cavity suitable for implantation and maintenance of normal pregnancy. Postoperative intrauterine balloon left for 1–2 weeks or IUCD left for 1 month may be required to avoid reformation of adhesions. A postoperative course of estrogens would be required to enhance growth of the normal endometrium to cover areas previously occupied by adhesions.



**Figure 9.** Hysteroscopic adhesiolysis: (A) resectoscopic adhesiolysis (hook electrode) and (B) scissors adhesiolysis.



## 2.14. ART for advanced pelvic adhesions

The endoscopist should be honest and document the post-CS findings meticulously. In extensive cases, he should counsel the couple for IVF/ICSI to save their time and money.

## 2.15. Topics related to CS that would affect future fertility

### 2.15.1. Isthmocele and infertility

#### 2.15.1.1. Definition and incidence of isthmocele

Isthmocele, endometrial reservoir, uterine niche or LSCS uterine scar dehiscence (CSD) are synonyms of the same disease which is discontinuation of the myometrium at the site of a previous CS. Simply, they describe a condition of deficiency of a part of lower segment CS scar as diagnosed in between pregnancies. This section will not cover uterine dehiscence during pregnancy and how to predict. Meta-analysis reports have shown the incidence of cesarean scar dehiscence to be around 1.9% [41]. The incidence of uterine niche irrespective of cause is around 0.6% worldwide [42]. On evaluation of 32 trials, cesarean scar defects are commonly found on ultrasound examination (24–88%) [43].

#### 2.15.1.2. What is the exact cause of isthmocele?

Definitely it develops at the scar of previous CS. Thus, CS is the principal cause of this condition of incompletely healed scar. But why develops in some women, this is a matter of suggestions. The cause may be surgical fault in the form of bad surgical technique like closure of the hysterotomy incision using a single later technique, bad suturing material with marked inflammatory reaction, nontightness of continuous sutures, missing the endometrium during suturing, missing a part of the scar, very wide sutures or other possible defective surgical steps. Others suggested underlying anatomical defects in the uterus which would have been corrected prior to pregnancy like uterine septum or fibroid uterus may weaken the uterus and the resultant scar of the cesarean section [44]. Postoperative infection is an important contributing factor. Vervoort et al. [45] suggested that the possible factors that could play a role in niche development include a very low incision through cervical tissue, inadequate suturing technique during closure of the uterine scar, surgical interventions that increase adhesion formation or patient-related factors that impair wound healing or increase inflammation or adhesion formation.

#### 2.15.1.3. Predisposing factors for isthmocele formation

Typical important causes would be previous lower segment cesarean section, classical cesarean section, previous uterine trauma, congenital anomaly, abnormal placenta implantation, and inappropriate oxytocin administration. Additional factors applicable to many patients would be nulliparity, diabetes, emergency surgery, infection, and incision placed too low in the uterine segment.

#### 2.15.1.4. Risk and probable factors for niche development

Risk factors could be classified into four categories: those related to closure technique, to development of the lower uterine segment or location of the incision or to wound healing, and

miscellaneous factors. Probable risk factors are single-layer myometrium closure, multiple CSs, and uterine retroflexion [46]. Others hypothesized some possible factors that could play a role in niche development including a very low incision through cervical tissue, inadequate suturing technique during closure of the uterine scar, surgical interventions that increase adhesion formation or patient-related factors that impair wound healing or increase inflammation or adhesion formation [45].

### *2.15.2. Types of isthmocele*

Uterine dehiscence is of two types—complete and incomplete dehiscence. In incomplete uterine dehiscence, the myometrium is disrupted, but the serosa is intact. Full thickness tears of uterine wall result in complete uterine ruptures. These ruptures mostly occur at the level of previous cesarean section scars. Compared to complete uterine rupture, uterine dehiscence has much lower maternal and neonatal morbidity [46].

#### *2.15.2.1. Forms of isthmocele*

There is no universally agreed classification of isthmocele. It can be mild and severe. Severe is defined as the loss of >50% of myometrial mantle at the scar level [47]. A depth accounting for 80% or more of the muscle layer in the anterior wall of the uterus was referred to as “dehiscence.” [48]

#### *2.15.2.2. Impact of isthmocele (niche) on woman's health*

Approximately 30% of women with a niche report spotting at 6–12 months after their CS. Other reported symptoms in women with a niche are dysmenorrhoea, chronic pelvic pain, and dyspareunia. Subfertility is an important sequence [49]. The association between a niche and gynecologic symptoms, obstetric complications, and potentially with subfertility highlights the importance of its prevention and proper management.

#### *2.15.2.3. How does isthmocele cause women's symptoms?*

The flow of menstrual blood through the cervix may be slowed by the presence of isthmocele, as the blood may accumulate in the niche because of the presence of fibrotic tissue, causing pelvic pain in the suprapubic area. Moreover, persistence of the menstrual blood after menstruation in the cervix may negatively influence the mucus quality and sperm quality, obstruct sperm transport through the cervical canal, interfere with embryo implantation, leading to secondary infertility [49].

#### *2.15.2.4. Clinical presentations of isthmocele*

The presentations are variable from silent to symptomatic. Main symptoms include dysmenorrhea, intermenstrual bleeding, irregular genital bleeding, chronic pelvic pain, dyspareunia, and secondary infertility [43]. Among the 293 patients diagnosed with CSD by transvaginal sonography, the most common symptom was intermenstrual spotting (64%), followed by dysmenorrhea (53%), chronic pelvic pain (40%), and dyspareunia (18%) [50]. The most serious

symptom is impending rupture uterus in late pregnancy. Isthmocele may present with postpartum hemorrhage, endomyometritis, and peritonitis (generalized/localized). Once peritonitis occurs as a result, sepsis may ensue risking the life of the patient [43]. Rare and unusual presentations have been reported in associations with wound infections, secondary PPH, concurrent postpartum uterine and abdominal wall dehiscence, site of implantation for ectopic pregnancy, etc. Infections with *Streptococcus anginosus* and *Staphylococcus aureus* have been reported also indicating the wide spectrum of infection possible in such a circumstance [43].

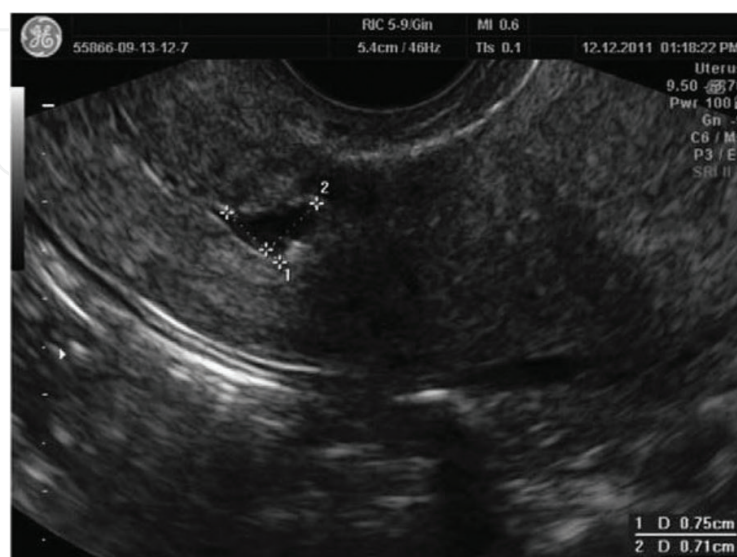
Scar tissue dehiscence, scar pregnancy, and abnormally adherent placenta are some of the obstetric complications associated with this defect [51].

#### 2.15.2.5. Isthmocele and infertility

Is isthmocele a direct cause of infertility? The exact correlation is not yet settled in literature and requires more intensive studies of women with post-CS secondary infertility. Possible mechanism includes persistence of the menstrual blood after menstruation in the cervix which may negatively influence the mucus quality and sperm quality, obstruct sperm transport through the cervical canal, and interfere with embryo implantation [49]. As an initial proof of isthmocele-induced infertility, some nonrandomized studies reported high pregnancy rate after proper management of isthmocele. Seven out of 9 patients with secondary infertility became pregnant after hysteroscopic treatment (resection and roller-ball coagulation) [52].

#### 2.15.2.6. Diagnostic aids of isthmocele

Transvaginal ultrasonography (TVS) with or without saline infusion hysteroGRAPHY (SIS) is usually quite sufficient for the diagnosis. TVS (**Figure 10**) shows an anechoic fluid-filled irregular defect seen at the anterior uterine isthmus, in relation to the site of a CS scar [53].



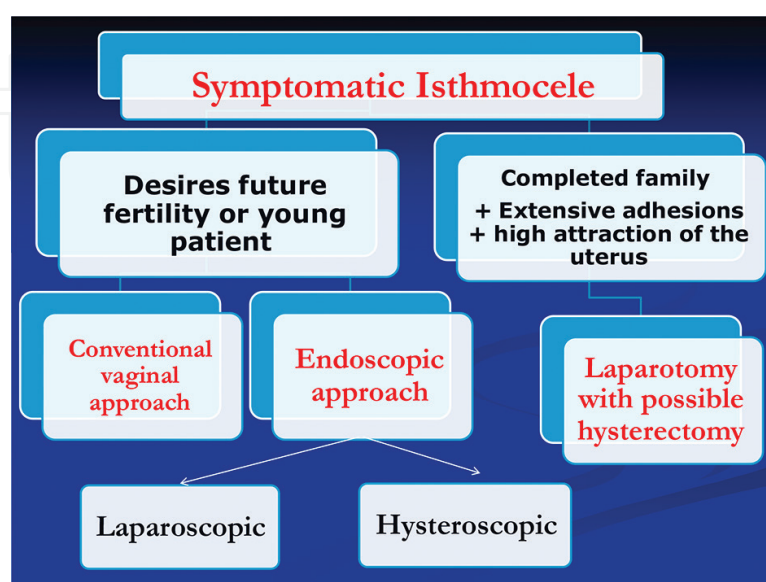
**Figure 10.** 2D TVS view of isthmocele at the scar site.

SIS can easily diagnose isthmocele by observing fluid accumulation in a reservoir at the site of previous CS scar. In selected cases, MRI may be ordered to complete the diagnosis particularly if the uterus is attracted upward by scars of previous CS(s), obese patients, posterior uterine wall defects after myomectomy, or if the size of the defect is not well defined. An important advantage of MRI is to detect the exact relationship between the defect and the urinary bladder prior to invasive endoscopic correction particularly in women with repeat CS.

#### 2.15.2.7. Treatment of isthmocele

Basically, if there is no symptoms, no treatment but only follow-up before and during subsequent pregnancy for fear of scar dehiscence. Do not ignore the role of assurance, medical treatment, for example, BS antibiotic and symptomatic treatment, for example, diosmin and tranxamic acid for spotting treatments prior to rushing to surgical intervention. Treatment of uterine scar defects should be performed after eliminating other causes of postmenstrual bleeding or infertility [43]. Conservative management of infected isthmocele can be very successful and save the patient from invasive risky surgical procedures [54].

Treatment depends on the clinical presentation, parity, surgical risks, and the need for further children (**Figure 11**). If the patient is symptomatic and completed her family with expected extensive adhesions and high attraction of the uterus, laparotomy would be the most suitable approach with a consent of hysterectomy whenever severe isthmocele infection with friable defect is intraoperatively diagnosed. Some authors performed vaginal nonendoscopic excision of isthmocele with clinical improvement in 85.9% (55/64) [55]. Transvaginal repair was considered a minimal invasiveness procedure with good exposure and accurate resection [56]. Contradictally, these studies reported a prolonged operative time and postoperative stay (operation time was  $67 \pm 12$  min, the mean blood loss was  $53 \pm 32$  ml, and the mean length of hospital stay was  $4.0 \pm 1.1$  days) which are against minimally invasive concept. Some surgeons rely on hysteroscopic confirmation and localization of isthmocele then proceed for vaginal nonendoscopic closure in two layers with good results [57].



**Figure 11.** Management plan of symptomatizing isthmocele.



Endoscopic management is an attractive approach if fertility is concerned, patient is young, surgery is feasible, and probably, safe and endoscopist expertise is sufficient.

The question is to use laparoscopy or hysteroscopy for excision of this defect. Since studies are mainly case reports or small sample sized, the answer is not clear so far. Some studies stratified patients according to the uterine defect thickness. They considered women who desire future pregnancies and had a residual myometrial thickness of  $<3.5$  mm or a defect that accounted for  $\geq 50\%$  of the anterior uterine wall, and laparoscopic surgical repair was performed with good postoperative anatomic outcomes. Women with residual myometrial thickness of  $\geq 3.5$  mm or a defect that accounted for  $<50\%$  of the anterior uterine wall can be treated with hysteroscopic surgery to relief of symptoms [58]. However, others considered laparoscopic approach would increase uterine wall thickness when compared to hysteroscopic approach, and both surgical techniques seem to be effective for the resolution of gynecologic symptoms. Hysteroscopic treatment most likely corrects the scar defect but does not strengthen the uterine wall; thus, the potential risk of dehiscence or rupture in subsequent pregnancies does not seem to be improved. Because large uterine defects are known risk factors for scar dehiscence, laparoscopic repair of the defect to reinforce the myometrial endurance is warranted [59].

In a recent systematic review, hysteroscopic repair of a cesarean scar defect or isthmoplasty was associated with an improvement in uterine bleeding in 59–100% of cases and a pregnancy rate of 77.8–100%. An improvement in uterine bleeding after vaginal repair occurred in 89–93.5% of cases. Laparoscopic repair led to uterine bleeding improvement in 86% of cases and a pregnancy rate of 86%. Hysteroscopic isthmoplasty appears to be the most popular treatment [43].

Laparoscopic management has been described in many papers. It starts by careful dissection and freeing of the densely adherent bladder lower uterine segment. The defect is then localized with a sharp curette placed transcervically into the uterus. The curette pushes anteriorly to delineate the margins of the defect and puncture the ceiling of the isthmocele cavity. The fibrotic tissue that forms the ceiling and the lateral borders of the defect is excised using laparoscopic scissors. Lastly, reapproximation of the edges is done with continuous nonlocking 3-0 V-Loc sutures [51].

Others claim that robotic surgery would be more precise and accurate than conventional surgery [60]. As described in a case report, the technique was similar to conventional laparoscopy as the scar tissue around the defect is resected, and the freshened edges of the defect are closed using delayed absorbable suture. Chromopertubation was used to confirm the water tightness of the repair [60]. The same robotic technique was used to treat ectopic pregnancy implanted in an isthmocele [61].

Whether hysteroscopic resection of uterine isthmocele at least 3 mm versus no intervention is under evaluation in a multicentric study [62]. Hysteroscopic treatment of isthmocele is usually performed utilizing the resectoscope. It starts by hysteroscopic resection of the edges and the bottom of the defect until the complete removal of the fibrotic scar tissue showing the muscular tissue below, using a cutting loop and pure cutting current. Then, aimed electrocoagulation of the bottom of the pouch with a roller-ball is done to avoid the in situ production of blood [52].



To recapitulate, isthmocele has a definite impact on women's health. Preventive measures include overcoming predisposing factors. Performing CS in a microsurgical way as described in detail in this chapter would avoid exposing many women to this debatable disease. To treat or not to treat isthmocele and by which approach requires more studies according to the clinical situation particularly in case of post-CS infertility.

#### *2.15.2.8. Impact of cesarean myomectomy (CM) on future fertility*

Despite not universally agreed, some obstetricians are courageous and perform myomectomy for even multiple fibroids during CS [63, 64]. Personally, since a long time, I practice the technique of cesarean myomectomy with safe and satisfactory results. Many advantages of CM include elimination of the need for another laparotomy and another hysterotomy (uterine incision) and minimize the postpartum complications of fibroid including hemorrhage, torsion, and infection. A pregnant uterus is not always an obstacle for concomitant CM. The procedure is always preceded by IV administration of 1 g of tranexamic acid half an hour preoperatively. Bilateral uterine artery ligation is always done in all cases before myomectomy. In many cases, the access to the myoma can be done via intramyometrial incision through the cesarean hysterotomy incision, that is, no additional incision is required. We usually make an incision with the cutting diathermy till reaching the myoma which can be easily extracted with a towel forceps with insignificant bleeding from the bed. An important issue is the physiologic changes of the uterus on postpartum involution. A separate myomectomy scar at CS would be smaller by at least its half-length on uterine involution. High vascularity of the gravid uterus would help rapid and complete healing without defective scar seen after conventional myomectomy [65]. Last postulated positive point is that lower adhesions formation after CM due to pregnancy peculiar characteristics (see the beginning of this chapter). Nevertheless, the majority of obstetricians are against CM for fear of excessive uncontrollable bleeding that may require blood transfusion. The question is how excessive bleeding occurs and both uterine arteries are already ligated prior to CM. Moreover, the use of electrosurgery can control any bleeding point or vessel in no time. Lastly, uterine tourniquet is an excellent back up if bleeding is remarkable. Since studies on this topic are scarce, so far no available data on the future fertility after CM as this requires a randomized study of different sizes, sites, and number of fibroids. To be safer and fertility-oriented, without evidence, the obstetrician should follow adhesions preventive measures and fix an adhesion-preventive sheet over any separate myomectomy scar after CM.

#### *2.15.3. Placenta accrete and future fertility*

Placenta accreta is a potentially life-threatening obstetric condition that requires a multidisciplinary approach to management. The incidence of placenta accreta has increased and seems to parallel the increasing CD rate. Women at greatest risk of placenta accreta are those who have myometrial damage caused by a previous CD with either an anterior or posterior placenta previa overlying the uterine scar [66].

In many cases, the future fertility of those women will be compromised due to the aggressive manoeuvres to control bleeding, possibility of incomplete removal of the placenta, and the high liability to cesarean hysterectomy. Surgical treatment of placenta previa may com-

promise future fertility. One study reported secondary amenorrhea due to IUAs in 8 out of 96 women treated for placenta previa (8.3%) [67].

#### 2.15.4. *Post-CS scar secondary endometriosis*

Endometriosis can be primary or secondary which develops after surgery. In a very big study on postpartum endometriosis, 709,090 women were included [68]. New cases of endometriosis were noted in 3110 (0.4%). Women who had a CS were 80% more likely than women who had a vaginal delivery to receive an in-hospital diagnosis of endometriosis after delivery of their first child (hazard ratio, 1.8; 95% confidence interval, 1.7–1.9). The risk of endometriosis does not increase with the number of cesarean deliveries. The risk of endometriosis increased over time, with 1 additional case of endometriosis occurring for every 325 women who underwent a CS in a 10-year period. However, there was no dose-response effect, meaning that endometriosis was no more likely to develop in women who had 2 or more cesarean deliveries than in women who had just 1 cesarean delivery. The overall risk of endometriosis developing after CS remains very low. Other more common maternal risks related to CS include infection, blood loss requiring transfusion, and deep vein thrombosis or pulmonary embolism. The long-term risks of CS include uterine rupture of the incision site and problems with the position or type of placental growth in future pregnancies. Generally, a triad consisting of underlying mass at the incision, cyclic menstrual scar pain, and history of previous gynecological or obstetric surgery leads to the preoperative diagnosis [69].

The most common symptom of endometriosis after CS is the formation of a painful mass or lump of variable sizes in the surgical scar. Characteristically, both pain and size increase before and during menstruation due to bleeding inside the mass. Continuously, this mass irritates the adjacent tissues causing more pain and inflammation. The mass is discolored and even bleeds. Bleeding can be very confusing after giving CS. Sometimes, the mass is painless. Diagnosis is mainly clinically by palpation of a tender cystic mass or a firm mass if fibrosed at CS scar site with restricted mobility. High-resolution ultrasonography can detect the nature of the mass in many cases. Rarely, CT or MRI is ordered to confirm the diagnosis and to exclude other parietal masses. Nevertheless, the most reliable method to diagnose secondary endometriosis is tissue biopsy. Medications don't usually work for surgical scar endometriosis. Surgery is the first-line treatment of this mass, and postoperative medication might reduce recurrence [70]. After surgery, the chances that endometriosis will come back are small. Women who choose surgery have a very low recurrence rate.

#### 2.16. Keynote points

- Despite pass smoothly in most cases, CS may compromise future fertility of women.
- Proper counseling for CS should stress on impact of CS on future fertility and the possibility of adhesion formation with subsequent endoscopic intervention or even assisted reproduction.
- Women awareness about other long-term complications of CS-like isthmocoele, placenta previa, CS scar endometriosis, and possible cesarean hysterectomy should be highlighted.

- Doctor awareness about the importance of microsurgical steps of CS would minimize or even eliminate some long-term sequelae of CS that would compromise women's health including future fertility.
- Additional procedures during CS require peculiar adhesion prevention precautions.

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