

An Overview on Complications of Cesarean Section

Muhannad Mohamed Elsayed Azab, Mohamed Abdallah El-bakry Lashin, Mohamed Fatouh Ahmed Lotfy, Alaa Eldin Abdelsalam Ahmed

Obstetrics & Gynecology Department, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Mohamed Fatouh Ahmed Lotfy

Abstract:

Cesarean section (CS) is one of the most frequently performed obstetric surgical procedures worldwide and plays a crucial role in reducing maternal and fetal morbidity and mortality when vaginal delivery is not feasible. However, the increasing global rate of cesarean delivery has been accompanied by a growing recognition of both short-term and long-term postoperative complications. These complications may include hemorrhage, infection, thromboembolic events, adhesions, abnormal uterine bleeding, infertility, and uterine rupture in subsequent pregnancies. One of the most important long-term sequelae is the formation of a cesarean scar niche (isthmocele), which represents defective healing of the uterine incision and may lead to gynecological symptoms and adverse obstetric outcomes. Understanding the mechanisms of uterine wound healing, the pathophysiology of niche formation, and the influence of surgical techniques—particularly in situ repair versus uterine exteriorization—is essential for improving surgical outcomes and reducing long-term morbidity associated with cesarean delivery.

Keywords: Cesarean section, Cesarean scar niche, Isthmocele, Uterine scar healing, Residual myometrial thickness, Cesarean complications.

Introduction:

Cesarean section (CS) is a life-saving surgical intervention in obstetrics, but like any major operation, it carries inherent risks. Complications may occur intraoperatively, in the immediate postoperative period, or years later, potentially affecting future reproductive outcomes. Understanding these complications is critical for optimizing surgical technique and patient counseling.

1. Short-term Complications

Short-term or immediate complications occur intraoperatively or within the first six weeks postpartum.

1) Intraoperative Complications:

- **Hemorrhage:**

Excessive bleeding (>1000 mL) may occur due to uterine atony, injury to uterine or pelvic vessels, or abnormal placentation (placenta previa, accreta). It is a leading cause of perioperative morbidity.

- **Injury to surrounding organs:**

Accidental trauma may occur to the urinary bladder (particularly in women with prior CS), ureters, or bowel, especially in cases with dense adhesions.

- **Anesthetic complications:**

Spinal, epidural, or general anesthesia carries risks such as hypotension, aspiration, or rare allergic reactions.

2) Early Postoperative Complications:

- **Infection**

- **Wound infection:** presents with redness, discharge, and pain at the incision site.

- **Endometritis:** characterized by fever, uterine tenderness, and foul-smelling lochia, more common after prolonged labor before CS.

- **Urinary tract infection (UTI)** due to catheterization.

- **Thromboembolic events**

Pregnancy and surgery both increase the risk of deep vein thrombosis (DVT) and pulmonary embolism (PE).

- **Paralytic ileus**

Transient cessation of bowel motility may cause abdominal distension and discomfort.

- **Delayed wound healing or dehiscence**

Poor apposition, infection, or tension on the wound can lead to partial or complete disruption of the incision.

2. Long-term Complications:

These manifest months to years after the initial CS, with implications for gynecologic health and future pregnancies.

1) Adhesion Formation:

Post-surgical adhesions can develop between the uterus, bladder, and anterior abdominal wall, causing chronic pelvic pain, bowel obstruction, or surgical difficulties in future abdominal operations.

2) Chronic Pelvic Pain:

Adhesions, nerve injury, or scar tissue can contribute to persistent pelvic discomfort.

3) Abnormal Uterine Bleeding:

A **cesarean scar niche** can cause postmenstrual spotting, prolonged bleeding, or intermenstrual bleeding due to accumulation of menstrual blood in the defect.

4) Secondary Infertility:

A poorly healed scar may interfere with sperm transport or implantation. Altered uterine contractility and chronic inflammation in niche areas may further impair fertility.

5) Cesarean Scar Pregnancy:

This rare but potentially life-threatening condition occurs when a gestational sac implants within the myometrial defect of a prior CS scar. It is associated with high risk of rupture and massive hemorrhage.

6) Placenta Accreta Spectrum (PAS):

Previous CS scars increase the risk of abnormal placental adherence, especially placenta accreta, increta, or percreta, in subsequent pregnancies. These conditions may necessitate hysterectomy and carry high maternal morbidity.

7) Uterine Rupture in Subsequent Pregnancy:

A weakened scar, particularly from a poorly healed LUS incision, may rupture under the stress of labor, posing risks to both mother and fetus.

3. Clinical Relevance to Scar Niche Formation:

The development of a cesarean scar niche is both a complication in its own right and a risk factor for several long-term morbidities. Understanding the relationship between surgical technique and niche formation is

essential to reducing these outcomes. Comparing **in situ repair** versus **exteriorization** of the uterus during CS offers an opportunity to identify best practices for minimizing scar defects.

Normal Myometrial Wound Healing:

Phases and special considerations:

Wound healing in uterine smooth muscle follows the canonical stages of tissue repair but with features specific to myometrium and pregnancy.

1. Hemostasis (minutes–hours):

- Immediate vasoconstriction and clot formation at the incision site.
- Platelet activation releases growth factors (PDGF, TGF- β) that recruit inflammatory cells and fibroblasts.

2. Inflammation (hours–days)

- Neutrophils then macrophages clear debris and bacteria.
- Macrophages secrete cytokines (IL-1, TNF- α) and growth factors (VEGF, TGF- β) that orchestrate repair.
- Excessive or prolonged inflammation predisposes to tissue breakdown and impaired regeneration.

3. Proliferation (days–weeks)

- Fibroblasts and myofibroblasts deposit extracellular matrix (ECM): collagen (primarily type III initially), fibronectin, and proteoglycans.
- Angiogenesis restores microcirculation—critical in the lower uterine segment where baseline vascularity is lower than the fundus.
- Re-epithelialization of the endometrial surface and early restoration of myometrial continuity occur.

4. Remodeling (weeks–months)

- Collagen type III is progressively replaced by stronger type I collagen; crosslinking increases tensile strength.
- Myofibroblast apoptosis and ECM reorganization occur; however, scar tissue attains less elasticity and strength than native myometrium.

Pregnancy-specific factors:

The LUS is stretched and thin at term with relatively less muscular bulk and differing vascularization, which influences the volume of tissue available for healing and the susceptibility to ischemia and mechanical stress.

Cesarean Scar Niche (Isthmocele):

1. Definition:

A **cesarean scar niche**, also referred to as an **isthmocele** or **uterine diverticulum**, is a **pouch-like defect or indentation** in the myometrium at the site of a previous cesarean section (CS) incision, typically located in the **lower uterine segment**, typically seen as a **triangular or semicircular anechoic area** on **transvaginal ultrasonography (TVUS), sonohysterography, or MRI**. The term “niche” describes a residual defect where the myometrial thickness is reduced compared to adjacent tissue, and in severe cases, a full-thickness gap may be visible (Al Kadri et al., 2020).

The defect represents poor healing or incomplete restoration of the myometrial continuity following cesarean section.

At the **apex** of the niche, the **residual myometrium thickness (RMT)** is often markedly reduced (Donnez et al., 2017).

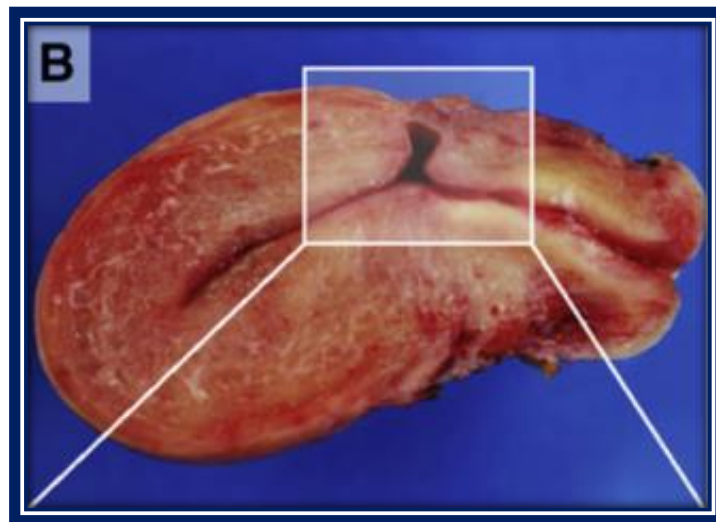


Figure (4): Sagittal view of a frozen section from a hysterectomy specimen. A deep anterior defect covered with a thin layer of myometrium (Donnez, 2020).

2. Pathophysiology :

The niche represents **impaired healing** of the uterine incision site. Multiple mechanisms may contribute:

1. Inadequate myometrial apposition:

- Poor approximation of myometrial edges at closure (gaps, inclusion of decidua rather than true myometrium) leaves a potential space that can persist as a niche.
- Endometrial (decidual) inclusion between suture lines impairs direct muscular continuity and promotes a cavity-like defect (Donnez et al., 2017) (Naji et al., 2012).

2. Ischemia and devascularisation:

- Excessive traction, tight locking sutures, or aggressive cautery can reduce local perfusion.
- The LUS has inherently less vascularity; any additional compromise delays angiogenesis and collagen deposition, favoring weak scar formation (Vikhareva et al., 2010).

3. Hematoma and seroma formation:

- Bleeding into the incision (subserosal or submyometrial hematoma) creates a separation plane and a nidus for poor healing or infection. Organized hematomas may prevent full apposition as the clot resolves (Stegwee et al., 2018).

4. Infection and prolonged inflammation:

- Endometritis or wound infection increases proteolytic activity, prolongs inflammatory cell presence, and alters fibroblast function, all of which degrade ECM and inhibit proper remodelling (Roberge et al., 2012).

5. Mechanical stress and uterine position:

- Postoperative uterine retroflexion or abnormal traction from adjacent adhesions can place shearing forces on the healing incision, promoting dehiscence or formation of pouching at the weakest point (Vervoort et al., 2015).
- Early postpartum involutinal forces and subsequent uterine distension in later pregnancies place ongoing mechanical loading on the scar.

6. Abnormal ECM remodeling and molecular dysregulation:

- An imbalance between matrix metalloproteinases (MMPs) and their inhibitors (TIMPs) may lead to excessive ECM breakdown.
- Altered TGF- β signaling can modify fibroblast phenotype and collagen deposition (quantity and organization), influencing scar thickness and resilience (**Vervoort et al., 2015**).

7. Adhesion-related traction

- Adhesions between the anterior uterine wall and bladder/abdominal wall can apply focal traction, preventing the uterine surface from re-approximating normally and leading to a persistent niche (**Armstrong et al., 2003**).

Surgical and technical contributors:

Several aspects of the operation directly influence the mechanisms above:

- **Incision placement:** Very low incisions close to the cervix encounter thinner, less muscular tissue predisposed to defective healing.
- **Suture technique and layers:** Single-layer locked closure may strangulate tissue or incorporate decidua; double-layer unlocked techniques that spare the decidua appear to improve RMT in several studies.
- **Tissue handling:** Excessive manipulation, traction (as seen with exteriorization if not gentle), or prolonged exposure and desiccation of tissues impairs cellular viability.
- **Hemostasis technique:** Heavy use of electrocautery causes thermal necrosis and delays repair; meticulous suture hemostasis is preferable.
- **Peritoneal closure and irrigation:** Practices vary—omission of peritoneal closure or inadequate irrigation may influence adhesion formation and local inflammatory milieu.

Patient and obstetric risk factors that modulate pathophysiology:

- **Multiple prior cesareans:** cumulative scarring, tissue loss, and reduced residual myometrium compromise subsequent healing.
- **Maternal comorbidities:** diabetes, anemia, smoking, malnutrition impair collagen synthesis and angiogenesis.
- **Prolonged labor or obstructed labor:** tissue edema and ischemia increase fragility at the time of incision.
- **Premature delivery:** a poorly developed lower uterine segment provides less robust tissue for closure.

Time-course and clinical correlation:

- A niche may be evident on imaging as early as several weeks to months postpartum, but remodeling continues over many months.
- Residual myometrial thickness (RMT) at 6–12 months is a widely used surrogate of scar quality; small RMT correlates with higher risk of dehiscence, placenta accreta spectrum, and symptomatic niches (**Stegwee et al., 2018**) (**Donnez et al., 2017**).
- Not all imaging-detected niches are symptomatic; clinical consequences depend on niche size, RMT, and interaction with uterine dynamics.

3. Clinical Presentation:

Many niches are **asymptomatic** and found incidentally. When symptomatic, they may cause:

- **Postmenstrual spotting:** due to menstrual blood pooling in the defect.

- **Dysmenorrhea:** from localized inflammation.
- **Chronic pelvic pain.**
- **Secondary infertility:** due to impaired sperm transport or altered uterine environment.
- **Obstetric complications in future pregnancies:**
 - Cesarean scar pregnancy.
 - Uterine rupture during labor.
 - Abnormal placentation (placenta previa/accreta spectrum).

(Van der Voet et al., 2014).

4. Diagnostic Criteria:

Transvaginal sonography (TVUS):

- Hypoechoic triangular or semicircular defect at the anterior lower uterine wall.
- Measured by **depth, width, and residual myometrial thickness (RMT)** (Al Kadri et al., 2020).

Sonohysterography (SIS):

- Enhances detection by filling defect with saline, improving contrast (Roberge et al., 2012).

MRI:

- Useful for complex cases or pre-surgical planning.

5. Clinical Significance:

- **Gynecological impact:** Irregular bleeding, chronic pain, and infertility can reduce quality of life (Vikhareva et al., 2010).
- **Obstetric impact:** Thinned myometrium increases risk of rupture and abnormal placentation in subsequent pregnancies (Donnez et al., 2017).
- **Public health relevance:** Rising CS rates globally make niche-related morbidity increasingly common.
- **Surgical relevance:** Preventing niche formation through optimal repair technique is a critical surgical priority (Naji et al., 2012).

6. Management:

Management depends on symptoms and reproductive desires:

- **Asymptomatic cases:** no intervention required, but careful monitoring in future pregnancies.
- **Symptomatic cases:**
 - **Hysteroscopic niche resection** (for abnormal bleeding) (Vervoort et al., 2018)
 - **Laparoscopic repair** (for large defects or infertility) (Donnez et al., 2017)
 - **Combined approaches** for complex cases.

Diagnostic Modalities for Uterine Scar Assessment:

1) Overview:

Assessment of the cesarean section (CS) scar is critical for understanding the prevalence, morphology, and clinical significance of uterine niche formation. Accurate diagnosis enables stratification of risk for future obstetric complications, guides counseling, and informs surgical repair decisions. Modern imaging has evolved

from basic 2D transvaginal sonography (TVS) to advanced 3D ultrasound and magnetic resonance imaging (MRI), each offering unique advantages in scar visualization and quantification (**Bij de Vaate et al., 2011; Jordans et al., 2019**).

2) Transvaginal Sonography (TVS):

Technique

- Performed with a high-frequency (5–9 MHz) transvaginal probe.
- The bladder should be partially filled to delineate the bladder–uterus interface while avoiding excessive compression of the lower uterine segment (LUS).
- The probe is positioned sagittally to visualize the endometrial stripe and LUS scar.

Diagnostic criteria for niche

- A hypoechoic or anechoic triangular or semicircular defect at the site of the CS scar, often with the apex pointing toward the bladder.
- **Residual myometrial thickness (RMT)**: measured from the base of the defect to the uterine serosa.
- **Defect depth**: measured from the endometrial surface to the deepest point of the niche (**Bij de Vaate et al., 2011**), (**Jordans et al., 2019**).

Advantages:

- Widely available, low cost, and non-invasive.
- Real-time assessment of uterine position and mobility.
- Good interobserver reliability for large defects.

Limitations:

- Operator dependent, especially for small or shallow defects.
- Reduced sensitivity in anteverted uteri due to acoustic shadowing.
- Lacks volumetric analysis capability.



Figure (5): Cesarean scar defect (arrow) on transvaginal ultrasound scan.

3) Saline Infusion Sonohysterography (SIS):

Technique:

- Sterile saline is instilled into the uterine cavity during TVS.

- Distension improves delineation of the endometrium and the contour of the defect.
- Often performed in the proliferative phase to maximize visualization (**Jordans et al., 2019**).

Advantages:

- Enhances detection of small or irregularly shaped defects.
- Allows evaluation of intra-cavity adhesions or polyps coexisting with a niche.
- Better estimation of niche width and communication with the uterine cavity.

Limitations

- More invasive than standard TVS.
- Requires cervical catheterization and may cause cramping.
- Contraindicated in active pelvic infection.



Figure (6): Cesarean scar defect (arrow) on SIS.

4) Three-Dimensional Transvaginal Sonography (3D TVS):

Technique:

- Acquisition of a volumetric dataset of the LUS, allowing multiplanar reconstruction and niche volume calculation.
- Coronal plane imaging enables precise measurement of niche width and length not possible with 2D (**Bij de Vaate et al., 2011; Naji et al., 2012**).

Advantages:

- High accuracy in niche detection and measurement reproducibility.
- Enables assessment of niche volume, shape classification, and spatial relation to surrounding tissues.
- Facilitates longitudinal monitoring of scar morphology in research and clinical follow-up.

Limitations

- Requires advanced equipment and training.
- Slightly longer acquisition and post-processing time.

5) Magnetic Resonance Imaging (MRI):

Technique:

- High-resolution T2-weighted sequences in sagittal and axial planes through the LUS.
- MRI performed with an empty bladder to optimize uterine position.

Advantages:

- Excellent soft tissue contrast; unaffected by bowel gas or uterine position.
- Allows detailed evaluation of surrounding pelvic structures, bladder involvement, or deep endometriosis overlying the scar.
- Useful in complex cases where ultrasound is inconclusive.

Limitations:

- Expensive and less accessible in routine obstetric follow-up.
- Lacks real-time dynamic assessment.
- Limited availability in low-resource settings.

6) Measurement Standards:

The most widely reported parameters for scar evaluation are:

- **Residual myometrial thickness (RMT):** thickness from the outer serosa to the base of the defect.
- **Defect depth (D):** from the endometrial surface to the deepest point of the defect.
- **Defect width (W):** maximal transverse measurement of the defect opening.
- **Defect length (L):** longitudinal measurement along the endometrium.
- **Niche volume:** computed in 3D datasets as $W \times D \times L \times \frac{W \times D \times L}{2}$ or using more sophisticated 3D planimetry (Naji et al., 2012).

7) Timing of Assessment:

- **Early postpartum (6–12 weeks):** allows detection of early dehiscence or poor healing but may overestimate defects due to incomplete remodeling.
- **Late postpartum (6–12 months):** provides stable RMT and niche size, better for long-term risk prediction (Vikhareva et al., 2010).

Surgical Techniques in Cesarean Section- In Situ Repair vs. Exteriorization:

Overview:

The method of uterine repair during cesarean section can influence operative visibility, repair precision, maternal recovery, and potentially the long-term integrity of the uterine scar. Two widely used approaches are:

1. **In Situ Repair:** Closure of the uterine incision while the uterus remains inside the abdominal cavity.
2. **Uterine Exteriorization:** Temporary delivery of the uterus outside the abdominal cavity for repair, followed by repositioning.

Both techniques have proponents and critics, and their impact on cesarean scar niche formation remains a subject of ongoing investigation (Bhatia et al., 2019).

1) In Situ Uterine Repair:

- Technique:

- After fetal and placental delivery, the uterus is kept in the pelvic cavity.
- The lower uterine segment incision is visualized and closed directly, typically in one or two layers, depending on surgical preference.
- Hemostasis is achieved within the confined surgical field (**Bhatia et al., 2019**).

- Advantages:

- Minimizes manipulation of the uterus, potentially reducing postoperative pain and nausea.
- Avoids stretching or kinking of uterine vessels.
- Maintains anatomical orientation, possibly reducing risk of mesosalpinx or broad ligament trauma.

- Disadvantages:

- Limited exposure, particularly in obese patients or those with adhesions.
- More challenging in cases of deep pelvic anatomy or profuse bleeding.
- May increase risk of suboptimal myometrial edge alignment if visualization is poor (**Bhatia et al., 2019**).

2) Uterine Exteriorization:

- Technique:

- The uterus is gently lifted out of the abdominal cavity and placed on the maternal abdomen, sometimes supported by sterile drapes.
- The uterine incision is closed under direct, unobstructed vision.
- Hemostasis is secured before returning the uterus to its anatomical position (**Al Kadri et al., 2020**).

- Advantages:

- Excellent visualization of incision edges, aiding precise myometrial approximation.
- Facilitates repair in difficult cases, especially with deep pelvic anatomy or bleeding.
- May allow more meticulous removal of blood clots and debris from the uterine cavity.

- Disadvantages:

- Potential increase in postoperative pain, nausea, and vomiting due to peritoneal traction and visceral manipulation.
- Transient maternal hypotension or bradycardia due to traction on the broad ligament.
- Rare risk of uterine vessel stretching or avulsion (**Al Kadri et al., 2020**).

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