Coming to Term: A Multimodality Review of Cesarean Section Complications

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Objectives

- Familiarize the reader with the most common Cesarean section surgical techniques and normal postoperative appearance
- Proper initial imaging choice between ultrasound, CT, and MR
- Suggested protocoling for MR
- Awareness of most common complications of Cesarean sections, both acute and chronic
Cesarean Section Overview

- Most commonly performed surgical procedure in U.S., with up to $\frac{1}{3}$ of all deliveries undergoing Cesarean delivery.
- Overall complication rate around 14.5%\(^1\)
  - Higher for emergent deliveries, lower for elective deliveries.
- Most common clinical symptoms after delivery include:
  - Fever
  - Fall in Hemoglobin
  - Heavy vaginal bleeding
  - Pain
- Most common complication = Endometritis
Surgical Technique

Skin Incision (Fig. 1)

- Transverse - Most common, with 2 variations
  - Pfannenstiel - curved, 2 to 3 cm above symphysis pubis, better cosmetic appearance
  - Joel-Cohen - straight, 3 cm below line that joins anterior superior iliac spine, slightly more cephalad than Pfannenstiel
- Vertical - midline incision, allows faster entry into abdomen.

Rectus Muscles

- Usually dissected bluntly
- Transection of muscles (Maylard technique) is usually avoided
Surgical Technique, cont.\textsuperscript{2}

Bladder Flap

- Incision made by superficially incising and dissecting peritoneal lining to separate the urinary bladder from the lower uterine segment (Fig. 2)

Hysterotomy

- Transverse incision
  - More common, lower risk of rupture in subsequent pregnancies
- Vertical Incision
  - Low vertical - performed in lower uterine segment
  - Classic incision - vertical incision extending to the upper uterine segment

Fig. 2. Illustration depicting the incision through the peritoneal reflection of the bladder and uterus (vesicouterine fold) to create a bladder flap.
Imaging Choice

• Initial imaging choice will be dictated by clinical presentation and timing after delivery.
  ○ Acute - Contrast enhanced CT (portal venous phase) or pelvic ultrasound is usually sufficient for diagnosis of hematoma, abscess, wound infection, uterine dehiscence/rupture, and pelvic thrombus/thrombophlebitis.
    ■ MRI has superior accuracy over CT for diagnosis of uterine dehiscence/rupture
  ○ Chronic - US can usually be diagnostic for most chronic complications including niche, scar endometrioma, and C-section scar ectopic

• Special cases
  ○ Ascites with concern for bladder/ureter injury → CT cystogram
  ○ Suspected scar endometrioma → US with high frequency linear transducer
  ○ Cesarean scar niche → sonohysterography
  ○ Suspected uterine adhesions → Transabdominal US with an empty bladder
MR Protocoling

- For most complications, contrast is beneficial. Suggested protocoling would include:
  - Axial/Coronal/Sagittal T2 fat saturated image
  - In and out of phase imaging
  - Diffusion weighted imaging
  - Axial T1W1 pre and post contrast
    - Large and small fields of view
Acute postoperative appearance

- Lower uterine incision
  - US - Oval, iso to hypoechoic region between bladder and uterus on US. Punctate echoes may represent sutures
  - CT - Linear hypodensity in the anterior lower uterine segment. Discontinuity of the myometrium may be visualized, a normal finding (Fig. 3)

- Endometrial cavity
  - US - echogenic material may be seen in cavity after delivery
  - CT - hyperdense, enhancing soft tissue density material may be seen

Fig. 3. Sagittal contrast enhanced CT 5 days after delivery demonstrates a hypodense incision line through the lower uterine segment (arrow) with apparent discontinuity of the myometrium secondary to adjacent edema.
Acute postoperative appearance, cont.

- Bladder flap hematoma
  - Small (<4 cm) hematomas considered routine and not clinically significant (Fig. 4).
  - Can occur in up to 50% of patients

Fig 4. Sagittal contrast enhanced CT - Small bladder flap hematoma between the uterus and bladder
Chronic postoperative appearance

- Cesarean section uterine scar (Fig. 5)
  - US - narrow transverse hypoechoic line with posterior shadowing
  - CT/MR - Thin hypodense/hypointense line through the anterior lower uterine segment
  - Thinning and retraction of the adjacent endometrium and serosal lining may be present

Fig 5. Normal healed Cesarean scars. Transvaginal US (A) depicts hypoechoic lines in the lower uterine segment (asterisk), corresponding with 2 prior Cesarean deliveries. T2 weighted sagittal MRI (B) shows retraction of the adjacent endometrium (arrows).
Complications of Cesarean Section

- Endometritis
- Retained products of conception
- Cesarean scar niche
- Bladder flap hematoma
- Uterine dehiscence
- Ovarian vein thrombosis/thrombophlebitis
- Scar endometrioma
- Cesarean section ectopic
- Adhesions/Uterine deformity
Endometritis

- Endometritis is the most common cause of postpartum fever and most common overall complication.⁵,⁶
  - Rates up to 30 times higher compared with vaginal delivery
- Primarily a clinical diagnosis
- Imaging findings significantly overlap with normal postoperative appearance, lowering sensitivity and specificity
  - Echogenic/hyperdense material in the uterus can be a normal finding up to 3 weeks postpartum.⁷
Endometritis, cont.

- Imaging (Fig. 6)
  - US
    - Endometrium often normal
    - Other findings are nonspecific: thickened endometrium, endometrial fluid, gas bubbles with dirty shadowing
    - Color Doppler - increased flow
  - CT
    - Nonspecific - heterogeneous density uterus with a distended endometrial cavity
  - MR
    - T1 - decreased uterine signal
    - T2 - increased signal with loss of junctional zone
    - Contrast - intense enhancement

Fig. 6. Clinically proven endometritis. TVUS (A,B) demonstrates echogenic gas with dirty shadowing. Sagittal and axial CT (C,D) demonstrates a thickened endometrium with endometrial gas.
Retained products of conception

- Residual trophoblastic tissue after delivery
- Can occur anywhere in the endometrial canal, including at the cesarean scar
- US (Fig. 7)
  - Echogenic mass in endometrium appears to be most accurate sign of RPOC with a sensitivity of 79% and 89%, respectively.\(^8\)
  - Vascularity increases specificity for RPOC.
  - However, there is still much overlap between normal and abnormal postoperative findings

Fig 7. Retained products of conception - US. Grayscale (A), Color (B), and Spectral Doppler (C) transvaginal US demonstrates a heterogeneously hyperechoic and hypervascular mass in the uterus with low resistance arterial waveforms.
Retained products of conception, cont.

- MRI\textsuperscript{9} (Fig. 8)
  - Intracavitary uterine soft tissue mass
  - Variable T1 and T2 signal
  - Variable enhancing tissue
  - May have significant overlap with gestational trophoblastic disease

Fig. 8. Retained products of conception - MR. Sagittal T2 (A) and T1 postcontrast (A) T1 imaging depicting high T2 signal mass in the posterior superior endometrial cavity with intense enhancement after contrast administration (arrows).
Cesarean Scar Niche

- Tethering of the endometrium at the site of the hysterotomy incision
- May accumulate fluid/blood, serving as a reservoir for dysfunctional uterine bleeding and infection
- Imaging - sonohysterography is test of choice.
  - US (Fig. 9) - semicircular or triangular fluid filled defect at the lower uterine segment

Fig. 9. Cesarean scar niche. Sagittal and axial TVUS demonstrates a triangular pocket of fluid along the anterior lower uterine segment (arrows).
Bladder Flap Hematoma

- Bleeding between urinary bladder and lower uterine segment at site of peritoneal incision
- Can be considered normal if less than 4 cm
  - May occur in up to 50% of patients.\(^4\)
- Imaging
  - US - heterogenous echogenicity fluid collection posterior to bladder
  - CT (Fig. 10) - variable density collection at same location
  - MR - Increased T1 signal - subacute hemorrhage - and usually increased T2 signal
  - Gas in collection or peripheral rim enhancement suggests infection.

Fig 10. Bladder flap hematoma. Coronal (A) and Sagittal (B) CECT shows a relatively low density collection between the bladder and lower uterine segment (arrows), consistent with a subacute to chronic bladder flap hematoma. There is no gas or peripheral enhancement to suggest infection.
Uterine dehiscence/rupture

- Dehiscence is incomplete rupture of the uterine wall. The serosa remains intact.
- Rare, occurring in 1:700-2400 cesarean births\(^{10}\)
  - ~0.5-1.0% risk of rupture when attempting vaginal birth after prior cesarean section
- Findings may overlap with normal appearance of the cesarean incision after delivery\(^{3}\)
- Bladder flap hematomas > 5 cm are concerning for dehiscence/rupture
Uterine dehiscence/rupture - Imaging

- **US**
  - Pelvic fluid collection anterior to the cesarean section scar and in continuity with endometrial cavity
    - Occurs through prior cesarean section scar 92% of the time
  - If patient is pregnant, may contain fetal parts
  - Can also contain IUDs (Fig. 11)

Fig 11. Uterine dehiscence - US. 28 year old with prior history of cesarean delivery, presenting with lost IUD. Midline sagittal TVUS (A) demonstrates a 1-2 cm defect at the site of patient’s lower uterine segment cesarean incision (long arrow). TVUS slightly off midline (B) shows a large fluid collection in communication with the uterine defect/endometrial cavity (not shown). Reverberation artifact within the collection correlates with patient’s lost IUD string (short arrows).
Uterine dehiscence/rupture - Imaging, cont.

- MR
  - Superior accuracy over CT given excellent soft tissue contrast
  - Lack of apposition of endometrium and serosa at incision site
    - Intact serosa → dehiscence (Fig. 12)
    - Disrupted serosa → rupture
  - Associated fluid collection/hematoma
    - Bladder flap hematoma > 5 cm
    - Gas within the uterine defect with hemoperitoneum increases likelihood of rupture

Fig. 12. Uterine dehiscence - MR. Axial T1 (A), sagittal T2 (B) and coronal T2 (C) images demonstrates an intrinsically T1 and T2 bright fluid collection protruding through the lower uterine segment cesarean scar into the parametrium. T1 and T2 signal characteristics are characteristic of subacute blood. Patient’s IUD can be seen best on the coronal image (arrow).
Ovarian vein thrombosis/thrombophlebitis

- Pregnancy is a prothrombotic state, usually resolving 2-6 weeks after delivery
- Venous thromboembolism is the leading cause of mortality in pregnant and postpartum patients in the developed world\(^{11}\)
- Ovarian vein thrombosis commonly seen in postpartum patients with abdominal pain and fever
- Involves right ovarian vein 80-90\% of time
  - Right vein longer
  - Gravid uterus often dextropositioned, causing compression of right vein
- Can progress to pulmonary embolism, septic emboli, and death
Ovarian vein thrombosis - Imaging

- **US**
  - Not utilized secondary to overlying bowel gas

- **CT (Fig. 13)**
  - Enlarged ovarian vein with central filling defect
  - May extend into IVC

- **MR**
  - T1 and T2 intermediate to high signal clot
  - Contrast - filling defect in vein

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**Fig. 13.** Ovarian vein thrombosis. Axial contrast enhanced CT demonstrates a small filling defect in the right ovarian vein (arrow). There are no surrounding inflammatory changes to suggest thrombophlebitis.
Ovarian vein thrombophlebitis

- Occurs in 1 in 2000 pregnancies, but 1 in 50 cases of endometritis
- More frequent on right
  - Same rationale as right ovarian vein thrombosis
- CT or MR should be performed on patients who fail antibiotic therapy\(^5\)
Ovarian vein thrombophlebitis - Imaging

- **CT (Fig. 14)**
  - NECT - hyperdense thrombus
  - CECT
    - Low attenuation filling defect
    - Thin enhancing venous walls producing targetoid appearance
    - Perivascular fat stranding

- **MR**
  - Intermediate to high T1 and T2 signal
  - Enhancement of vessel wall

Fig 14. Ovarian vein thrombophlebitis. There is intraluminal thrombus of the right ovarian vein (A,C) with associated enhancement of the venous wall and perivenous inflammatory changes (long arrows). A normal left ovarian vein (B) is shown for comparison (arrowhead)
Scar Endometrioma

- Rare, occurring in less than 1% of patients after cesarean section.
- Likely caused by iatrogenic seeding of endometrium after hysterotomy.
- Like other endometriomas, can cause cyclical pain.
- Imaging
  - US: Ill defined, hypoechoic mass in the abdominal wall.
    - Linear probe should be used for better spatial resolution.
  - CT: Soft tissue mass.
  - MR (Fig. 15): T1 hyperintense (subacute blood) and T2 hypointense mass, variable enhancement.

Fig 15. Scar Endometrioma. There is a T1 hyperintense (A) and T2 hypointense (B) lesion in the right rectus muscle (arrows). The T1 signal does not suppress during fat saturation. No significant enhancement is appreciated on T1 weighted postcontrast subtraction images (C).
Cesarean scar ectopic

- Rare, estimating to occur in 0.15% of pregnant women with prior cesarean
- Implantation of pregnancy within the cesarean scar in the lower uterine segment
  - Trophoblast invades into the myometrium through tract created at surgery
- May lead to life threatening uterine rupture and hemorrhage
- Two types
  - Implantation on scar with growth into cervicoisthmic space and uterine cavity
  - Deep implantation into scar with progression outward → increased chance of rupture
- Most common presenting symptom → painless vaginal bleeding.
Cesarean scar ectopic - Imaging, cont.

- **MR (Fig. 16)**
  - T2 - Gestational sac will be centered in the myometrium of the lower uterine segment.
  - A thin layer of myometrium should be seen between the uterus and bladder.

Fig 16. Cesarean scar ectopic - MR. Sagittal (A) and Coronal (B) T2W1 demonstrates a gestational sac centered in the anterior lower uterine segment (asterisk). Fetal parts are best seen on coronal imaging (long arrow). Old cesarean abdominal scar is noted (short arrow).
Cesarean scar ectopic - Imaging

- Ultrasound (Fig. 17) - transvaginal US first imaging modality
  - 86.4% sensitivity\(^{13}\)
  - Empty endometrial cavity
  - Gestational sac located in the lower uterine segment myometrium
  - Doppler US → low resistance arterial flow between bladder and anterior uterine wall

Fig. 17. Cesarean scar ectopic - US. There is an empty uterine cavity (asterisk) on the transabdominal US image (A). A gestational sac with fetal parts is centered on the lower uterine segment (arrow). TVUS (B,C) demonstrates a gestational sac adjacent to the cervix centered in the anterior lower uterine segment. Spectral doppler (D) shows a fetal heart rate of 176.
Adhesions/Uterine Deformity

- Adhesions are common, with a prevalence around 50%
  - Increases frequency with subsequent cesareans
- Uterus can become anteverted and retroflexed from adhesions, tethering uterus to the abdominal wall (Fig. 18)
  - Should be evaluated with transabdominal US secondary to orientation. Bladder should be emptied.

Fig. 18. Transabdominal US (A) demonstrates the uterine body adherent to the abdominal wall, with slight deformity of the anterior body (arrow). Axial (B) and Sagittal (C) T2 weighted MRI showing a retroflexed and anteverted uterus, presumably secondary to adhesions from patient’s cesarean delivery.
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