

Laparoscopic Surgery In The Pregnant Patient For Non-Obstetric Indications

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Disclosures

I have no financial relationships with industry or other conflicts of interest



Scope and Perspective

- Surgical procedures unrelated to pregnancy has been reported in 0.7 – 2% of pregnant women

Total number and proportion of common procedure groups

	Total number	Proportion of total (%)
Abdominal (any kind)	12,493	26.2
Appendicectomy	3062	6.4
Cholecystectomy	1306	2.7
Dental	5365	11.3
Nail-skin	4762	10.0
Orthopedic	4563	9.6
ENT	3060	6.4
Perianal	2977	6.2
Breast	1884	4.0
Cancer related	710	1.5

The number and proportion of surgery types from a cohort study of 47,628 pregnancies complicated by nonobstetric surgery.

Balinskaite V et al (2017) The risk of adverse pregnancy outcomes following nonobstetric surgery during pregnancy: estimates from a retrospective cohort study of 6.5 million pregnancies. *Ann Surg* 266:260.
 Rasmussen AS et al (2019) Obstetric and non-obstetric surgery during pregnancy: a 20-year Danish population-based prevalence study. *BMJ Open* 2019;9:e028136. doi:10.1136/bmjopen-2018-028136.
 Morwitz ER et al (2020) Nonobstetric surgery in pregnant patients: Patient counseling, surgical considerations, and obstetric management. www.uptodate.com

Scope and Perspective

- 1 in 500 pregnant women will have an abdominal surgical procedure

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Scope and Perspective

- Historical hesitation to operate during pregnancy



- Risk of anesthesia
- Risk of pregnancy loss
- Risk of preterm labor
- Risk of low birth weight (<2500g)
- Risk of neonatal death (first 7 days of life)
- Risk of birth defects

- Has only been studied critically since 1970

- Surgical risk and fetal risk studies began in the 1970s / 1980s
- Route of surgery (abdominal vs laparoscopic) emerged in 1990s / 2000s

Kort B et al (1993) The effect of nonobstetric operation during pregnancy. *Surg Gynecol Obstet* 177:371.

Schwarzman P et al (2015) The effect of nonobstetric invasive procedures during pregnancy on perinatal outcomes. *Arch Gynecol Obstet* 292:603.

Mazze R et al (1989) Reproductive outcome after anesthesia and operation during pregnancy: A registry study of 5405 cases. *Am J Obstet Gynecol* 161:1178.

Cohen-Kerem R et al (2005) Pregnancy outcome following non-obstetric surgical intervention. *Am J Surg* 190:467.

Balinskaite V et al (2017) The risk of adverse pregnancy outcomes following nonobstetric surgery during pregnancy: estimates from a retrospective cohort study of 6.5 million pregnancies. *Ann Surg* 266:260.

Rasmussen AS et al (2019) Obstetric and non-obstetric surgery during pregnancy: a 20-year Danish population-based prevalence study. *BMJ Open* 2019;9:e028136. doi:10.1136/bmjopen-2018-028136.



Scope and Perspective

- Retrospective study of 6.5 million patients
- 1-2% incidence of non-obstetric surgery
- Incidence and **relative risk (RR)**
 - Multiplier by which surgery would increase the incidence of a specific outcome in a specific pregnant woman who underwent a surgical procedure (strength of association or causal link in an individual)



Outcome	Overall Crude Rate (%)	RR*
Miscarriage associated with hospitalization	5.8	1.13 (1.09–1.17)
Stillbirth	0.6	1.64 (1.50–1.81)
Preterm delivery	7.5	1.43 (1.39–1.47)
Low birth weight	5.6	1.49 (1.44–1.54)
Cesarean section	23.9	1.21 (1.19–1.23)
Long inpatient stay	9.5	1.22 (1.20–1.25)
Maternal death	0.004	4.72 (2.61–8.52)

Balinskaite V et al (2017) The risk of adverse pregnancy outcomes following nonobstetric surgery during pregnancy: estimates from a retrospective cohort study of 6.5 million pregnancies. *Ann Surg* 266:260.

Scope and Perspective

- Retrospective study of 6.5 million patients
- **Attributable risk**
 - Multiplier by which surgery would increase the incidence of a specific outcome in a group of pregnant women undergoing a surgical procedure (measurement of the excess risk in a population of pregnant women undergoing surgery)



Outcome	Overall Crude Rate (%)	RR*	AR (%)†
Miscarriage associated with hospitalization	5.8	1.13 (1.09–1.17)	0.7 (0.4–0.9)
Stillbirth	0.6	1.64 (1.50–1.81)	0.4 (0.3–0.4)
Preterm delivery	7.5	1.43 (1.39–1.47)	3.2 (2.9–3.4)
Low birth weight	5.6	1.49 (1.44–1.54)	2.6 (2.5–2.9)
Cesarean section	23.9	1.21 (1.19–1.23)	4.0 (3.6–4.5)
Long inpatient stay	9.5	1.22 (1.20–1.25)	2.0 (1.7–2.4)
Maternal death	0.004	4.72 (2.61–8.52)	0.013 (0.003–0.028)

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Scope and Perspective

- Retrospective study of 6.5 million patients
- Attributable risk
- **Number needed to harm**
 - A derived statistic - how many pregnant women must undergo a surgical procedure during pregnancy for 1 additional patient to experience a particular outcome

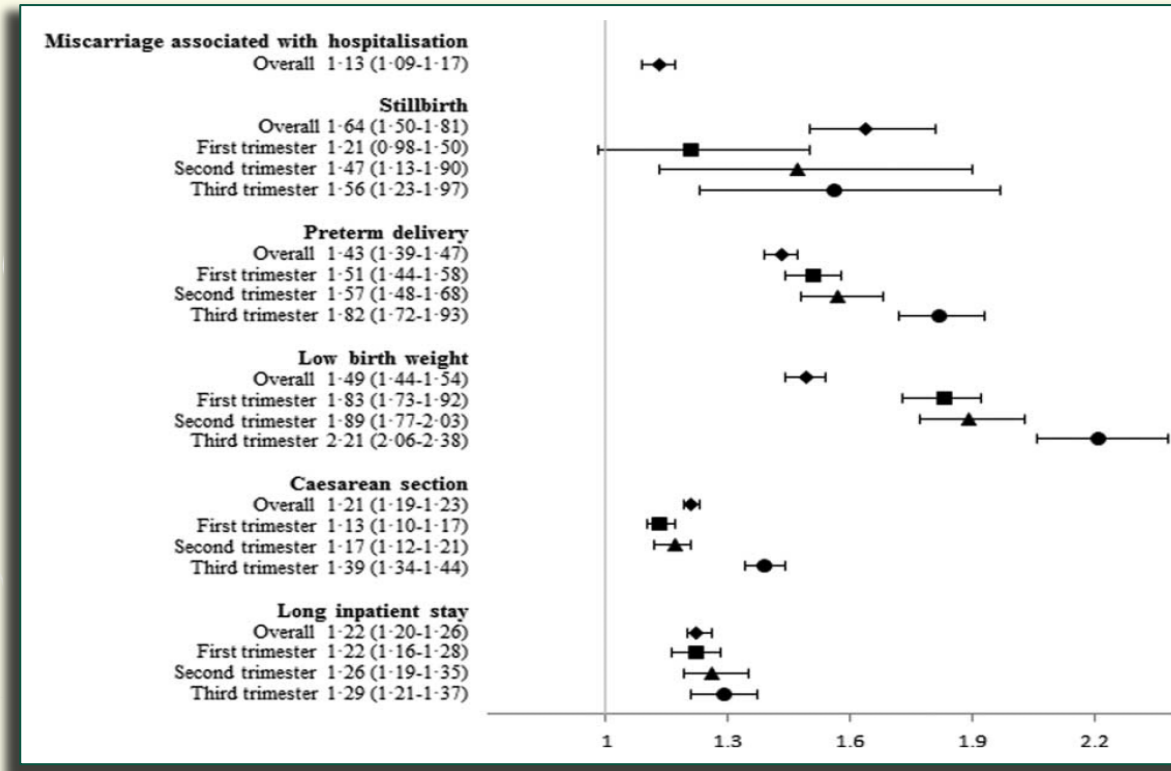


Outcome	Overall Crude Rate (%)	RR*	AR (%)†	NNH‡
Miscarriage associated with hospitalization	5.8	1.13 (1.09–1.17)	0.7 (0.4–0.9)	143 (107–230)
Stillbirth	0.6	1.64 (1.50–1.81)	0.4 (0.3–0.4)	287 (227–386)
Preterm delivery	7.5	1.43 (1.39–1.47)	3.2 (2.9–3.4)	31 (29–34)
Low birth weight	5.6	1.49 (1.44–1.54)	2.6 (2.5–2.9)	39 (37–42)
Cesarean section	23.9	1.21 (1.19–1.23)	4.0 (3.6–4.5)	25 (22–28)
Long inpatient stay	9.5	1.22 (1.20–1.25)	2.0 (1.7–2.4)	50 (41–60)
Maternal death	0.004	4.72 (2.61–8.52)	0.013 (0.003–0.028)	7692 (3571–33333)

Balinskaite V et al (2017) The risk of adverse pregnancy outcomes following nonobstetric surgery during pregnancy: estimates from a retrospective cohort study of 6.5 million pregnancies. *Ann Surg* 266:260.

Scope and Perspective

- Relative risk increases with gestational age

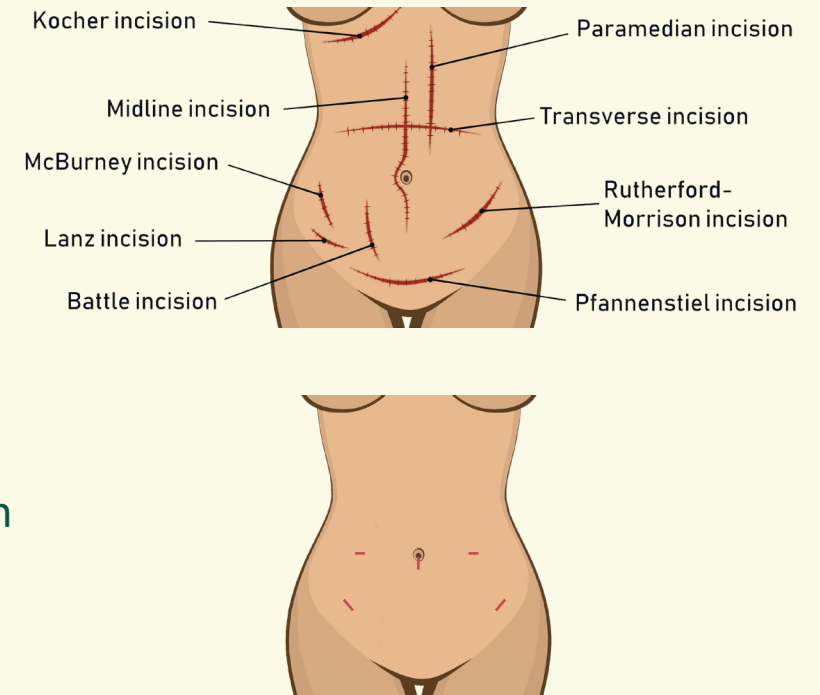


- 20% higher risk for preterm delivery or cesarean delivery if surgery in 3rd trimester vs 1st trimester

Balinskaite V et al (2017) The risk of adverse pregnancy outcomes following nonobstetric surgery during pregnancy: estimates from a retrospective cohort study of 6.5 million pregnancies. *Ann Surg* 266:260.

Historical Perspective of Laparoscopy

- Really became integrated into OBGYN in the 1990s
- Benefits of laparoscopy over laparotomy
 - Shorter operative times
 - Shorter length of stay
 - Less trauma and pain from incisions
 - Less analgesia requirement with less opioid use
 - Less blood loss
 - Decreased infection rate
 - More rapid convalescence
 - Less thromboembolic risk with rapid ambulation
 - Better cosmetic effect



- Do these benefits apply to the pregnant patient?

Agha R, Muir G (2003) Does laparoscopic surgery spell the end of open surgery? *J R Soc Med* 96:544.

Dizon AM, Carey ET (2018) Minimally invasive gynecologic surgery in the pregnant patient: considerations, techniques, and postoperative management per trimester. *Curr Opin Obstet Gynecol* 30:267.

Historical Perspective of Laparoscopy

- Arguments that laparoscopy was contraindicated during pregnancy
 - Concerns for uterine injury
 - Concerns for compromise of fetal perfusion
 - Increased abdominal pressure with insufflation and Trendelenburg positioning



- With experience, laparoscopy has become preferred treatment for many surgical procedures in gravid patients

Pearl J et al (2019) Guidelines for diagnosis, treatment , and use of laparoscopy for surgical problems during pregnancy. *Surg Endosc* 25:3479-3492.

Pearl JP et al (2019) Guidelines for the Use of Laparoscopy During Pregnancy. www.sages.org/publications/guidelines

Tolcher MC et al (2018) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 132:395-403.



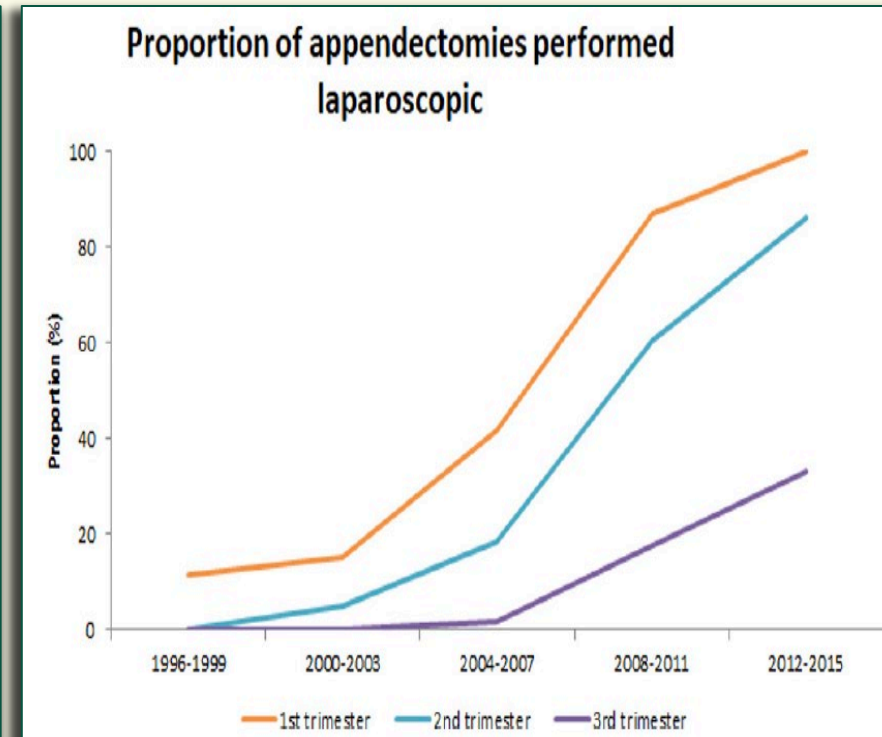
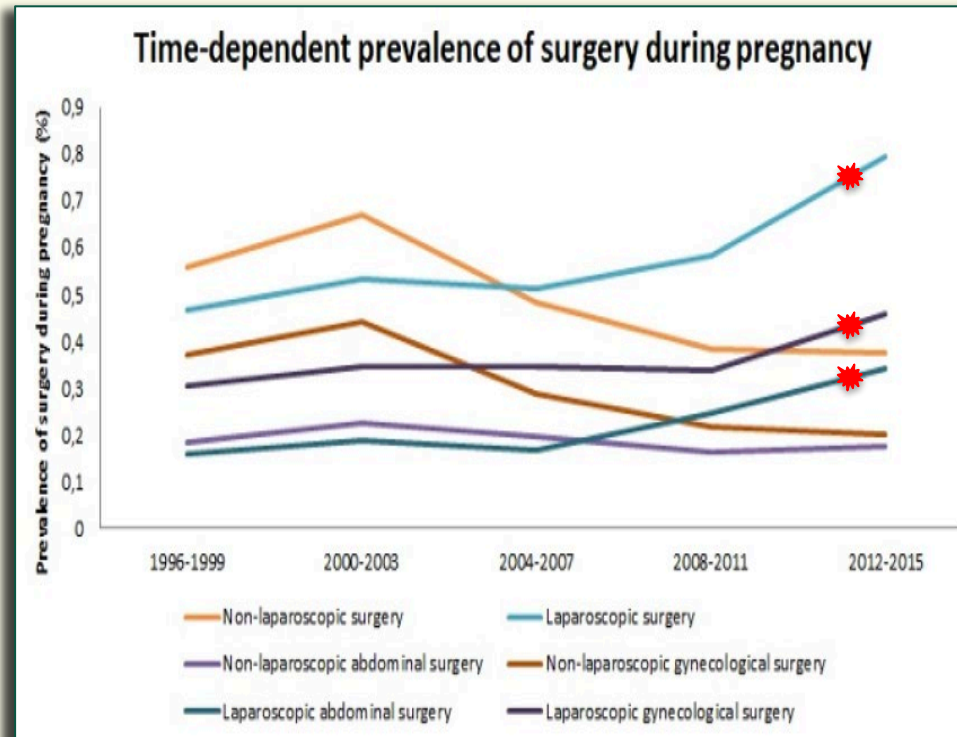
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Prevalence and Route of Surgery

- Danish study 1.68 million pregnancies 1996-2015
 - 108.5K operations in 117.4 pregnancies
 - General trend favoring laparoscopy over laparotomy



- Increase in laparoscopic appendectomy from 4.2% to 79.2%

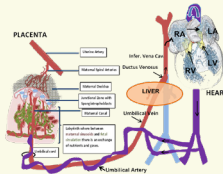
Rasmussen AS et al (2019) Obstetric and non-obstetric surgery during pregnancy: a 20-year Danish population-based prevalence study. BMJ Open 2019;9:e028136. doi:10.1136/bmjopen-2018-028136.

Laparoscopic Surgery in Pregnant Patients



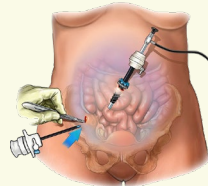
Physiology of anesthesia

- Impact of anesthesia regardless of surgical route



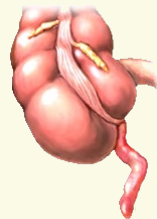
Physiology of pregnancy

- Characteristics that specifically impact surgery



Physiology of laparoscopy

- Features of laparoscopy that might impact outcomes



Pathophysiology of specific disease

- Natural clinical history of the disease process in patient

Agha R, Muir G (2003) Does laparoscopic surgery spell the end of open surgery? *J R Soc Med* 96:544.

Dizon AM, Carey ET (2018) Minimally invasive gynecologic surgery in the pregnant patient: considerations, techniques, and postoperative management per trimester. *Curr Opin Obstet Gynecol* 30:267.

Anesthetic Agents

- Common agents used for general anesthesia are not teratogenic in humans
- Placental transfer of neuromuscular blocking used for general anesthesia agents is minimal
- Nitrous oxide associated with theoretical concern
 - Inhibits methionine synthase activity
 - Potential effects on DNA production and myelin deposition
 - Actual detrimental clinical effects on developing fetus have yet to be demonstrated in >70,000 cases
- **Choice of anesthetic agents should be based on standard anesthetic considerations**

Tolcher MC et al (2018) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 132:395-403.



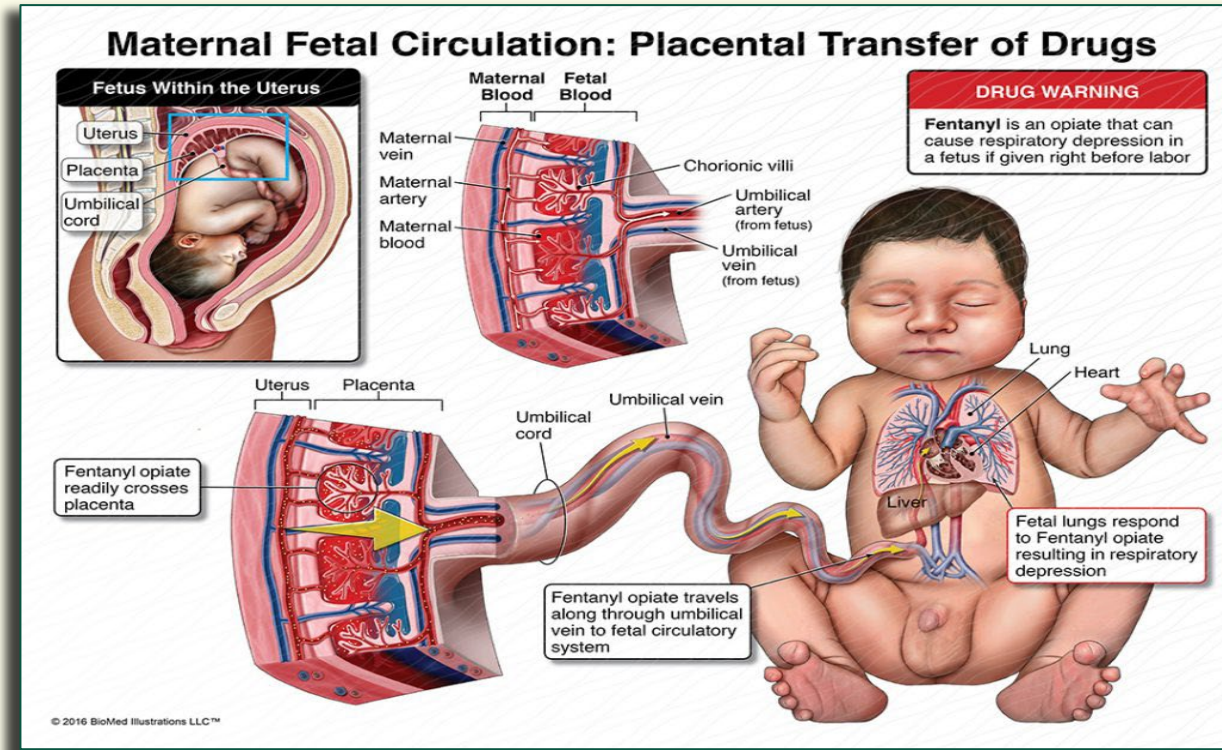
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Anesthetic Agents

- A more critical concern
 - Rapid passage of most anesthetic agents across placenta
 - Potential for severe neonatal depression should delivery be necessary during maternal surgery



Tolcher MC et al (2018) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 132:395-403.

Pregnancy and Anesthesia Effect

Pregnancy Physiology

- Maternal blood volume
 - 15% increase by 10 weeks; 30-50% by term
 - Decreased intravascular colloid pressure
- Systemic vascular resistance
 - Decrease 33% by 10 weeks
- Cardiac output Increases 30% by 10 weeks
- Maternal heart rate Increases 15%
- Increased dysrhythmia risk (atrial stretch)
- Minute ventilation increases 40%
- Expiratory reserve decreases almost 40%
- Oxygen demand increases
 - 3 mL/kg/min (nonpregnant)
 - 4 mL/kg/min (third trimester) (~15 in labor)
- Increased renal blood flow + GFR (20%)
- Hypercoagulable state

Anesthesia Physiology

- 15-degree left tilt after 18 weeks
- Standard physiologic monitoring
 - No specific fetal monitoring indicated
 - Arterial line depends on patient co-morbidities
- No routine intraoperative fetal heart monitoring indicated
- Adequate maternal BP is most important determinant of placental perfusion
 - Vasopressors if BP drops 20% or more
 - Ephedrine or phenylephrine are drugs of choice
- IV induction rather than inhalation
 - More rapid onset of optimal intubation conditions
- More sensitive to neuromuscular agents
 - Use peripheral twitch monitor
- Mechanical ventilation to match normal respiratory alkalosis of pregnancy
 - Maintain end-tidal CO₂

Dizon AM, Carey ET (2018) Minimally invasive gynecologic surgery in the pregnant patient: considerations, techniques, and postoperative management per trimester. *Curr Opin Obstet Gynecol* 30:267.

Norwitz E et al (2019) Management of the pregnant patient undergoing nonobstetric surgery. *UpToDate online resource.*

Sviggum H et al (2020) Anesthesia for nonobstetric surgery during pregnancy. *UpToDate online resource.*

Stany MP, Elkas JC (2019) Laparoscopic surgery in pregnancy. *UpToDate online resource.*

Laparoscopy Effect

Abdominal Insufflation

- Decreased preload (IVC compression)
 - Increased intra-abdominal pressure
 - Gravid uterus causes IVC compression
 - Decreased BP, stroke volume, and cardiac output
- Diaphragm displaced upward (hypoxia)
 - Decreased functional pulmonary reserve
 - Increased peak airway pressure
 - Increased ventilation-perfusion mismatch
 - Risk for increased end tidal CO₂

Trendelenburg Positioning

- Increased preload (venous return)
 - Increased venous return due to gravity
 - Increased MAP (20-30%) and cardiac output (10%)
 - Increased SVR (40%) and BP

Accommodating Laparoscopic Techniques

- Use Left upper quadrant laparoscopic entry to visualize around gravid uterus (open technique not necessary)
- Decrease insufflation pressure, minimize Trendelenburg positioning, left lateral tilt
- Hand-assisted laparoscopy can improve manipulation and minimize electrosurgical complications
- Skill of surgeon and team - - - KNOW YOUR SKILL AND LIMITATIONS

Dizon AM, Carey ET (2018) Minimally invasive gynecologic surgery in the pregnant patient: considerations, techniques, and postoperative management per trimester. *Curr Opin Obstet Gynecol* 30:267.

Norwitz E et al (2019) Management of the pregnant patient undergoing nonobstetric surgery. *UpToDate online resource*.

Stany MP, Elkas JC (2019) Laparoscopic surgery in pregnancy. *UpToDate online resource*.

Arvizo C, Mehta ST, Yunker AC (2018) Adverse events related to Trendelenburg position during laparoscopic surgery: recommendations and review of the literature. *Curr Opin Obstet Gynecol* 30:272.



Scope and Perspective

ACOG COMMITTEE OPINION

Number 775

(Replaces Committee Opinion No. 696, April 2017)

Committee on Obstetric Practice American Society of Anesthesiologists

This Committee Opinion was developed by the American College of Obstetricians and Gynecologists' Committee on Obstetric Practice and the American Society of Anesthesiologists.

INTERIM UPDATE: The content on nonobstetric surgery in this Committee Opinion has been updated as highlighted (or removed as necessary) to reflect a limited, focused change in the language regarding sedative drugs, medically necessary surgery, antenatal corticosteroids, and venous thromboembolism.

Nonobstetric Surgery During Pregnancy

- No evidence that in utero exposure to anesthetics/sedatives has adverse effect on fetus
- Pregnant women should not be denied necessary surgery regardless of trimester
- Screen for thromboembolism risk and provide appropriate prophylaxis
- Given risk of preterm birth, consider corticosteroids if viable fetus
- Informed consent to include emergent cesarean delivery for fetal indications

ACOG (2017) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 133:e285.

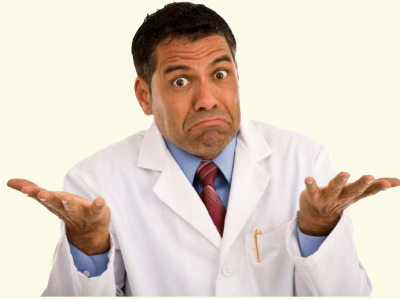


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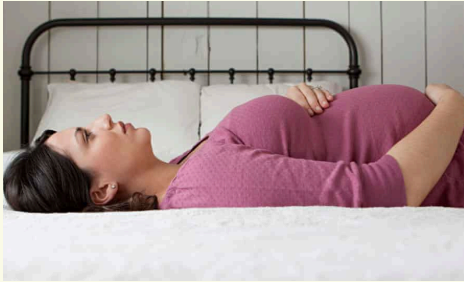


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Greatest Risk: DELAY



- Physician delay of surgery
 - Diagnostic challenges during pregnancy
 - Hesitant to order testing that may be necessary



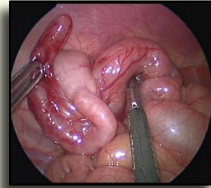
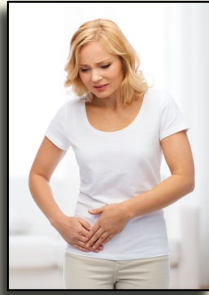
- Patient delay of surgery
 - Fear of preterm birth or fetal harm
 - Fear of complications



- **End result**
 - **Disease process likely to be more advanced**
 - **More likely to result in emergent surgery**

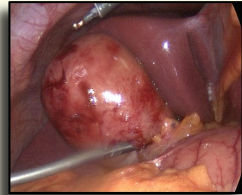
Most Common Non-obstetric Problems

- Appendicitis



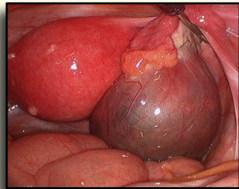
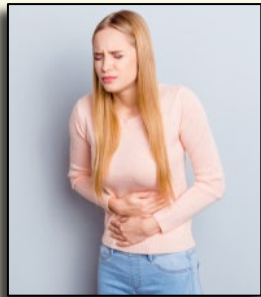
- Most common procedure (1/500 – 1/1000)

- Cholecystitis



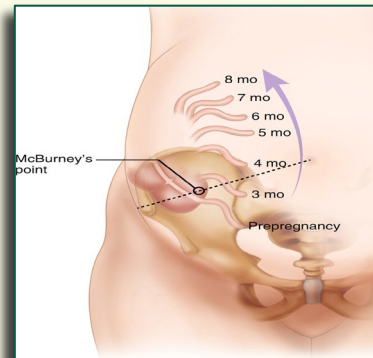
- Second most common procedure (1/2000 – 1/2500)

- Adnexal Masses



- Most common problem, not most common operation
- 2% of pregnancies, of which 2-3% are malignant
- 60-70% are mature teratomas or corpus luteal cysts

Appendicitis



Diagnosis can be challenging

- Upward displacement of appendix by the gravid uterus
- Confusion of symptoms with other pregnancy-related issues
- Absence or blunting of usual signs/symptoms
- Physiological leukocytosis during pregnancy

Appendectomy

- Most common surgery during pregnancy
 - 25% of all nonobstetrical procedures; 1/500-1000 pregnancies
- Appendicitis rate same in pregnant vs nonpregnant patients
 - Risk of appendicitis peaks in 2nd trimester
- More likely to progress to perforation
 - 43% (pregnancy) vs 5-15% baseline (Delayed diagnosis + reluctance to operate)
- Maternal mortality <0.4% (delay, perforation, peritonitis)
- Fetal mortality (2-8%) increases to 11% with peritonitis
- Preterm delivery and hemorrhage risk increases with peritonitis
- Compared with appendectomy, conservative medical management associated with increased risk of
 - Septic shock (adjusted OR 6.3)
 - Venous thromboembolism (adjusted OR 2.5)
 - Peritonitis (adjusted OR 1.6)

Appendectomy



Appendectomy

Patient selection	Laparoscopic treatment of acute abdominal processes has the same indications in pregnant and nonpregnant patients
Patient positioning	Gravid patients should be placed in the left lateral recumbent position to minimize compression of the vena cava and the aorta
Initial port placement	Initial access can be safely accomplished with an open or Hasson, Veress needle, or optical trocar if the location is adjusted according to fundal height, previous incisions, and experience of the surgeon
Insufflation pressure	CO ₂ insufflation of 10–15 mmHg can be safely used for laparoscopy in the pregnant patient Intra-abdominal pressure should be sufficient to allow for adequate visualization

Intraoperative CO ₂ monitoring	Intraoperative CO ₂ monitoring by capnography should be used during laparoscopy in the pregnant patient
Venous thromboembolic prophylaxis	Intraoperative and postoperative pneumatic compression devices and early postoperative ambulation are recommended prophylaxis for deep venous thrombosis in the gravid patient
Fetal heart monitoring	Fetal heart monitoring should occur pre- and postoperatively in the setting of urgent abdominal surgery during pregnancy
Obstetrical consultation	Obstetric consultation can be obtained pre- and/or postoperatively based on the acuteness of the patient's disease and availability
Tocolytics	Tocolytics should not be used prophylactically but should be considered perioperatively when signs of preterm labor are present in coordination with obstetric consultation



Recommendations from The Society of American Gastrointestinal and Endoscopic Surgeons

Kilpatric CC , Orejuela FJ (2008) Management of the acute abdomen in pregnancy: A review. *Curr Opin Obstetr Gynecol* 20:534.

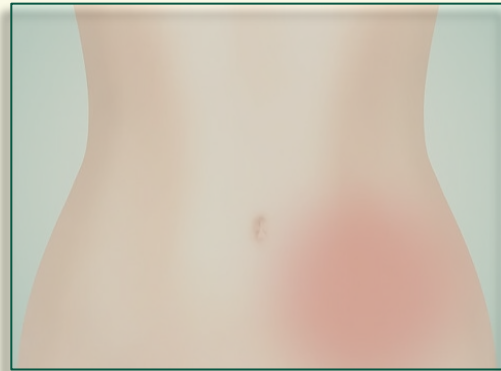
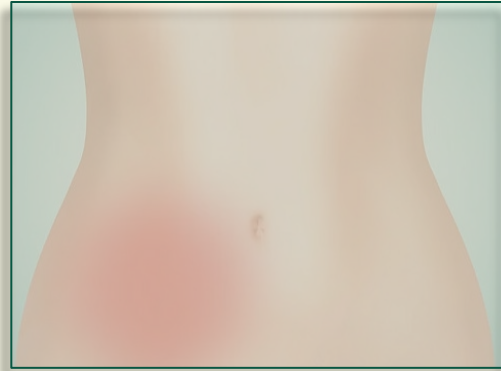


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Cholecystitis



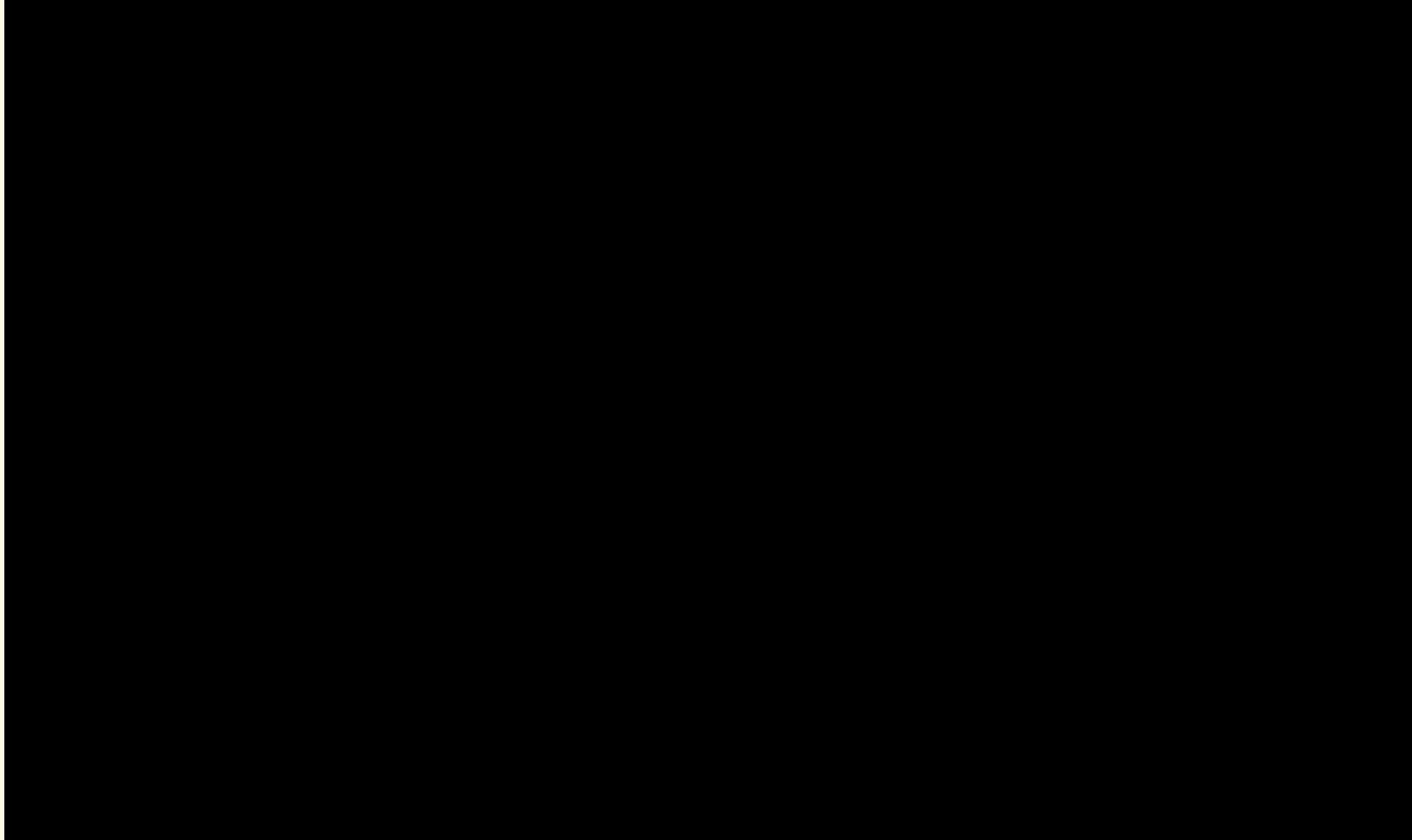
Cholecystectomy

- Second most common surgery during pregnancy
 - 1/2000-2500 pregnancies, increased risk if history of biliary colic prior to pregnancy
 - Actually more common in early postpartum interval
- 10-15% of population has gallstones (~3.5% of pregnant women)
 - 10-20% develop symptomatic disease
 - ~ 40% will require surgery during pregnancy
- Pregnancy-induced gallbladder stasis increases bile acid accumulation
 - Alters bile salt kinetics and enterohepatic circulation
 - Promotes formation of biliary sludge and cholesterol gallstones
- Symptoms same as in nonpregnant patients
 - Mid-epigastric + RUQ pain, Nausea + vomiting, Fatty food intolerance, Abdominal bloating
 - Murphy's sign less common in pregnant patients
 - Easily confused with appendicitis due to displacement of appendix by gravid uterus
- Ultrasound is diagnostic modality of choice
- Medical management successful in up to 70% of cases
 - But if managed surgically, lower maternal (4% vs 16%) and fetal (6% vs 16%) complication rates

Lanzafame RJ (2019) Cholelithiasis, cholecystitis, and cholecystodochotomy during pregnancy. Chapter 11 in: *Non-obstetric surgery during pregnancy*. (Nezhat CH, ed). Springer, Cham, Switzerland. Pp 147-154.



Cholecystectomy



Cholecystectomy

- Can be performed during any trimester when indicated
- Most commonly performed in 2nd trimester



- Cholecystectomy in 3rd trimester increases adverse outcomes
 - More likely inpatient, more likely to convert to laparotomy
 - Increased risk of preterm delivery (2x), increased risk of readmission

Fong ZV et al for California Cholecystectomy Group (2019) Cholecystectomy during the third trimester of pregnancy: Proceed or delay? *J Am Coll Surg* 228:494.



Adnexal Mass



Adnexal Masses

- Incidence of adnexal masses during pregnancy ~2%
 - Most are functional cysts, resolve spontaneously
 - >30% are asymptomatic incidental findings during pregnancy (esp mature teratomas)
- ~ 60% present with pain
 - 60% adnexal torsion
 - 7.6% rupture of the mass
 - 5.2% intra-cystic hemorrhage
- Removal of masses might be warranted
 - persisting at 16 weeks and > 6 cm in diameter
 - symptomatic, concern for torsion, suspicion for malignancy
- Close observation acceptable if asymptomatic
 - ultrasound findings not concerning for malignancy
 - tumor markers normal (CA125, LDH)
- Study of 4.85 million patients
 - laparotomy vs laparoscopy yield equivalent maternal and fetal outcomes

Soriano D et al (1999) Laparoscopy versus laparotomy in the management of adnexal masses during pregnancy. *Fertil Steril* 71:955.

Canis M et al (2002) Laparoscopic management of adnexal masses: a gold standard? *Curr Opin Obstet Gynecol* 14:423.

Bozzo M et al (1997) The management of persistent adnexal masses in pregnancy. *Am J Obstet Gynecol* 177:981.

Sherard GB et al (2003) Adnexal masses and pregnancy: a 12-year experience. *Am J Obstet Gynecol* 189:358.

Leiserowitz GS et al (2006) Adnexal masses in pregnancy: How often are they malignant? *Gynecologic Oncology* 101:315-321.



PRACTICE BULLETIN

CLINICAL MANAGEMENT GUIDELINES FOR OBSTETRICIAN—GYNECOLOGISTS

NUMBER 174, NOVEMBER 2016

(Replaces Practice Bulletin Number 83, July 2007)

Evaluation and Management of Adnexal Masses

- Evaluating pregnant patient similar to premenopausal patient
 - abdominal or transvaginal ultrasonography
 - MRI is modality of choice if additional imaging is needed
- CA 125 peaks in the first trimester (7–251 units/mL)
 - decrease consistently thereafter; tumor markers not always useful in pregnancy
 - low-level elevations in pregnancy typically do not necessarily reflect malignancy
- Excision of persistent masses during pregnancy is safe and not uncommon
 - intent to prevent emergent intervention for torsion or rupture
 - 2nd trimester is optimal due to uterine quiescence and access to mass
- Multiple reports supportive of expectant management
 - 51–70% of adnexal masses are functional cysts and will resolve during pregnancy
 - predictors of persistence are size > 5 cm and complex morphology
- Low risk for both malignancy and acute complications
 - actual occurrence of acute complications is reportedly less than 2%
 - may be considered for expectant management

ACOGI (2016) Evaluation and management of adnexal masses. Practice Bulletin No. 174. *Obstet Gynecol* 128:e210-226.

Diagnostic Risk of Malignancy

- Very elevated tumor markers
- Presence of abdominal ascites
- Nodular or fixed pelvic mass
- Evidence of abdominal or distant metastasis
- Imaging findings suggestive of malignancy

	β -hCG	AFP	LDH	CA 125
Dysgerminoma	+	-	+	-
Endodermal sinus tumor	-	+	-	-
Choriocarcinoma	+	-	-	-
Immature teratoma	-	+	+	+
Embryonal carcinoma	+	+	-	-

Abbreviations: AFP, alpha fetoprotein; CA, cancer antigen; LDH, lactate dehydrogenase.

Modality	Sensitivity	Specificity
Bimanual examination	45	90
Ca-125 > 35 U/mL	78	78
Ultrasound	86-91	68-83
Magnetic resonance imaging	91	87
Computed tomography scan	90	75
Positron emission tomography scan	67	79

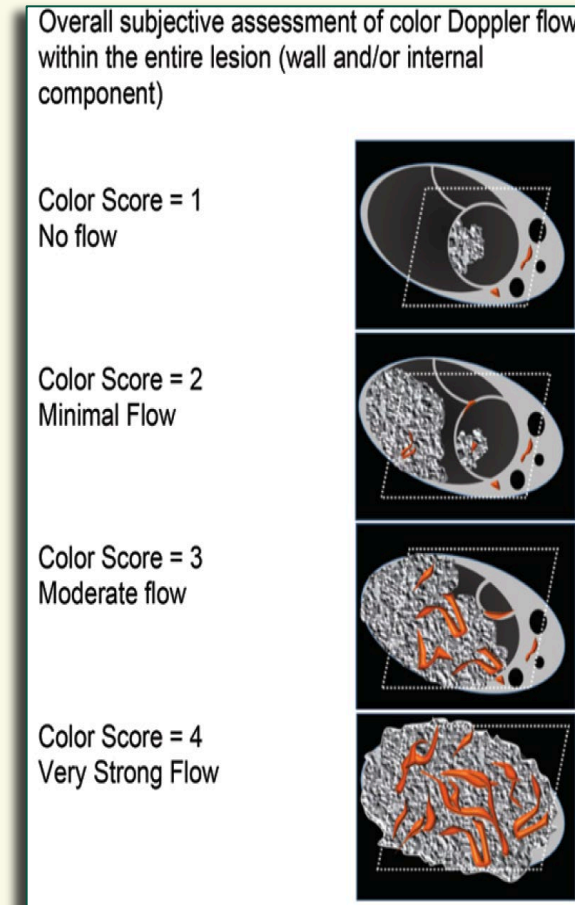
ACOGI (2016) Evaluation and management of adnexal masses. Practice Bulliten No. 174. *Obstet Gynecol* 128:e210-226.

Clark RM et al (2015) Role of minimally invasive surgery in the management of adnexal masses. *Clin Obstet Gynecol* 58:66-75.



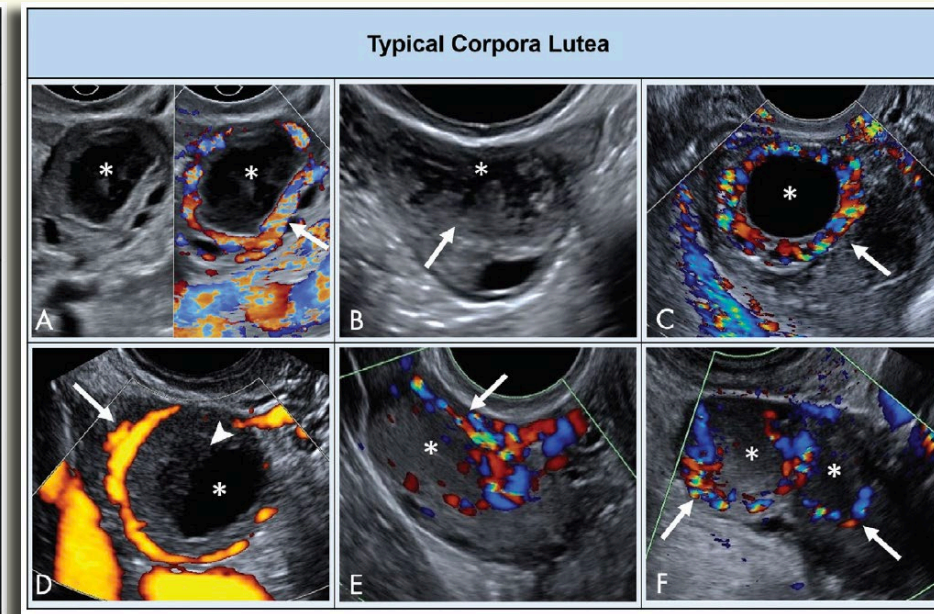
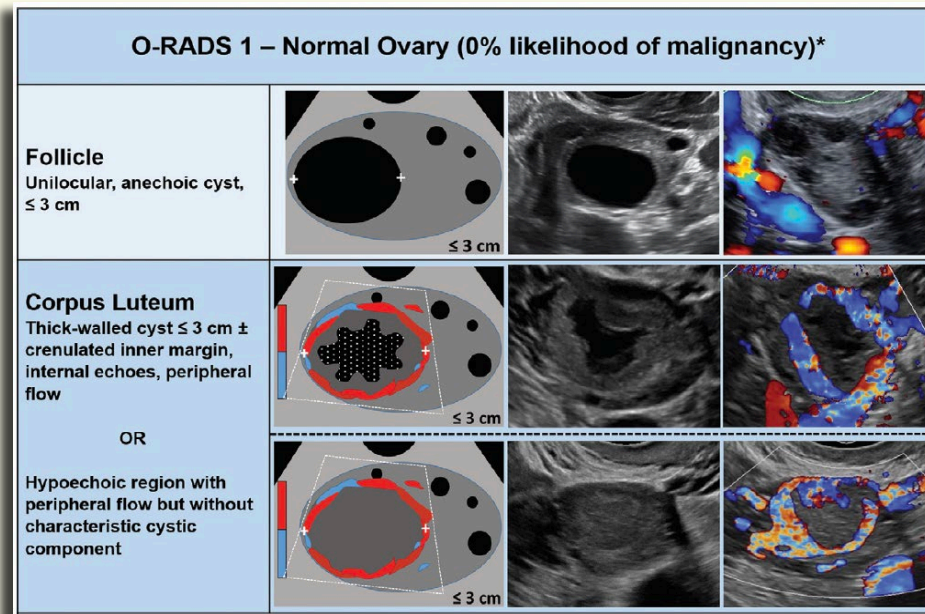
O-RADS Ultrasound Risk Stratification

- Lesion not consistent with normal physiology
 - Unilocular, multilocular, + or – solid component
- Size of adnexal mass
 - Maximum diameter in any plane
- Solid or solid-appearing
 - Smooth or not, regular or not,
 - acoustic shadowing
- Cystic lesions
 - Smooth or papillary projections, regular or not
 - anechoic or hyperechoic fluid
- General and extra-ovarian findings
 - Ascites or culdesac fluid
 - Peritoneal thickening or nodules
- **Vascularity**
 - Expressed as color score



O-RADS Ultrasound Risk Stratification

O-RADS Score	Risk Category [IOTA Model]	Lexicon Descriptors	Management	
			Pre-menopausal	Post-menopausal
0	Incomplete Evaluation [N/A]	N/A	Repeat study or alternate study	
1	Normal Ovary [N/A]	Follicle defined as a simple cyst ≤ 3 cm	None	N/A
		Corpus Luteum ≤ 3 cm		



Andreotti RF et al (2020) O-RADS US risk stratification and management system: A consensus guideline from ACR ovarian-adnexal reporting and data system committee. *Radiology* 294:168-185.

O-RADS Ultrasound Risk Stratification

O-RADS Score	Risk Category [IOTA Model]	Lexicon Descriptors		Management			
				Pre-menopausal	Post-menopausal		
2	Almost Certainly Benign [$< 1\%$]	Simple cyst	≤ 3 cm	N/A	None		
			> 3 cm to 5 cm	None	Follow up in 1 year. *		
			> 5 cm but < 10 cm	Follow up in 8 - 12 weeks			
		Classic benign descriptors - See Table 4 for separate management strategies					
		Non-simple unilocular cyst, smooth inner margin	≤ 3 cm	None	Follow up in 1 year * If concerning, US specialist or MRI		
			> 3 cm but < 10 cm	Follow-up in 8 - 12 weeks If concerning, US specialist	US specialist or MRI		
3	Low Risk Malignancy [1- $<10\%$]	Unilocular cyst ≥ 10 cm (simple or non-simple)		US specialist or MRI Management by gynecologist			
		"Typical" dermoid cysts, endometriomas, hemorrhagic cysts ≥ 10 cm					
		Unilocular cyst, any size with irregular inner wall <3 mm height					
		Multilocular cyst < 10 cm, smooth inner wall, color score < 4					
		Solid smooth, any size color score 1					

Andreotti RF et al (2020) O-RADS US risk stratification and management system: A consensus guideline from ACR ovarian-adnexal reporting and data system committee. *Radiology* 294:168-185.

O-RADS Ultrasound Risk Stratification

O-RADS Score	Risk Category [IOTA Model]	Lexicon Descriptors		Management	
				Pre-menopausal	Post-menopausal
4	Intermediate Risk [10- < 50%]	Multilocular cyst, no solid component	≥ 10 cm, smooth inner wall, color score 1-3	US specialist or MRI	Management by gynecologist with gyn-oncologist consultation or solely by gyn-oncologist
			Any size, smooth inner wall, color score 4		
			Any size, irregular inner wall and/or irregular septation, any color score		
		Unilocular cyst with solid component	Any size, no papillary projections, CS= any		
			Any size, 1-3 papillary projections, CS= any		
		Multilocular cyst with solid component	Any size, CS = 1-2		
Solid	Smooth, any size, CS = 2-3				
5	High Risk [≥ 50%]	Unilocular cyst, any size, ≥ 4 papillary projections, CS = any	Gyn-oncologist		
		Multilocular cyst, any size with solid component, CS = 3-4			
		Solid smooth, any size, CS = 4			
		Solid irregular, any size, CS = any			
		Ascites and/or peritoneal nodules**			

Andreotti RF et al (2020) O-RADS US risk stratification and management system: A consensus guideline from ACR ovarian-adnexal reporting and data system committee. *Radiology* 294:168-185.

Benign and Malignant Ovarian Masses

Histology	Number of cancers
Serous (including papillary)	14
Mucinous	10
Endometrioid	5
Clear cell	3
Other epithelial	12
Pseudomyxoma peritonei	8
Germ cell	34
Dysgerminoma	14
Malignant teratoma	12
Endodermal sinus tumor	3
Mixed germ cell tumor	3
Choriocarcinoma	2
Granulosa cell tumor	
Total	87

- 10 yr study of 4,846,505 pts
 - **9375 with ovarian mass (0.19%)**
 - 87 ovarian cancers
 - **0.93% of 9375 cysts**
 - **0.0179 per 1000 deliveries**
 - 115 LMP tumors
 - **1.22% of 9375 cysts**
 - No adverse neonatal outcomes
 - Increased C-sections
 - Longer hospital stay
 - Increased transfusions
 - Increased hysterectomy
-
- Cause-specific maternal mortality is low (4.7%)
 - Most are early stage
 - Predominance of germ cell tumors among ovarian cancers

Leiserowitz GS et al (2006) Adnexal masses in pregnancy: How often are they malignant? *Gynecologic Oncology* 101:315-321.

Summary of Ovarian Masses in Pregnancy

- Incidence of adnexal cysts in pregnancy is low (1-2%)
 - Most are functional cysts
- Ultrasound and/or MRI imaging modality of choice
- Majority resolve spontaneously (~70%)
- Persistent cysts are mostly dermoids or cystadenomas
 - Similar incidence as in non-pregnant patients
- Ovarian cancer in pregnancy is rare (< 2-3% of cysts)
 - Most common type are early stage germ cell tumors
- Can usually delay intervention until after pregnancy
 - Persistent and symptomatic, concern for torsion, suspicion for malignancy
- Approach depends on size of mass, size of uterus, surgeon skill

Soriano D et al (1999) Laparoscopy versus laparotomy in the management of adnexal masses during pregnancy. *Fertil Steril* 71:955.

Canis M et al (2002) Laparoscopic management of adnexal masses: a gold standard? *Curr Opin Obstet Gynecol* 14:423.

Bozzo M et al (1997) The management of persistent adnexal masses in pregnancy. *Am J Obstet Gynecol* 177:981.

Sherard GB et al (2003) Adnexal masses and pregnancy: a 12-year experience. *Am J Obstet Gynecol* 189:358.

Leiserowitz GS et al (2006) Adnexal masses in pregnancy: How often are they malignant? *Gynecologic Oncology* 101:315.

Zanetta G et al (2003) A prospective study of the role of ultrasound in the management of adnexal masses in pregnancy. *Br J Obstet Gynaecol* 110:578.



Laparoscopic Surgery During Pregnancy



American College of Obstetricians and Gynecologists (ACOG)
Society of American Gastrointestinal Endoscopic Surgeons (SAGES)



- Diagnostic laparoscopy is safe and effective in the workup and treatment of acute abdominal processes in pregnancy
- Laparoscopic treatment of acute abdominal disease has same indications and benefits over laparotomy in pregnant and nonpregnant patients
- Laparoscopy can be safely performed during any trimester of pregnancy; **2nd trimester optimal**
- Initial abdominal access can be safely performed with any technique by experienced surgeons if location is adjusted according to fundal height and previous incisions
- Intraoperative and postoperative pneumatic compression devices and early postoperative ambulation are recommended prophylaxis for deep venous thrombosis in the gravid patient

ACOG (2017) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 133:e285.

Pearl J et al (2019) Guidelines for diagnosis, treatment, and use of laparoscopy for surgical problems during pregnancy. *Surg Endosc* 25:3479-3492.



New England Obstetrical
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C.P Noel McCarthy Memorial Lecture
Laparoscopic Surgery in the Pregnant Patient
for Non-obstetric Indications

Laparoscopic Surgery During Pregnancy



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 - Laparoscopic treatment of acute abdominal disease has same indications and benefits over laparotomy in pregnant and nonpregnant patients
 - Laparoscopy can be safely performed during any trimester of pregnancy; 2nd trimester optimal
 - Initial abdominal access can be safely performed with any technique by experienced surgeons if location is adjusted according to fundal height and previous incisions
 - Intraoperative and postoperative pneumatic compression devices and early postoperative ambulation are recommended prophylaxis for deep venous thrombosis in the gravid patient
- Gravid patients > 1st trimester should be placed in left lateral decubitus position to minimize compression to vena cava
 - CO2 insufflation of 10–15 mmHg can be safely used; adjust to patient's physiology
 - Intraoperative CO2 monitoring should be used during laparoscopy in the pregnant patient
 - Fetal heart monitoring pre- and postoperatively with abdominal surgery during pregnancy
 - Tocolytics should not be used prophylactically but should be considered perioperatively when signs of preterm labor are present
 - Steroids should be administered prior to surgery in viable preterm pregnancies
 - Consent for c-section in addition to indicated surgical procedure

ACOG (2017) Nonobstetric surgery during pregnancy. *Obstet Gynecol* 133:e285.

Pearl J et al (2019) Guidelines for diagnosis, treatment, and use of laparoscopy for surgical problems during pregnancy. *Surg Endosc* 25:3479-3492.



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Yesterday I was
clever, so I wanted
to change the
world

Today I am **wise**,
so I am changing
myself.





Ted L. Anderson, MD, PhD, FACOG, FACS

Past President, American College of Obstetricians and Gynecologists

Betty and Lonnie S. Burnett Professor

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