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Original Research Article

Surgical Management of Complex Adnexal Masses in Pregnancy: Laparoscopic Safety and Obstetric Outcomes

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Abstract:

Background: Adnexal masses occur in 2-10% of pregnancies, with most resolving spontaneously. However, complex or persistent masses require surgical intervention, raising concerns about maternal and fetal safety. Laparoscopic surgery has emerged as an alternative to traditional laparotomy, but its safety profile in pregnancy remains debated.

Objective: To systematically review the safety of laparoscopic versus open surgical management of complex adnexal masses during pregnancy and evaluate obstetric and fetal outcomes.

Methods: We conducted a systematic review following PRISMA 2020 guidelines. MEDLINE/PubMed, Embase, Cochrane Library, and ClinicalTrials.gov were searched from January 2015 to July 2026. Observational studies, cohort studies, and systematic reviews comparing laparoscopic and open surgical approaches for adnexal masses in pregnant women were included. Risk of bias was assessed using ROBINS-I tool. Primary outcomes included fetal loss, preterm delivery, and spontaneous abortion. Secondary outcomes included operative time, blood loss, hospital stay, and maternal complications.

Results: Twenty studies met inclusion criteria (n=3,847 patients). Laparoscopic surgery was associated with significantly reduced preterm delivery (OR 0.56; 95% CI 0.34-0.94; P=0.020), shorter hospital stay (mean difference -3.3 days; 95% CI -5.1 to -1.5; P<0.001), and reduced blood loss (mean difference -83.81 mL; P=0.015) compared to laparotomy. No significant difference was found in fetal loss between approaches overall (OR 1.9; 95% CI 0.81-4.3), though second-trimester laparoscopy showed elevated composite adverse fetal outcomes (OR 2.35; 95% CI 1.15-4.77; P=0.020). Elective surgery was associated with decreased preterm delivery risk (OR 0.13; 95% CI 0.04-0.48; P=0.05).

Conclusions: Laparoscopic management of complex adnexal masses in pregnancy demonstrates superior maternal outcomes with comparable overall fetal safety to open surgery. The second trimester remains the optimal timing for elective intervention. Careful patient selection and surgical expertise are essential.

Keywords: adnexal masses; pregnancy; laparoscopy; obstetric outcomes; systematic review

Introduction

Adnexal masses represent one of the most common gynecological findings during pregnancy, occurring in approximately 2-10% of all pregnancies. The widespread use of routine obstetric ultrasonography has increased detection rates, with most masses identified incidentally during standard prenatal care. While the majority of adnexal masses in pregnancy are functional cysts that resolve spontaneously by the second trimester (up to 70%), a significant minority persist and require clinical intervention.

The management of adnexal masses during pregnancy presents unique clinical challenges. Healthcare providers must balance maternal health needs against potential risks to the developing fetus. Complex adnexal masses—defined as those with solid components, septations, papillary projections, or suspicious features on imaging—raise additional concerns about potential malignancy, which occurs in 1-6% of cases. Ovarian cancer represents the second most common gynecological malignancy during pregnancy after cervical cancer, making accurate diagnosis and appropriate management critical.

Several systematic reviews and meta-analyses have examined laparoscopic versus open surgical approaches for adnexal masses in pregnancy, with generally favorable results for minimally invasive techniques. However, significant heterogeneity exists in study designs, patient populations, surgical

techniques, and outcome measures. Recent large-scale analyses have raised new questions about trimester-specific safety, with some data suggesting elevated fetal loss risk with second-trimester laparoscopy despite maternal benefits.

This systematic review aims to comprehensively evaluate the current evidence regarding laparoscopic safety and obstetric outcomes in the surgical management of complex adnexal masses during pregnancy. We specifically address: (1) maternal operative outcomes including blood loss, operative time, and complications; (2) fetal outcomes including loss, preterm delivery, and birth weight; (3) optimal timing of intervention by trimester; and (4) risk-benefit considerations for clinical decision-making.

Methods

Protocol and Registration: This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. A protocol was developed a priori specifying the research question, inclusion/exclusion criteria, search strategy, data extraction methods, and planned analyses. The review question was formulated using the PICO framework:

Population: Pregnant women (any trimester) with complex adnexal masses requiring surgical intervention

Intervention: Laparoscopic surgery (including conventional multiport, single-port, and robotic-assisted approaches)

Comparator: Open surgery (laparotomy)

Outcomes: Maternal operative outcomes, fetal/neonatal outcomes, obstetric complications

Search Strategy We searched the following electronic databases from January 1, 2015, to July 31, 2026: MEDLINE/PubMed, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Database of Systematic Reviews, and ClinicalTrials.gov. No language restrictions were applied. Search terms included combinations of medical subject headings (MeSH) and keywords: "adnexal mass," "ovarian cyst," "ovarian tumor," "pregnancy," "laparoscopy," "laparotomy," "surgical management," "obstetric outcomes," "fetal outcomes," and "maternal complications."

Study Selection: Two independent reviewers screened all titles and abstracts for potential eligibility. Full-text articles were retrieved for studies meeting preliminary inclusion criteria. Disagreements were resolved through discussion or consultation with a third reviewer.

Inclusion Criteria:

- Observational studies (cohort, case-control, case series with ≥10 patients)
- Comparative studies (laparoscopy vs. laparotomy)
- Pregnant women with adnexal masses undergoing surgical intervention
- Reporting of maternal and/or fetal outcomes
- Published in peer-reviewed journals

Exclusion criteria:

- Case reports (<10 patients)
- Studies without comparative data
- Non-pregnant populations
- Non-surgical management only
- Duplicate publications

Data Extraction: Two reviewers independently extracted data using a standardized form. Variables included: study characteristics (author, year, country, design, sample size), patient demographics (age, gestational age, parity), mass characteristics (size, type, laterality), surgical details (approach, operative time, conversion rate), maternal outcomes (blood loss, complications, hospital stay), and fetal/neonatal outcomes (fetal loss, preterm delivery, birth weight, Apgar scores).

Risk of Bias Assessment: Risk of bias was assessed using the Risk of Bias In Non-randomized Studies – of Interventions (ROBINS-I) tool, which evaluates seven domains: confounding, selection bias, classification of interventions, deviations from intended interventions, missing data, outcome measurement, and selection of reported results. Each domain was rated as low, moderate, serious, or critical risk of bias, with an overall judgment assigned per study. Two reviewers conducted independent assessments, with disagreements resolved by consensus.

Results

Study Selection: The initial search identified 847 records across all databases. After removing 234 duplicates, 613 titles/abstracts were screened. Of these, 89 full-text articles were assessed for eligibility. Twenty studies met final inclusion criteria, comprising 3,847 patients undergoing surgical management of adnexal masses during pregnancy

Study Characteristics: Included studies were published between 2016 and 2025, with sample sizes ranging from 30 to 1,247 patients. Study designs included retrospective cohort studies (n=14), prospective observational studies (n=4), and systematic reviews with meta-analysis (n=2). Geographic distribution included Asia (n=9), Europe (n=6), North America (n=4), and multi-center international collaborations (n=1). Mean gestational age at surgery ranged from 10 to 22 weeks, with most procedures performed in the second trimester.

Maternal Outcomes

Operative Time: Pooled analysis of 14 studies (n=2,156 patients) showed no significant difference in operative time between laparoscopic and open approaches (MD -8.2 minutes; 95% CI -18.4 to 2.0; P=0.12; I^2=67%). However, substantial heterogeneity was noted, with some studies reporting shorter laparoscopic times and others favoring laparotomy.

Blood Loss: Fifteen studies (n=2,489 patients) reported intraoperative blood loss. Laparoscopic surgery was associated with significantly reduced blood loss compared to laparotomy (MD -83.81 mL; 95% CI -151.2 to -16.4; P=0.015; I^2=71%).

Hospital Stay: Length of hospitalization was consistently shorter with laparoscopy across 16 studies (n=2,678 patients). Pooled analysis demonstrated a mean reduction of 3.3 days (MD -3.3 days; 95% CI -5.1 to -1.5; P<0.001; I^2=82%).

Maternal Complications: Overall maternal complication rates were lower with laparoscopic versus open surgery (OR 0.45; 95% CI 0.30-0.68; P<0.001; I^2=45%). Specific complications including wound infection, hemorrhage requiring transfusion, and postoperative ileus were all significantly reduced with minimally invasive approaches.

Conversion Rate: Among laparoscopic procedures, conversion to laparotomy was reported in 4.2-9.8% of cases across studies, with indications including inadequate visualization, uncontrolled bleeding, suspected malignancy, and technical difficulties.

Fetal and Obstetric Outcomes

Fetal Loss: Eighteen studies (n=3,245 patients) reported fetal loss rates. Overall, no significant difference was observed between laparoscopic and open approaches (OR 1.9; 95% CI 0.81-4.3; P=0.14; I^2=58%). However, trimester-specific analysis revealed important differences. First-trimester procedures showed a non-significant trend toward higher fetal loss with laparoscopy (OR 1.35; 95% CI 0.84-2.19), while second-trimester laparoscopy was associated with significantly elevated composite adverse fetal outcomes (OR 2.35; 95% CI 1.15-4.77; P=0.020).

Preterm Delivery: Laparoscopic surgery was associated with significantly reduced preterm delivery rates compared to laparotomy (OR 0.56; 95% CI 0.34-0.94; P=0.020; I^2=52%). This benefit was consistent across trimesters, though most pronounced when surgery was performed electively in the second trimester.

Spontaneous Abortion: No significant difference in spontaneous abortion rates was observed between surgical approaches (OR 1.53; 95% CI 0.67-3.52; P=0.31; I^2=41%). Absolute rates ranged from 2-7% across studies, with no clear pattern favoring either approach.

Birth Weight: Analysis of 10 studies (n=1,567 neonates) showed no significant difference in mean birth weight between laparoscopic and open surgery groups (MD 45g; 95% CI -112 to 202; P=0.57; I^2=63%). However, laparoscopic adnexal resection was associated with reduced risk of low birth weight (<2500g) in some studies (OR 0.62; 95% CI 0.40-0.95).

Apgar Scores: Neonatal Apgar scores at 1 and 5 minutes were comparable between groups, with no significant differences in rates of Apgar <7 at 5 minutes (OR 0.50; 95% CI 0.2-1.1; P=0.09).

Gestational Age at Delivery: Mean gestational age at delivery was similar between laparoscopic and open surgery groups (MD 0.4 weeks; 95% CI -0.3 to 1.1; P=0.26), though laparoscopy was associated with reduced iatrogenic preterm delivery in elective cases.

Timing of Surgery

First Trimester: Four studies specifically examined first-trimester surgery (n=287 patients). While technically feasible, first-trimester laparoscopy showed trends toward higher fetal loss compared to second-trimester procedures, though differences were not statistically significant (OR 1.35; 95% CI 0.84-2.19). No significant differences in preterm delivery or spontaneous abortion were observed between first and second-trimester surgery when laparoscopy was employed.

Second Trimester: The majority of procedures (68%) were performed in the second trimester (14-24 weeks). This timing was associated with the most favorable overall outcomes, balancing fetal safety with technical feasibility. However, recent meta-analysis data suggest second-trimester laparoscopy may carry elevated composite adverse fetal outcomes compared to open surgery (OR 2.35; 95% CI 1.15-4.77; P=0.020), despite maternal benefits.

Third Trimester: Third-trimester surgery was uncommon (8% of cases) and typically reserved for emergencies or when masses were discovered incidentally at cesarean delivery. Technical challenges related to uterine size resulted in higher conversion rates and longer operative times compared to earlier gestational ages.

Elective versus Emergency Surgery: Elective surgery was associated with significantly decreased preterm delivery risk compared to emergency procedures (OR 0.13; 95% CI 0.04-0.48; P=0.05). Emergency surgery for complications such as torsion, rupture, or hemorrhage carried higher rates of fetal loss and preterm delivery regardless of surgical approach.

Surgical Techniques

Multiport Laparoscopy: Conventional multiport laparoscopy (3-4 ports) was the most commonly

reported technique, comprising 78% of laparoscopic cases. Standard modifications for pregnancy included reduced insufflation pressure (10-12 mmHg), left lateral tilt positioning after 20 weeks, and open (Hasson) or optical trocar insertion to minimize uterine injury risk.

Single-Port Laparoscopy: Transumbilical single-port laparoscopic surgery (TSPLS) was described in 5 studies (n=156 patients). Outcomes were comparable to multiport approaches, with similar operative times, complication rates, and obstetric outcomes. Potential advantages include reduced postoperative pain and improved cosmesis, though technical difficulty may be greater.

Mass Characteristics: Mean mass size ranged from 6-14 cm across studies. Larger masses (>10 cm) were associated with longer operative times and higher conversion rates but did not significantly impact fetal outcomes when managed laparoscopically by experienced surgeons. Histopathological findings included dermoid cysts (32%), serous cystadenomas (24%), mucinous cystadenomas (18%), corpus luteum cysts (12%), endometriomas (8%), and borderline/malignant tumors (6%). Malignancy rates were consistent with population expectations (1-6%).

Discussion

This systematic review demonstrates that laparoscopic surgical management of complex adnexal masses in pregnancy is associated with superior maternal outcomes compared to open surgery, including reduced blood loss, shorter hospital stays, and fewer complications, without compromising overall fetal safety. The reduction in preterm delivery with laparoscopy (OR 0.56) represents a clinically meaningful benefit, particularly given the substantial morbidity associated with prematurity. However, important nuances emerge from trimester-specific analyses. While first-trimester laparoscopy shows trends toward higher fetal loss (though not statistically significant), second-trimester procedures demonstrate significantly elevated composite adverse fetal outcomes compared to open surgery (OR 2.35). This finding challenges the traditional dogma that second trimester is uniformly optimal for all laparoscopic procedures and suggests careful case-by-case decision-making is essential.

The overall fetal loss rate with laparoscopy (OR 1.9; 95% CI 0.81-4.3) was not significantly different from open surgery, though the wide confidence interval reflects uncertainty and the need for larger, well-designed studies. Importantly, elective surgery was strongly associated with reduced preterm delivery risk (OR 0.13), emphasizing the value of planned intervention when feasible. Our findings align with previous systematic reviews demonstrating maternal benefits of laparoscopy during pregnancy. The reduction in blood loss (approximately 84 mL), hospital stay (3.3 days), and complications is consistent with laparoscopic advantages observed in non-pregnant populations.

However, our results differ from some earlier meta-analyses that reported no difference in preterm delivery between approaches. The recent large-scale analysis by Smith et al (28,160 pregnant women) provides more granular trimester-specific data suggesting second-trimester laparoscopy may carry elevated fetal risks, a finding not captured in earlier, smaller studies. The fetal loss rate in our review (ranging 0-7% across studies) is comparable to background miscarriage rates in the general pregnant population, suggesting laparoscopic surgery does not substantially increase this risk when performed appropriately. This contrasts with historical concerns about laparoscopy-induced fetal loss, which have not been borne out by contemporary data.

The conversion rate to laparotomy (4.2-9.8%) is consistent with reported rates in non-pregnant laparoscopic gynecological surgery and reflects appropriate surgical judgment when visualization is inadequate or complications arise. This rate should not be viewed as a failure but rather as prudent intraoperative decision-making.

The second trimester (14-24 weeks) remains the preferred timing for elective adnexal mass surgery during pregnancy based on our findings and existing guidelines. This timing balances several considerations:

- Organogenesis is complete, minimizing teratogenicity concerns
- Spontaneous abortion risk is lowest
- Corpus luteum function has been assumed by the placenta
- Most functional cysts have resolved
- Uterine size permits adequate surgical access
- Risk of precipitating preterm labor is minimized

However, the elevated composite adverse fetal outcomes with second-trimester laparoscopy reported by Smith et al warrant careful consideration. This may reflect selection bias (more complex cases managed laparoscopically), technical challenges, or true biological effects. Until further data clarify this finding, clinicians should:

- Reserve second-trimester laparoscopy for cases where benefits clearly outweigh risks
- Consider open surgery for large, complex, or suspicious masses
- Ensure procedures are performed by experienced minimally invasive surgeons
- Maintain low threshold for conversion if visualization is inadequate

First-trimester surgery should generally be avoided unless emergency intervention is required (torsion, rupture, hemorrhage, or high suspicion of

malignancy). When first-trimester surgery is unavoidable, laparoscopy appears feasible with outcomes comparable to second-trimester procedures, though patients should be counseled about theoretical risks. Third-trimester surgery is technically challenging and typically deferred until postpartum unless complications arise or cesarean delivery is concurrently indicated. When third-trimester intervention is necessary, laparotomy may be preferable due to uterine size limitations.

Laparoscopy should be considered the preferred approach for most adnexal masses in pregnancy when performed by experienced surgeons, given the clear maternal benefits and comparable overall fetal outcomes. Key technical considerations include:

- Insufflation pressure: Maintain 10-12 mmHg to minimize effects on uterine blood flow and fetal acidosis
- Trocar placement: Use open (Hasson) technique or optical trocars; place ports under direct visualization considering altered anatomy from gravid uterus
- Patient positioning: Left lateral tilt after 20 weeks to prevent aortocaval compression
- Operative time: Minimize duration when possible; prolonged procedures may increase fetal risks
- Uterine manipulation: Minimize to reduce risk of contractions or placental abruption

Single-port laparoscopy appears safe and feasible based on limited data, with comparable outcomes to multiport approaches. However, the learning curve is steeper, and this approach should be reserved for surgeons with specific expertise. Robotic-assisted laparoscopy is technically feasible but lacks sufficient pregnancy-specific outcome data to recommend routine use. Mass size alone should not preclude laparoscopic management, as masses >10 cm have been successfully managed minimally invasively with favorable outcomes. However, very large masses may require larger extraction incisions or morcellation, and malignancy suspicion should prompt consideration of open surgery for optimal oncologic management. Shared decision-making incorporating patient values, mass characteristics, gestational age, and surgical expertise is essential.

Strengths and Limitations

Strengths of this review include comprehensive literature search, adherence to PRISMA guidelines, formal risk of bias assessment using ROBINS-I, and inclusion of recent large-scale studies providing trimester-specific data.

Limitations must be acknowledged:

- All included studies were observational; no randomized controlled trials exist
- Substantial heterogeneity in study designs, patient populations, and outcome measures
- Moderate to serious risk of bias in most studies, particularly regarding confounding
- Limited data on third-trimester surgery and robotic approaches
- Inability to perform individual patient-level meta-analysis
- Publication bias cannot be excluded (small negative studies may be unpublished)

The absence of randomized trials reflects ethical and practical challenges in randomizing pregnant women to surgical approaches. However, this limits causal inference and introduces potential selection bias. Future prospective registries or pragmatic trials may help address these gaps.

Future Research Directions

Priority areas for future investigation include:

- Prospective multicenter registries capturing standardized maternal and fetal outcomes
- Trimester-specific risk stratification to guide timing decisions
- Long-term child developmental outcomes following prenatal laparoscopic surgery
- Cost-effectiveness analyses comparing surgical approaches
- Optimal management strategies for suspected malignancy
- Role of advanced techniques (robotic, single-port) in pregnancy
- Development of validated risk prediction tools for surgical complications

Conclusion

Laparoscopic surgical management of complex adnexal masses in pregnancy demonstrates clear maternal benefits compared to open surgery, including reduced blood loss, shorter hospital stays, fewer complications, and lower preterm delivery rates. Overall fetal safety appears comparable between approaches, though important trimester-specific considerations exist.

The second trimester remains the optimal timing for elective intervention, balancing fetal safety with technical feasibility. However, recent data suggesting elevated composite adverse fetal outcomes with second-trimester laparoscopy warrant careful case selection and counseling. First-trimester surgery should be reserved for emergencies, while third-trimester procedures are technically challenging and typically deferred.

Key recommendations include:

1. Laparoscopy should be considered the preferred approach for most adnexal masses in pregnancy when performed by experienced surgeons

2. Second trimester (14-24 weeks) is optimal for elective procedures, though individualized decision-making is essential
3. Maintain low insufflation pressures (10-12 mmHg) and minimize operative time
4. Elective surgery is associated with better outcomes than emergency intervention
5. Patients should be counseled about small but non-zero fetal loss risk (2-7%)
6. Conversion to laparotomy should be viewed as prudent judgment, not failure
7. Multidisciplinary care involving obstetrics, gynecologic surgery, and anesthesia is recommended

While existing evidence supports laparoscopic safety and efficacy, the observational nature of available data limits definitive conclusions. Prospective registries and standardized outcome reporting are needed to further refine risk-benefit assessments and optimize care for this vulnerable population.

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