Green-top Guideline No.

Laparoscopy in Pregnancy

RCOG/BSGE Joint Guideline
BSGE GUIDELINE Laparoscopy in Pregnancy

This guideline is endorsed by XXX

The scope of this guideline is the laparoscopic management of non-obstetric, abdominal conditions in pregnancy.

This is the first edition of this guideline.

1. Purpose and scope

Laparoscopy is widely utilised to diagnose and treat, acute and chronic, gynaecological and general surgical conditions. It has only been in recent years that laparoscopy has become an acceptable surgical alternative to open surgery in pregnancy. To date there is little clinical guidance pertaining to laparoscopic surgery in pregnancy.

The intended audience for this guideline is obstetricians and gynaecologists in secondary and tertiary care, general surgeons and anaesthetists. However, only surgeons who have specialist laparoscopic skills and who perform complex laparoscopic surgery regularly should undertake laparoscopy in pregnant women.

2. Identification and assessment of evidence

This guideline was developed in accordance with standard methodology for producing RCOG Green-top Guidelines. MEDLINE, EMBASE, CINAHL and the Cochrane library were searched for relevant articles. The searches covered the fifteen years preceding February 2015. An update search ensured relevant papers were included up to February 2017. No other restrictions were placed on the searches. The databases were searched using the relevant MeSH terms and keywords. The main search terms were: laparoscopy and pregnancy, these were used with combinations of the following words and appropriate synonyms, depending upon the area of laparoscopy in pregnancy being examined; anaesthesia, appendicectomy, cholecystectomy, ovarian cysts, performance and safety of imaging.

Literature searches were performed in MEDLINE (from 1950 to September 2015), EMBASE (from 1980 to September 2015), CINAHL (from 1981 to September 2015) and the Cochrane library. No restrictions were placed on the searches in an attempt to reduce selection bias.

The results of the searches were systematically reviewed to identify relevant articles. The reference lists of selected papers were then searched to identify any additional articles not captured by the literature search. When a study, which was relevant to one of the other topic areas, was identified in a search, we cross-referenced to ensure that it had been identified in the relevant search. Studies were included if they addressed the diagnosis and / or management of acute surgical conditions, such as acute appendicitis, acute cholecystitis and symptomatic benign adnexal tumours in pregnancy. Overt ovarian malignancy,
ectopic and heterotopic pregnancy were excluded (guidance regarding these conditions can be found in the RCOG Green-op Guideline No. 62 2011(1) and the NICE guideline CG154(2) respectively.

Where possible, recommendations are based on available evidence and the areas where evidence is lacking are annotated as 'good practice points'. Further information about the assessment of evidence and the grading of recommendations may be found in Appendix I.

3. Introduction and background epidemiology

What is the incidence of acute abdominal conditions in pregnancy, which are potentially suitable for laparoscopic management?

Clinicians should be aware that the incidence of acute, non-obstetric abdominal surgical emergencies in pregnancy is low.

Clinicians should be aware of the possibility of appendicitis in pregnancy, but its incidence is lower than in the non-pregnant state.

Clinicians should be aware that the risk of gallbladder disease appears to be reduced in pregnancy despite hormonal changes increasing the ultrasound scan findings of gallstones and sludge.

The absolute numbers of torted and haemorrhagic ovarian cysts are low in pregnancy, but fertility treatment with GnRH analogues appears to present a risk factor but the magnitude of risk is difficult to quantify.

Non-obstetric abdominal surgery during pregnancy is rare and occurs in 1–2/1000 pregnancies (Silvestri 2011, Balinskaite 2016).

Two large cohort studies from the USA reported the incidence of appendicitis to be less than 1 in 1000 pregnancies (Abbasi, 2014 USA, n= 7,037,386 pregnancies, incidence of (0.1%), Mourad 2000 USA, n= 66, 993 pregnancies (0.1%); A Korean health registry study (Yuk 2013) showed a reduced incidence of appendicitis in pregnancy compared to the non-pregnant state (OR, 0.376; 95% CI, 0.31- 0.46, p <0.001).

The search identified one large series of 46,075 pregnant women (Swisher 1994) that reported the incidence of biliary disease in pregnancy to be 0.16%, compared to 10 -15%, in the general population with a female-to-male ratio of 4:1 (Schirmer 2005), despite the predilection for sludge and stone formation in pregnancy.

The reported incidence of ovarian cysts in pregnancy varies between studies, depending upon the study population, the inclusion criteria and the size of ovarian cysts. If the cut off of >3cm is used the incidence in pregnancy is 1.2% (Zanetta 2003), if the cut off of >5 cm is used the incidence in pregnancy is 0.05% (Katz (2010) and Duic (2002). In non-pregnant women of reproductive age the incidence is 1.8% if the cut off of >4 cm is used. (Borgfeldt Ultrasound Obstet Gynecol. 1999 May;13(5):345-50) (Borgfieldt 1999)
Ovarian torsion in pregnancy is rare in absolute terms. In Duic’s series, torsion, sub-acute torsion or haemorrhage necessitating a surgical intervention occurred in 1:4000 pregnancies. Katz reported a torsion rate of 1:70000, with hospital admissions for pain required in 16% of women with cysts. The incidence of ovarian torsion in non-pregnant women is not known.

An association with ovarian stimulation for fertility treatment was observed in a retrospective review of 180 consecutive patients of childbearing age over an 11-year period with surgically confirmed adnexal torsion; 48 patients were pregnant (Median gestation 7 weeks), of those 39 women had received fertility treatment and nine had not. The relationship between ovarian enlargement and fertility treatment was not investigated (Tsafir 2012) Z Eur J Obstet Gynecol Reprod Biol. 2012;162(2):203

4. Ovarian cyst accidents, appendicitis and cholecystitis causing complications specific to pregnancy

What is the incidence of acute abdominal conditions in pregnancy, which are potentially suitable for laparoscopic management?

Clinicians should be aware that without appropriate surgical treatment appendicitis and cholecystitis carry specific risks in pregnancy including generalised peritonitis and maternal sepsis resulting in miscarriage, prematurity and stillbirth.

When comparing pregnant to non-pregnant women a large retrospective cohort study showed a higher rate of pre-operative systemic infection (POS) and systemic inflammatory response syndrome (SIRS) in pregnant women.(3) For appendicitis the incidence of POS was 39.7% versus 33.6% (p<0.001) and for SIRS it was 35.7% versus 32.2% (p=0.001). For cholecystitis the incidence was 11.9% versus 5.2% (p=0.001) for POS and 11.2% versus 4.8% (p=0.0010 for SIRS. The authors suggested that compounding factors might include suppressed maternal immunity in pregnancy, difficulty making the diagnosis and reluctance to operate. There was a higher rate of fetal loss and early delivery when appendicitis was complicated by generalised peritonitis or peritoneal abscess (p < 0.05), (6% fetal loss and 11% early delivery in complex appendicitis versus 2% fetal loss and 4% early delivery in simple appendicitis.(15)

No studies were identified that compared the incidence of ovarian cyst complications in pregnant and in non-pregnant women in our search. For instance, there are no data on whether cyst accidents lead to more severe peritonitis or haemorrhage when a woman is pregnant. The risk of torsion appears to decrease with increasing gestation in a retrospective series of 107 fertility patients.(10) After one episode of torsion the recurrence risk of repeat torsion was 19.5% in pregnant women and 9.1% in non-pregnant women in a retrospective case control study (n=118). (16)

Cyst complications that are specific to pregnancy include, fetal loss and premature delivery as well as complications related to cysts that only occur in pregnancy, such as corpus luteal cysts (Evidence level 2-).

5. Safety of Laparoscopy

Is laparoscopy in pregnancy safe for mother and fetus?

In comparison with open surgery laparoscopy for adnexal and gallbladder disease has no increased risk to open surgery for mother and fetus where the appropriate surgical equipment
and expertise is available and in these circumstances it should be considered an appropriate surgical approach.

Clinicians should be aware that there is no additional risk of fetal malformation or stillbirth in women who underwent non obstetric surgery compared with non-surgical pregnant patients.

Laparoscopy is associated with equal or better maternal and similar fetal outcomes in the context of gallbladder and adnexal surgery compared to conventional open approaches.

Controversy exists regarding the association between laparoscopic appendicectomy and early miscarriage. Further research should gather evidence to establish any causal relationship.

Only experienced laparoscopists should carry out these procedures and outcomes should be carefully monitored.

The decision between laparoscopic and open routes of surgery should be based upon the available expertise, infrastructure, patient factors, gestation and patient preference.

Previously pregnancy was thought to be a contraindication for laparoscopy, but now there are numerous publications, showing acceptable maternal and fetal outcomes. Most evidence is based on case series and systematic reviews of those.

Compared with laparotomy, laparoscopic surgery for ovarian cysts in pregnancy was associated with better maternal outcomes, and no increase in adverse obstetric outcomes (miscarriage, preterm delivery or fetal growth restriction) in a systematic review of 240 patients (17) (See ovarian cyst section).

Two systematic reviews of non-RCT studies of laparoscopy for gallbladder disease reported good maternal and fetal safety. Adverse fetal outcomes (OR 0.42 CI 0.28-0.63 p<0.001), maternal complications (OR 0.42 CI 0.33-0.53 p<0.001), or intraoperative immediate post-operative surgery related complications (0.45 CI 0.25-0.82 p=0.01) were all less frequent in laparoscopy than in laparotomy. (18) In a non-comparative systematic review, Nasioudis reported the rate of fetal loss as 0.4%. Intraoperative maternal complications were 3.86% and postoperative maternal complications were 4%, of which fewer than 1/3 in each section could be classed as severe (19) (see specific section).

A systematic review of suspected appendicitis in pregnancy identified 11 non-randomised comparative studies of open (n=2816) and laparoscopic (n=599) treatment. (20) Fetal loss was significantly increased in the laparoscopy group (RR 1.91, CI 1.31-2.77).

However, the increased report of fetal loss was caused by a single large study. (15) No adverse fetal outcomes associated with laparoscopy were reported by the remaining smaller ten studies. No adverse fetal outcomes associated with laparoscopy were reported by the remaining smaller ten studies. No adverse fetal outcomes associated with laparoscopy were reported by the remaining smaller ten studies. McGory et al. studied retrospective administrative hospital records of pregnant (n=3133) and non-pregnant women (n=91656) who underwent open (n=73269) or laparoscopic appendicectomy (n= 24,214). (15) Gestational ages at surgery and at the time of fetal loss were not reported. Fetal loss was identified by diagnosis codes for miscarriage, dilatation and curettage or intrauterine death. Laparoscopy was
associated with a higher rate of fetal loss (7%) compared with open appendicectomy (3% OR 2.31, CI 1.51-3.55) but early delivery was less common in laparoscopic appendicectomy (<1%) compared to open (8% p, <0.5).

In this study, it was not possible to make a causal link between laparoscopic appendicectomy and fetal loss. It has to be taken into account that the laparoscopic approach is the preferred approach in the first trimester, when spontaneous fetal loss occurs most frequently and the association could be spurious.

When comparing laparoscopic to open appendectomy, Balinskaite et al. in a retrospective review of routinely collected hospital data in the UK reported higher incidence of spontaneous miscarriage (OR 2.36 (CI 1.71 – 3.26). There were no increase in the other primary outcomes such as delivery by caesarean section, preterm delivery < 37 weeks gestation, low birth weight of <2500g, stillbirth, long inpatient stay and maternal death. They analysed data of the 6,486,280 pregnant women of whom 47,628 (0.7%) underwent non-obstetric surgery, 26% underwent abdominal surgery, including 3061 appendicectomy. They reported that in the first trimester laparoscopic procedures were nearly 5 times more common than open surgery. Conversely, in the third trimester open procedures were 2.5 times more common than laparoscopic surgery. The authors stated that cause and effect could not be established and that the higher risk of miscarriage could be related to the preference of laparoscopic approach in the first trimester, when there is a higher chance of miscarriage.

Mazze reviewed Swedish birth registries over a period of nine years, and investigated the risk of adverse fetal outcomes, after non-obstetric surgery in pregnancy. A total of 5405 operations (25% open abdominal - mainly appendicectomy, 19% gynaecological/urological and 16% laparoscopic) were reviewed. Out of 868 women who had laparoscopic surgery, 768 had surgery in the first, 29 second and 71 in the third trimester respectively. No direct comparison was made between open and laparoscopic approach. Mazze concluded there was no additional risk of fetal malformation or stillbirth when compared with expected rates in non-surgical pregnant patients. However, there was an increase in the risk of fetal growth restriction (FGR) (<1500grams risk ratio 2.2, 95% CI 1.8-2.8; <2500 grams risk ratio 2.0, 95% CI 1.8-2.2); preterm birth <37/40 weeks (rate 7.5% vs. 5.1% p=0.001) and neonatal death at 168 hours (risk ratio 2.1 CI 1.6-2.7) when compared with expected rates in non-surgical patients. Neonatal deaths were associated with prematurity, but preterm births did not occur from delivery immediately after the operation but with an average delay of 21, 7 and 5 weeks in the first, second, and third trimester respectively. The relationship between the condition necessitating surgery in pregnancy and adverse outcomes of pregnancy was not investigated and could be a confounding factor.

Reedy et al looked at 20-year period of health registry data (a proportion also included in Mazze) and compared open (n=1522) to laparoscopic (n=2181) surgery in pregnancy at gestations between four weeks and twenty weeks. When these women who had undergone surgery, either open or laparoscopic, were compared to the normal pregnant population they had no increased risk of fetal malformations (open surgery vs. total studied population risk ratio 1.08, 95% CI 0.85-1.11; laparoscopic surgery vs. total studied population risk ratio 1.09, 95% CI 0.9-1.11).

No developmental or physical abnormalities were seen in children born to mothers who had laparoscopic surgery between 16 and 28 weeks gestation (including cholecystectomy, appendicectomy and surgery for small bowel obstruction). The follow up ranged from 1 to 8 years.
What are the maternal benefits to laparoscopic compared to open surgery?

Clinicians should be aware that laparoscopic surgery is associated with faster recovery, shorter hospital stay and a trend to lower rate of wound infection for pregnant women

Cox et al, using the US National Surgical Quality Improvement Program (NSQIP) which included 1999 pregnant women undergoing laparoscopic or open cholecystectomies or appendectomies in non-perforated appendicitis, reported shorter operation time (p<0.0001), shorter hospital stay (2.3+ 5.8 versus 3.3 + 2.5, p<0.01), and fewer postoperative wound complications (0.67% versus 3.9%, p<0.01) for laparoscopic surgery.(24)

There were fewer postoperative wound complications (0.67% versus 3.9% p<0.01), shorter hospital stay (2.3 + 5.8 versus 3.3 + 2.5 p<0.01) and shorter operation times (p<0.0001) with the laparoscopic approach as reported by Cox (2016. In a retrospective review of 2000 cases of open and laparoscopic appendicectomies in pregnancy from the NSQIP database (Evidence 2+), laparoscopy was associated with fewer wound infections (p=0.04), return to theatre, other infections, respiratory morbidity, VTE, and blood transfusion (p=0.048), whilst open cases had more pre-operative systemic infections.(25)

Wilasrusmee et al conducted a meta-analysis of 11 non-RCT studies of pregnant women undergoing surgery for appendicectomy (n= 599 laparoscopic, n= 2816 open).(20) Only three studies reported wound infection, which was not significantly reduced in laparoscopy (RR of 0.91, 95% CI 0.12 to 7.18). Hospital stay was shorter by half a day (95% CI −1.76 to −0.78 days) with the laparoscopic approach.

Since the publication of Wilasrusmee two comparative care series have been published. Laustsen et al reported a small-scale comparison between 19 laparoscopic and 25 open appendectomies and reported fewer complications including wound infection; abscess, haematoma (5.3% versus 36% p=0.03) and shorter hospital stay (2.6 versus 5.5 days, p = 0.004) with the laparoscopic approach.(26)

Segev et al compared 50 laparoscopic with 42 open appendicectomy cases in pregnancy.(27) Two per cent of the open cases were conversions from laparoscopy. The laparoscopy group had a lower median gestational age at surgery (16 weeks versus 24 weeks, P < .001), a shorter median hospital stay (5 days versus 3 days, P < .001), and a lower rate of postoperative complications (8% versus 24%, p = 0.04), with no difference in gestational age at delivery, Apgar scores, and rates of preterm delivery or fetal loss.

6. Anaesthesia

No studies were identified which examined the maternal risks of anaesthesia for women undergoing laparoscopic surgery in pregnancy. Recommendations regarding the maternal anaesthetic risks for non-obstetric laparoscopic surgery in pregnancy have been extrapolated from both non-pregnant patients having laparoscopy, and the delivery of anaesthesia in the pregnant population.

What are the maternal anaesthetic risks of laparoscopy in pregnancy and how can these specific risks be safely managed?

The pre-operative anaesthetic review should include an assessment of patient's medical history and co-morbidities.

A thorough assessment and early strategy for airway management should be made. Provision of pre-medication for aspiration prophylaxis should be considered.
If the patient is haemodynamically unstable, they should receive timely pre-operative resuscitation.

Care and vigilance should be undertaken to detect and avoid endobronchial intubation.

The creation of maternal pneumoperitoneum and alterations in maternal positioning should be a gradual process.

Pregnant patients undergoing non-obstetric surgery are at an added risk for venous thromboembolism. Their risk for venous thromboembolism should be stratified and prophylaxis considered as per the Royal College of Obstetricians and Gynaecologists Green top Guidance.

The pre-operative anaesthetic review should include an assessment of the patient’s presenting complaint and past medical, surgical and anaesthetic history.

A thorough assessment of the patient’s airway is necessary and early planning of an airway strategy is advised. Pregnant patients are at a higher risk of difficult airway management secondary to changes in airway anatomy, compared to non-pregnant patients. Failed intubation is more likely in advanced pregnancy versus non-pregnant patients. Meticulous planning is essential when managing the airways of pregnant patients, as the risks and complications of failed intubation can lead to severe morbidity in the obstetric population.

Consideration must also be given to minimising the risk of peri-operative aspiration. Pregnant women are at a higher risk of pulmonary aspiration of gastric contents, secondary to incompetence of the lower oesophageal sphincter, and alterations of gastric anatomy. If time allows, fasting should be undertaken: six hours for food, and two-hours for clear fluid. Premedication with metoclopramide, a H2 antagonist and a non-particulate antacid such as sodium citrate should be administered if there are no contraindications. In addition, the airway should be secured with a rapid sequence induction technique with cricoid pressure, if appropriate.

Due diligence must be applied to avoid inadvertent intubation of the bronchus rather than the trachea, which can cause subsequent hypoxia and hypoventilation and is a significant risk of laparoscopic surgery.

In the non-pregnant patient, establishment of pneumoperitoneum can be accompanied by marked changes in cardiovascular and respiratory physiology. To minimise the risks of cardiorespiratory instability and to promote smooth and safe anaesthesia, the patient should receive timely resuscitation prior to the induction of anaesthesia if they are haemodynamically unstable. Additional maternal risks of laparoscopy relate to the insufflation of carbon dioxide, and Trendelenburg or reverse Trendelenburg positioning. Therefore alterations in positioning and the creation of the pneumoperitoneum should be gradual, with vigilance and monitoring of the patient’s haemodynamic status.

The risk of venous thromboembolism (VTE) in pregnant women, compared to non-pregnant women of the same age, is four to five-fold higher, however the absolute risk of VTE in pregnancy remains low at around 1 in 1000 pregnancies. Non-obstetric surgery during pregnancy is associated with an increased risk of venous thromboembolism (VTE). In a retrospective study of 1518 pregnant women undergoing non-obstetric abdominal and pelvic surgery (65% laparoscopic), the overall rate of VTE was 0.5%. The Royal
College of Obstetricians and Gynaecologists has identified any surgery in pregnancy or the puerperium (except immediate perineal repair) as a risk factor for VTE.\(^{(36, 37)}\) As per the RCOG, there are no standard recommendations for a generalised population of pregnant women undergoing non-obstetric surgical procedures. Instead, the emphasis is to stratify the risk prior to recommending the necessary thromboprophylaxis. As a minimum, the RCOG classifies any surgical procedure as an intermediate risk, whereby pharmacological prophylaxis with low molecular weight heparin should be considered.\(^{(36, 37)}\)

**What are the fetal risks associated with anaesthesia?**

No primary studies were identified that selectively investigated the fetal anaesthetic risks of laparoscopic surgery separately from the risks of the surgical intervention. There are no primary studies that distinguish the effects of anaesthetic factors from surgical factors with regards to fetal risks.

The risks of anaesthesia for the fetus of pregnant women undergoing non-obstetric laparoscopic surgery can broadly be divided into two. Firstly, the risks related to pharmacological agents used in anaesthesia and the risk of teratogenicity. Secondly, the risks related to a reduction in uteroplacental blood flow, secondary to changes in maternal mean arterial pressure, partial pressure of arterial carbon dioxide (Paco\(_2\)), oxygenation, aorto-caval compression and increased intra-abdominal pressure.

**What strategies can be employed to increase the safety of anaesthesia for the fetus, when pregnant women require non-obstetric laparoscopic surgery?**

Modern anaesthetic agents, muscle relaxants and opioids are not teratogenic when used in therapeutic clinical doses and when the maternal physiology is maintained.

Clinicians should ensure the utero-placental blood flow is maintained by avoiding maternal hypotension.

Clinicians should aim to keep the pneumoperitoneum at levels of <15 mmHg most of the time, to prevent reductions in uteroplacental flow.

Maternal arterial CO\(_2\) should be controlled, avoiding hypo- and hypercapnia, to maintain optimal utero-placental flow and thus avoid fetal acidosis.

End-tidal CO\(_2\) can be used as a surrogate marker for arterial CO\(_2\).

Uterine displacement to avoid aorto-caval compression by wedging or table tilt may be of benefit.

No studies investigating the specific consequences arising from the use of anaesthetic medications in pregnant patients undergoing laparoscopy were identified. Our knowledge on this topic is based primarily on animal studies and retrospective human studies. No anaesthetic agents have yet been proven to be teratogenic in humans when used in clinical doses and when normal physiology is maintained.\(^{(38)}\)

Utero-placental blood flow is essential for oxygen delivery to the fetus, and impairment to this can threaten fetal viability. A reduction in maternal blood pressure, can reduce uterine blood flow.\(^{(39)}\) No adverse
maternal or fetal outcomes were reported when maternal blood pressure was maintained within 30% of baseline (40), 20% of baseline (41), or at baseline (42).

When maternal end-tidal CO$_2$ was controlled at 4.3kPa, there were no significant differences in maternal pH, base deficit or PaCO$_2$ before, during or after pneumoperitoneum (41). Another study reported no adverse outcomes when ETCO$_2$ was controlled between 3.7-4.3kPa (40).

With regards to monitoring maternal arterial CO$_2$, end-tidal CO$_2$ monitoring may be used as a surrogate. In pregnant women undergoing laparoscopic cholecystectomy, there were no significant differences of PaCO$_2$:ETCO$_2$ before, during or after pneumoperitoneum (41). ETCO$_2$ can be used as a surrogate marker for maternal arterial CO$_2$ monitoring, and invasive arterial monitoring is not routinely required in otherwise healthy and stable women, however the decision should be made on a case by case basis.

An increase in intra-abdominal pressures can mechanically affect utero-placental flow. Pneumoperitoneum pressure should be controlled to less than 15mmHg. Five case series, when pneumoperitoneum pressures were less than 15mmHg, reported good fetal outcomes (40-44). This is addressed further in the surgical section of this guidance.

A Cochrane review of 22 RCTs on the effect of maternal positioning at the time of Caesarean section stated that there was limited evidence to support or clearly disprove the value of tilting or flexing the table or the use of wedges and cushions or the use of mechanical displacers and that larger trials were needed to determine possible risks and benefits (45). Therefore, uterine displacement should be used unless it adversely impacts on the ability to carry out the surgery in a timely and effective manner, when gestational age is greater than 18 weeks.

**What type of anaesthesia should be used?**

**In most cases general anaesthesia should be employed.**

There is limited evidence on the use of regional anaesthesia for laparoscopy in pregnancy. The benefits of general anaesthesia include securing the airway to reduce the risk of aspiration, good muscle relaxation to allow excellent surgical conditions and controlled ventilation to regulate maternal PaCO$_2$. In addition, general anaesthesia can avoid any discomfort that an awake patient may endure, related to either a high neuraxial sensory block level for an adequate pneumoperitoneum, or steep positioning.

7. Peri- and intraoperative laparoscopic management of non-obstetric emergencies

**Who should be involved in the management of pregnant women requiring laparoscopy for abdominal non-obstetric conditions?**

A multi-disciplinary team should be in charge of the care of the pregnant women requiring laparoscopy. Depending on the individual case this team may include gynaecologists, general surgeons, anaesthetists, obstetricians and neonatologists.

Laparoscopic surgery in pregnancy should be performed only by experienced laparoscopic surgeons, who completed appropriate training in advanced laparoscopy and perform complex
procedures often enough to maintain competence and confidence. This approach minimises complications and operating time.

If there is the need to operate on a pregnant woman, urgent surgery should not be denied because of pregnancy. If the expertise to do surgery in pregnancy is lacking, expertise should be sought.

Both laparoscopic and open routes are acceptable, depending on circumstances, since maternal and fetal outcomes are equally acceptable.

General surgeons with a large caseload (top quartile of participating surgeons in annual number of cholecystectomies) experienced fewer maternal (1% versus 14% p<0.0001), fetal (4% versus 10% p<0.0001) and surgical (10% versus 13% p<0.05) complications than other surgeons. Their patients also had a shorter length of stay (4 versus 5 days p<0.0001) in a retrospective cohort study of 9,714 predominantly laparoscopic surgeries (89% cholecystectomies) in pregnancy (p<0.0001) (46).

The maternal benefits of laparoscopy are only observed before perforation occurs (24). Higher rates of perforation are associated with symptoms duration for more than 24 hours (47), thus timely intervention is important to avoid risk of perforation and subsequent sepsis.

Maternal and fetal outcomes are satisfactory in both open and laparoscopic interventions (48), therefore open surgery in experienced hands is preferable to delayed laparoscopic treatment.

At what gestation should laparoscopic surgery in pregnancy be performed?

When deciding on the route of surgery clinicians should be aware that recent small series have shown good maternal and fetal outcomes for laparoscopic appendicectomy, cholecystectomy and adnexal surgery up to 34 weeks gestation, which extends the previous recommendation to limit laparoscopic surgery to the second trimester.

Clinicians should be aware that any surgery in pregnancy is associated with maternal and fetal risks. Non-urgent surgery should be postponed until after pregnancy.

According to previous recommendations clinicians should carry out laparoscopic surgery in the second trimester only, because preterm contractions and miscarriage are least likely (49). Furthermore, access to pelvic organs and the gallbladder is easier because the uterus is smaller than in the third trimester.

A series of third trimester cases managed laparoscopically included five cholecystectomies, four appendicectomies, and two adnexal surgeries (50). One patient went into labour at 34 weeks following appendicectomy complicated by peritonitis. Another patient (29 weeks) was converted to open salpingo-oopherectomy for torsion after diagnostic laparoscopy due to operator preference, but required emergency laparotomy and cesarean section due to bleeding from the ovarian pedicle. The two complications are not likely to be due to the laparoscopic approach.

Another observational study compared 117 laparoscopic surgeries (adnexal torsion, persistent cysts, cholecystitis and appendicitis) in the first trimester (n=71 mean gestational age 7.7 ± 1.9 weeks) with laparoscopic surgeries in the second and third trimesters (N= 46, mean gestational age 18.1 ± 4.3 weeks, 11 cases in third trimester, up to 34 weeks) (51). No difference was found between the two groups.
regarding surgical complications and pregnancy outcomes. In both groups, in half of the deliveries were before 37 weeks.

Where should laparoscopic surgery in pregnancy be performed?

Laparoscopic surgery in pregnancy should be carried out in settings where adequate time, laparoscopic and monitoring facilities are available.

After the age of fetal viability pregnant women undergoing laparoscopic surgery should be treated in a unit with adequate neonatal and obstetric facilities in case the immediate delivery of the baby is indicated.

The studies, which informed this guideline originated mainly from tertiary care units in developed countries and so the recommendations cannot be extrapolated to all settings.

What interventions are needed when planning laparoscopic surgery in pregnancy?

Fetal heart Doppler ultrasound monitoring may be done before and after surgery to confirm fetal wellbeing and reassure the mother. There is no need for routine intraoperative monitoring.

If there is a risk of pre-term delivery antenatal steroids for fetal lung maturation and magnesium sulphate for fetal neuro-protection should be administered dependent upon the gestation of the fetus.

Anti-D administration is not deemed necessary according to guidelines since laparoscopic surgery is not included in the list of potentially sensitising events.

Routine tocolysis for women undergoing laparoscopic or open surgery in pregnancy is not recommended because has not been shown to improve outcomes.

In the past intraoperative fetal heart monitoring, especially with open surgery, was seen as mandatory. Newer large case series have shown good outcomes without routine intra-operative fetal heart monitoring during laparoscopy (54, 55)

A small quasi-experimental study showed no Doppler anomalies of the fetal heart or the maternal uterine arteries (measured trans-vaginally) during laparoscopic surgery on ovarian cysts using a routine laparoscopic approach with less than 12mmHg pneumoperitoneum (44).

Intra-operative monitoring may be required only in selected cases and when emergency delivery of the fetus is being considered. According to ACOG the following items need to be present before considering fetal monitoring: fetal viability, technical feasibility for intraoperative electronic fetal monitoring, an obstetrician willing to intervene for fetal indications, maternal consent for Caesarean section (desirable) and feasibility to interrupt laparoscopic surgery for emergency CS. (56) Intraoperative monitoring during laparoscopy can be achieved trans-vaginal or trans-abdominal ultrasound scanning with a steep left tilt to overcome the pneumoperitoneum.

If there is a risk of preterm delivery of a viable fetus antenatal steroids between 24+0 and 34+6 weeks and magnesium for fetal neuro-protection should be used in accordance with existing NICE guidance. (52)
Caution needs to be exercised in steroid administration in sepsis. Urgent surgery should not be delayed for administering steroids.

A systematic review showed no difference in the preterm delivery rate between women who received prophylactic tocolysis and those who did not.\(^{(57)}\)

Laparoscopic surgery is generally not considered a sensitising event and therefore routine administration of prophylactic anti D is not required.\(^{(53)}\)

8. Intraoperative considerations

The following chapter discusses intraoperative issues relating to laparoscopy in pregnancy. Specific conditions (appendectomy, gallbladder disease and adnexal surgery) will be discussed in chapter 9.

8.1 Ports

*How should the primary and secondary ports be placed?*

For generic entry techniques refer to the recommendations for non-pregnant women.\(^{(58)}\) This section will address the issues specifically relevant to laparoscopy in pregnancy.

*Where should the primary port be placed in pregnancy?*

The location of the primary port will depend on the level of the uterine fundus

The uterine size should be determined by palpation or ultrasound

In the absence of RCTs clinicians should choose their primary port location including umbilical, supra-umbilical / sub-xiphoid and Palmers’ point (left upper quadrant in the mid-clavicular line) according to uterine size, location of pathology and operator experience.

Clinicians should be aware that in the late second and the third trimester suggestions for primary port sites include 1-2cm below costal margin in the left (Palmers’ point) or right mid-clavicular line or 3-6 cm above the umbilicus in the midline.

No study was identified that randomised for location of primary port, thus no recommendations can be made for one location over another.

Researchers describe a variation of different locations for primary ports depending on gestational age.\(^{(18-20, 55, 59-67)}\).

In order to avoid uterine perforation and restricting views from having the camera port too close to the uterus it is recommended to adjust the port location according to the fundus\(^{(61)}\). Therefore the fundus should be palpated before insufflation. In very obese patients trans-abdominal ultrasound and obstetric guidance may be required. Upadhyay et al reported 11 laparoscopies between 26-28 weeks gestation...
(appendicectomy, cholecystectomy and adnexal surgery) using 1-2cm below the costal margin on the left or right mid-clavicular line using Veress’ insufflation in 10 cases and Hasson’s in one case with no access-related complications.

Should the Veress or Hasson technique be used for primary port placement?

In pregnancy Veress needle entry, open technique (Hasson) and optical trocar can be safely used in experienced hands.

The Hasson technique has been reported inside or above the umbilicus in the midline.

With either approach clinicians should be mindful of the possibility of uterine injury.

The benefits of the Hasson technique may include reducing the risk of uterine trauma and spillage of contents of ovarian cysts.

Clinicians should be aware that in experienced hands direct (gasless) entry may be an alternative, but there is insufficient information in late pregnancy to suggest this as a routine approach.

Although there are no studies randomised for Hasson’s and Veress’ entry techniques, a number of authors have recorded case series using these approaches throughout all gestations for cholecystectomy, appendicetomy and adnexal surgery without entry-related complications.

Chen et al reported direct entry in 33 laparoscopies for ovarian cysts in 2nd trimester (mean gestation 16.8) without entry-related complications. The direct entry technique was described as placing an optical trocar under visual control in the umbilicus, bringing up umbilicus with a towel forceps. Park et al described direct entry via Palmer’s point (left upper quadrant in the mid-clavicular line) in n=8 cases of pregnancy appendicetomies (2 in first trimester, 5 in second trimester, one in third trimester) using a 5mm trocar. No maternal or fetal complications were observed. The incidence of port entry complications is very low and the studies above are too small to detect entry related complications.

Where should secondary ports be placed?

Secondary port placement will be dictated by uterine size, pathology and operative approach.

Pre-surgical planning is paramount due to the challenges of accessing the pathology, given the limited degrees of freedom in laparoscopic surgery and the added obstacle of the size of the pregnant uterus. Ipsilateral port placement may circumvent this obstacle.

A systematic search returned no randomised control trials, but authors of case series of appendicetomy and cholecystectomy in pregnancy stated that secondary port placement is dictated by uterine size and pathology.

Ipsilateral operating secondary port placement should be considered on the same side where the pathology has been identified as this technique prevents the surgeon from having to instrument across the pregnant uterus.
8.2 Pneumoperitoneum in pregnancy

What insufflation pressures and operative pressures should be used in laparoscopic surgery in pregnancy?

Insufflation pressures should not exceed 20-25mmHg.

Clinicians should be aware that current evidence supports operating pressures of 12 mmHg.

Current recommendation on operating pressures in pregnancy are in keeping with recommendations for the non-pregnant state. There are no studies on insufflation pressure during port insertions in pregnancy. The recommendation for an insufflation pressure of 20-25mmHg is extrapolated from the RCOG recommendation in non-pregnant patients.\(^\text{(58)}\) Since these pressures are only maintained for a short duration until the primary port is placed they are unlikely to harm the fetus.

No adverse changes to the feto-maternal perfusion or adverse pregnancy events were recorded at less than 12mmHg pneumoperitoneum in a quasi-experimental setting using intraoperative Doppler studies.\(^\text{(44)}\) This was backed up by numerous case reports showing no adverse effects on the fetus at operating pressures at or below 12 mmHg\(^\text{(54, 55, 59, 61, 63, 65, 66, 71-74)}\).

8.3 Choice of laparoscope

What diameter laparoscope is preferred for laparoscopic procedures during pregnancy?

Both 5 and 10 mm diameter scopes have been used in pregnancy and choice of diameter depends upon the surgical requirements and availability of equipment.

The benefit of using a 10mm diameter laparoscope include better quality of image and the possibility of removing a larger specimen through the camera port. The benefits of a smaller, 5mm laparoscope includes the need for smaller incisions with better cosmesis and the ability to insert them through secondary ports to gain different views. Although numerous authors describe their use of 5 and 10 mm laparoscope, no data specifically comparing laparoscope diameter during pregnancy were identified.

What degree of laparoscope is preferred for laparoscopic procedures during pregnancy?

The choice of degree of laparoscope depends upon the preference of the surgeon and the surgical situation. Skilful use of a 30-degree laparoscope might improve the visual field in the presence of a large uterus.

There is no evaluation of laparoscope the degree of laparoscope that should be used in pregnancy. Traditionally, many gynaecologists use zero degree and general surgeons more often use 30-degree laparoscopes. However, extrapolating from non-pregnant laparoscopic surgery on large fibroid uteri, a 30-degree scope can improve visibility in the pelvis in trained hands.

What retrieval technique should be used to remove surgical specimens during laparoscopic surgery in pregnancy?

The choice of extraction method for surgical specimens during laparoscopic surgery in
pregnancy should be in accordance with the preference of the operating surgeon.

Infected and potentially dangerous specimens should be contained in a tissue bag.

Consideration should be given to the use of a tissue bag to avoid peritoneal spill of cystic contents bearing in mind the likely preoperative diagnosis. For example care should be taken not to spill contents of dermoid cyst to avoid chemical peritonitis and spillage of potentially malignant cysts as clinical assessment cannot absolutely preclude malignancy.(1)

The systematic search identified 10 case series that mention techniques of tissue removal at laparoscopy during pregnancy between 5-34 weeks gestation.(54, 55, 59, 61, 62, 68, 73, 75-77) The indications for surgery included appendicetomy, cholecystectomy and adnexal surgery. The devices used included endobag, endocatch, endopouch and sterile condoms.

Bearing in mind the likely diagnosis of the specimen, consideration should be given to carrying out the dissection within the bag as well as using it for removal.

No comparative data to guide preferred techniques for tissue extraction specimen were identified. There was no data on power morcellation, which should be discouraged in pregnancy due to the risk of uterine trauma.

What energy modalities should be used during laparoscopic surgery in pregnancy?

Ultrasound, bipolar and monopolar energy sources have all been safely used during laparoscopy in pregnancy.

The operating surgeon should choose energy modality based on his or her own preference. The surgeon should be mindful of the principals of safe electrosurgery in laparoscopy

No papers were available that investigated energy use during laparoscopic procedures in pregnant women as their main research question. There is no evidence that electrosurgery in a pregnant woman is harmful to the fetus or embryo. When monopolar energy is used it is recommended that the return plate should not be placed such that the uterus is between the electrode and the plate.

Amniotic fluid, which is electrolyte rich, protects the fetus from concentration of current and there is no neuromuscular stimulation at the output frequency of electrosurgical generators. Whilst there is a discrepancy between advice from different manufacturers, published literature does not suggest increased risk of energy related complications with any type of energy devices including monopolar during pregnancy.

Nine case series' reported on the use of energy modalities but this is not the main topic under investigation. (54, 55, 59, 61, 66, 68, 74, 78, 79) The range of energy sources, which were used without complications, include ultrasonic, bipolar, and monopolar energy. Monopolar energy was reported as being used by YY Lee in 2010 (79). Lee et al used monopolar scissors during 29 ovarian cystectomies between 6-16 weeks gestation without any operative complications (79). Mathevet et al also used monopolar scissors in addition to bipolar diathermy in 48 pregnant women undergoing laparoscopic adnexal surgery (17 in first trimester, 27 in second and 4 in the third trimester) (74). There were no intraoperative complications but one woman suffered a miscarriage at 17 weeks three days after surgery, which was not ascribed to the operating
technique after review of the operative video. The Harmonic scalpel® use was reported in 2 case series (54, 68) Chung et al carried out 22 laparoscopic appendicetomies (6 in first, 13 in second and 3 in third trimester) (54). No intra-operative complications occurred. Park reported the use of Harmonic scalpel® in 8 cases of appendicetomy during pregnancy (2 in first trimester, 5 in second trimester, one in third trimester) with no operative complications (68).

Given the restricted access and visibility in laparoscopy in pregnancy the surgeon needs to respect electrosurgical principles to avoid trauma. General safety rules for monopolar diathermy apply (avoiding indirect thermal damage, pedicle effect, avoid coupling, checking for faulty insulation).

### 8.4 Closure Techniques

*What wound closure techniques are recommended in pregnancy?*

The risk of hernia formation is 1-2% in incisions greater than 10mm therefore the fascia should be closed

No data were identified for port closure after laparoscopy in pregnancy. In in non-pregnant women ports >10 mm should by formal sheath closure with a port closure system, such as Endoclose® (with pneumoperitoneum maintained) or by using a J-needle, unless the Hasson entry technique has been used, in which case previously placed stay sutures are tied together. The risk of postoperative hernia formation is greater at the lateral port sites, especially taking into account the impact of the enlarging uterus on the abdominal wall stretch, which may further increase the risk of herniation. The skin can be closed by a variety of techniques e.g. subcuticular vicryl and skin glue.

### 8.5 Use of drains

*Should an abdominal drain be inserted peri-operatively on completion of laparoscopic procedures in pregnancy?*

The operating surgeon should decide whether it is necessary to use a drain based on their preference and assessment of the individual case

Drain placement has been only described in the context of laparoscopic appendicitis in pregnancy, not for cholecystectomy or adnexal surgery. Comparative data between routine placement (54, 68) and selective placement (61) is lacking.

### 8.6 Post-operative care

*What maternal care and fetal monitoring should be offered post-operatively?*

Antibiotics should be used if there is an infective process. The choice of antibiotic should be based upon local anti-microbial guidance.

In the case of elective surgery for adnexal masses, antibiotics would not be routinely required.
Good analgesia, adequate rehydration to maintain euvoilaemia and measures to prevent postoperative nausea and vomiting should be integrated into maternal postoperative care.

In a prospective case series of adnexal cysts operated on electively in the first trimester in 12 women no routine antibiotics were given and there were no complications including infections (73).

9. Management of the commonest laparoscopically treatable abdominal emergencies in pregnancy

9.1 Appendicitis

Is there a role for expectant management of appendicitis in pregnancy?

In suspected appendicitis in pregnancy timely surgical management is preferable to delay and antibiotic treatment, because of better fetal outcomes. Delay may cause adverse maternal and fetal outcome.

Two large retrospective studies were identified comparing conservative to operative approach to suspected appendicitis in pregnancy. Abassi et al reported higher rate of complications was reported in women who had antibiotics only (9/41) compared to open appendicectomy (37/369) and laparoscopic appendicectomy (7/66) (miscarriage OR 6.3 CI 1.9-20.8, peritonitis OR 1.6 (CI 1.3-2.1) (5). This study also showed higher rates of septic shock (OR 6.3; CI 1.9-20.8), peritonitis (OR 1.6; CI 1.3-2.1) and increase in venous thromboembolic disease (OR 1.6; CI 1-2.5), when comparing pregnant women who underwent treatment with antibiotics (n=412) with those who underwent open (n=3421) or laparoscopic surgery (n=3279) (Evidence level 2-). Cheng et al investigated outcomes in pregnant women with appendicitis and antibiotic treatment (n=78), open (n=653) and laparoscopic surgery (n=128) and compared outcomes with pregnant women without appendicitis (n=3436) from a national database (80). Pregnant women who had conservative treatment for appendicitis had a higher incidence of preterm labour (OR 2.47, CI 1.17-5.24) and pregnancy loss (OR 31.37, CI 13.12-75.01) than pregnant women who did not have appendicitis. Compared to pregnant women without appendicitis, women with open appendicectomy had significantly increased rates of preterm labour (OR 2.76 CI 2.06-3.70), pregnancy loss 14.34 CI 70-26.71) and caesarean delivery (OR 1.24 CI 1.05-1.48). In contrast, women who underwent laparoscopic surgery had no statistically increased rates of preterm labour (OR 1.26 CI 0.57-2.73), or caesarean delivery OR 1.31 CI 0.91-1.88) compared to women without appendicitis. The risk of miscarriage was increased in all women who had appendicitis in pregnancy compared to pregnancy women without appendicitis (conservative treatment 11.5% OR 31.37 (CI13.12–75.01), open appendicectomy 5.7% OR 14.34 (CI 7.70–26.71), laparoscopic appendicectomy 5.5% OR 13.88 (CI 5.50–35.04). There was no direct comparison between the antibiotic and the surgical groups. All three outcomes were similar when the two surgical approaches were compared.

Tamir et al reported that a 24-hour delay in operating (laparotomy) in suspected appendicitis in pregnant women led to a 66% increase in perforation (47). Retrospectively, laparotomy occurred within 24 hours of symptom onset in 19/54 (35%) cases. Perforation was seen in 23/54 patients, all of who had symptoms exceeding 24h (p<0.0005).

Should the laparoscopic approach to appendicectomy be preferred over laparotomy in pregnancy?
Clinicians should be aware that, whilst maternal outcomes are good, controversy exists regarding the association of laparoscopic appendicectomy and miscarriage. Further research is needed to distinguish between association and causality. In view of this we cannot recommend one approach over the other and only very experienced laparoscopists should carry out these procedures and outcomes should be monitored.

A systematic review of 11 non-randomised comparative studies of open (n=2816) and laparoscopic (n=599) cases for suspected appendicitis in pregnancy was identified (20). Most cases were from the second trimester, but cases from all trimesters were included. There was no data on complexity of cases in either group. Fetal loss was significantly increased in the laparoscopy group (RR 1.91, CI 1.31-2.77).

The adverse findings reported by Wlasrusmee were influenced by a single study by McGory et al, without which there would be no increase in fetal loss associated with laparoscopy (15). McGory studied retrospective administrative hospital records of pregnant (n=3133) and non-pregnant women (n=91656) who underwent open (n=73269) or laparoscopic appendicectomy (n= 24 214) and reported a higher rate of fetal loss compared with open appendicectomy (OR 2.31, CI 1.51-3.55).

A small retrospective study was published after the systematic review by Wlasrusmee et al (20). Laustsen et al compared 19 laparoscopic with 25 open appendicetomies and reported no miscarriages, no differences in Apgar score, weight, length and gestational age birth and improved maternal outcomes (26).

A large retrospective UK study on hospital data included 3061 appendicectomies (4, 48). Laparoscopic appendicectomies were associated with an increased risk of spontaneous miscarriage RR 2.36 (CI 1.71-4.41), but very few (1.8%) occurred during immediately after laparoscopic appendicectomy. No differences were observed in risk of in preterm delivery <37/40, maternal death, long inpatient stay and low birth weight <2500g. They reported that in the first trimester laparoscopic procedures were nearly 5 times more common than open ones. Conversely, in the third trimester open procedures were 2.5 times more common than laparoscopic ones.

Both studies have a large risk of a systematic distortion in measuring the true frequency of miscarriage due to laparoscopy because of the over representation of first trimester pregnancies in the laparoscopy group. Hence the risk of spontaneous miscarriage associated with appendicectomy during pregnancy should be interpreted with caution.

**9.2 Gallbladder disease (Symptomatic gallstones and acute cholecystitis)**

*Is there a role for expectant management of cholecystitis in pregnancy?*

Clinicians should be aware that a conservative approach to gallbladder disease in pregnancy is associated with higher maternal morbidity than surgery.

Clinicians should avoid complications such as gallstone pancreatitis, since this may be associated with a high risk of fetal mortality.

Clinicians should be aware that in pregnant women with biliary colic, supportive care will lead to resolution of symptoms in most cases. Complicated gallstone disease requires a more proactive approach.
The search identified one systematic review of moderate quality (81) and a retrospective case series (82) that compared conservative, endoscopic retrograde cholangiopancreatography (ERCP) and laparoscopic management. 112 pregnant women (first 29, second 43 and third trimester 40) were analysed retrospectively according to their approach to treatment. In the first and third trimester there were more conservative than active (laparoscopic and ERCP) treatments, but outcomes were not reported by gestation (82). Conservative treatment was associated with more recurrent biliary symptoms (30/50 versus 4/31, p=0.002) mean visits to the emergency department (1.7 versus 1.1, p=0.0060) and mean days spent in hospital (1.5 versus 1.2, p=0.034) and caesarean section delivery (15/43 vs 2/25, p=0.04), but the duration of hospital stay (5 days versus 6.5 days p=0.07) and the mean fetal birth weight (2752g versus 2999g, p=0.1) were not significantly different.

Date et al systematically reviewed six case series, comparing conservative with surgical management of cholecystitis (open and laparoscopic) and showed no significant difference in the incidence of preterm delivery (3.5% vs. 6.0%, P = 0.33) or fetal mortality (2.2% vs. 1.2%, P = 0.57) (81). There was no maternal or fetal mortality in 20 reports of laparoscopic cholecystectomy and 9 reports of ERCP. In 12 reports of gallstone pancreatitis, fetal mortality was 6/75 versus 1/38 (p= 0.28) in conservative and surgical groups respectively.

Should the laparoscopic approach to cholecystectomy be preferred over laparotomy in pregnancy?

Laparoscopic cholecystectomy appears to be associated with better composite maternal and composite fetal outcomes than open approach, fewer surgical complications and shorter hospital stay

The search identified a systematic review comparing laparoscopic and open cholecystectomy in pregnancy (18). Sedagat et al reviewed eleven studies including 10 632 pregnant women with gallbladder disease or symptomatic gallstones who underwent open or laparoscopic cholecystectomy. All studies were retrospective, comparative and non-randomised. In the 161 cases trimester was reported. The first and second trimester predominated (first trimester 44/161 second trimester 102/161 third trimester 16/161) but outcomes were not stratified by trimester. One maternal death was reported in connection with laparoscopic cholecystectomy at 20 weeks for chronic cholecystitis 2 weeks postoperatively due to intra-abdominal haemorrhage from a non-identified source (83). Kuy et al was also included in the systematic review (46). The authors reported five maternal deaths in connection with cholecystectomies, but were unable to ascertain the route of surgery (personal communication). Due to this uncertainty and to investigate if maternal deaths were associated with cholecystectomy in the UK, the authors of MBRRACE-UK (Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK) report were contacted and confirmed that no maternal deaths in connection with cholecystectomies between 2012-2014 and 2015 (personal communication). Composite fetal complications (OR 0.42 CI 0.28-0.63 p<0.001), composite maternal complications (OR 0.42 CI 0.33-0.53 p<0.001), and composite surgical complications (OR 0.45 CI 0.25-0.82 p<0.01) were all less frequent in the laparoscopy group. There was no significant difference in fetal mortality, (OR 0.39 CI 0.07-2.19) p=0.29, or preterm delivery before 27/40 (OR 1.35. CI 0.41-5.14 p=0.59) between the open and laparoscopic group. Operation time was not significantly different in four studies that reported it (86.2 min vs. 85.9 min p=0.98). Length of hospital stay was reported in 5/11 studies and was significantly shorter in the laparoscopic group (mean 3.2 versus 6.0 days p=0.02).
9.3 Ovarian cysts and masses

Should surgery for ovarian cysts be preferred over the conservative approach in pregnancy?

During pregnancy it is appropriate to manage cysts without suspicious features on imaging conservatively in most cases provided that symptoms are absent or acceptable to the patient.

In women with large but non-torted symptomatic cysts and when clinicians/patients want to avoid surgery, aspiration under ultrasound guidance may be offered with definitive cystectomy after pregnancy when needed.

The risk of torsion of ovarian cysts requiring emergency surgery in pregnancy is low and in most cases surgery may be delayed until the patient becomes symptomatic, with good fetal outcomes.

A systematic search identified a retrospective series that observed the rate of torsion and malignancy by adnexal mass size in 470 women who underwent surgery for adnexal masses during all trimesters of pregnancy between 2002-2009 (71). Fifty-five women (11.7%) had torsion and 28 women (31.8%) had emergency surgery for this indication. Torsion was more likely to occur when cysts were between 6-10cm than if they were smaller or larger than that (odds ratio 2.68, 95% CI 1.35-5.40, p<0.006). More than half of the torsions occurred in the first trimester, and a corpus luteum were the most common cyst type. Risk of torsion was not directly proportional to the cyst size.

A systematic search identified four retrospective and two prospective case series that evaluated conservative management of ovarian cysts in pregnancy (10, 84). No evidence was found that recommended conservative treatment when an acute cyst accident was suspected.

Condous et al followed up one hundred and sixty-one women with 166 ovarian cysts diagnosed at first trimester ultrasound (43% asymptomatic, 56.3% had pain or vaginal bleeding) throughout pregnancy with serial scans every 4-6 weeks until either the cyst resolved or intervention was required (84). Expectant management of ovarian cysts in pregnancy appeared to be safe with a low intervention rate of 4.2% (one ERPC and laparoscopic cystectomy, three cystectomies at term section, two laparotomies in second trimester, aspiration in second trimester), 3% underwent torsion but only 0.13% of women required emergency surgery (laparotomy in second trimester, cystectomy at term section and second trimester cyst aspiration).

Zanetta et al followed up 72 women with ovarian cysts in pregnancy >3cm, (after excluding those who were scanned in acute pain and required emergent surgery for torsions at presentation) (10). Only two women required intervention (one had a cystectomy at caesarean section at 37 weeks for torsion, and one transcutaneous cyst aspiration for pain). All other pregnancies carried on to term. Two women required a caesarean section because cysts were obstructing labour. A high proportion of cyst resolution and decrease in size >50% was observed (27/39 simple cysts, 7/9 endometrioma, no dermoids, 8/15 cysts with borderline appearance).

Caspi et al followed up 68 pregnancies with ultrasound-diagnosed dermoid cysts smaller than 6 cm, all treated conservatively (85). Cysts did not increase in size and no cyst accidents were observed. There were no fetal or maternal complications attributable to the presence of dermoid cysts in the population group.
Katz et al compared outcomes in pregnant women with (n=93) and without ovarian cysts (n=212,017) [Katz, 2010, Pregnancy outcome of patients with dermoid and other benign ovarian cysts]. Twenty-two women were diagnosed before or during pregnancy by ultrasound and 71 were diagnosed at CS. Among women with ovarian cysts, three cases of ovarian torsion and one of haemorrhage were diagnosed. In the ovarian cyst group 15 patients needed hospitalisation due to abdominal pain, but no data is provided for the control group. Fetal outcomes (rate of preterm delivery, low birth weight, APAGAR<5 and perinatal mortality) did not differ statistically.

Majeed et al reported 16 patients diagnosed with persistent ovarian cysts and followed them up conservatively with ultrasound scan (frequency not stated) until they became symptomatic.(86) Four patients had emergency laparotomy due to ovarian cyst torsion and rupture, two patients had elective laparotomy in second trimester due to large cyst size (>20cm) and ten patients had a laparotomy in the post partum period. Fetal outcomes included one miscarriage and all remaining patients had a term delivery.

**Should the laparoscopic approach to ovarian cysts be preferred over the open approach in pregnancy?**

**Clinicians should be aware that, when surgery is indicated, laparoscopic cystectomy is associated with better maternal outcomes than laparotomy in the second trimester, with similarly good fetal outcomes.**

**Clinicians should be aware that good maternal and fetal outcomes have also been reported for laparoscopic surgery for the first and third trimester but number of cases is smaller. More research is needed to prove the superiority of one approach over the other outside the second trimester. In the interim, choice of approach should be decided based on local circumstances and expertise.**

A Cochrane database review from 2013 did not identify any RCTs. A newer systematic review of one RCT (59) and 3 non-randomised comparative studies investigated laparoscopic and open surgery for suspected adnexal masses in the second trimester in 240 patients. Laparoscopic surgery was associated with a reduced risk of post-operative complications (RR 0.20, 95% CI 0.06–0.72); there was no difference in the risk of post-operative miscarriage (p=0.26). Laparoscopy was associated with lower estimated intra-operative blood loss, lower post-operative pain scores, and a shorter hospitalisation, readmission and immobilisation. Laparoscopy was associated with a longer operation duration compared with laparotomy (mean difference 13.7 min, 95% CI 12.58–14.82; p<0.001). In one of the reviewed studies significantly fewer adhesions at the time of Caesarean section were observed in patients who had undergone laparoscopy.

In addition, three further retrospective studies (n=401) comparing laparoscopic with open approach for persistent or torted ovarian cysts were identified.(64, 88) These studies confirmed that maternal outcomes were better and fetal outcomes were similar in the laparoscopic compared to the laparotomy group. However, the case number of first and third trimester pregnancies and large cysts (>6cm) were small. The fact that most reports were retrospective and from specialist centres could lead to the risk of reporting bias, with better outcomes for the reported techniques than could be expected in non-specialist settings.

**Cyst aspiration with or without concurrent cystectomy may be a safe alternative.**

Chung et al reports a technique of extra-corporeal cystectomy or oophorectomy after aspiration of the cyst, in four obese second trimester patients.(89) Dohi et al reports two cases of USS guided culdotomy for cysts incarcerated in the pouch of Douglas after needle aspiration via scan probe (90). There were no operative
complications and both women had vaginal deliveries. Duić et al. describes a technique of trans-vaginal ultrasound guided cyst aspiration in 1st and of percutaneous ultrasound guided cyst aspiration 2nd trimester with good outcomes. Hutt et al. also reports aspiration of 2 cases of large ovarian cysts, one twice after re-accumulation with normal pregnancy outcome. Kitade et al. reports a 2 puncture extra-corporeal method of cyst aspiration including a specialised retractor and balloon to bring the cyst to a 3 cm suprapubic incision in a case series of n=18.

10. Safety of imaging in pregnancy

Guidance on ionising radiation in pregnancy can be found in Health protection agency & Royal College of Radiologists & College of radiographs guidance. Recommendations on contrast media in pregnancy can be found in the European Society of Urogenital Radiology guidelines. The smallest possible dose of one of the most stable gadolinium contrast agents may be given to the pregnant mother if there is a very strong indication for enhanced MRI. No neonatal tests are recommended.

11. Audit

Laparoscopy in pregnancy is a relatively rare procedure, for which is it difficult to run RCTs. There are already large databases on routinely collected hospital/health data in the USA (3, 25) (and Scandinavia (21, 22), and one study from the UK on English Hospital Episode Statistics (48).

It is necessary gynaecologists and surgeons to prospectively record data regarding the management and outcomes of laparoscopic procedures in pregnancy nationally and in a standardised way, which will allow scientific evaluation and audit. The BSGE endometriosis database could serve as a model for development of a laparoscopy in pregnancy database.

The BSGE has developed a platform (BSGESICS) for collection of minimal access surgery details and this could be used in conjunction with general surgeons to collate a database of all cases of non-obstetric laparoscopy in the UK. Data collection could be linked to existing platforms such as the UK Obstetric Surveillance System.


APPENDIX 1

Clinical guidelines are: ‘systematically developed statements which assist clinicians and patients in making decisions about appropriate treatment for specific conditions’. Each guideline is systematically developed using a standardised methodology. Exact details of this process can be found in Clinical Governance Advice No.1: Development of RCOG Green-Top Guidelines (available on the RCOG website at http://www.rcog.org.uk/womens-health/clinical-guidance/development-rcog-green-top-guidelines-policies-and-processes). These recommendations are not intended to dictate an exclusive course of management or treatment. They must be evaluated with reference to individual patient needs, resources and limitations unique to the institution and variations in local populations. It is hoped that this process of local ownership will help to incorporate these guidelines into routine practice. Attention is drawn to areas of clinical uncertainty where further research may be indicated.

The evidence used in this guideline was graded using the scheme below and the recommendations formulated in a similar fashion with a standardised grading scheme.

<table>
<thead>
<tr>
<th>Classification of evidence levels</th>
<th>Grades of recommendations</th>
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<tbody>
<tr>
<td>1++ High-quality meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a very low risk of bias</td>
<td>At least one meta-analysis, systematic review or randomised controlled trial rated as 1++ and directly applicable to the target population; or</td>
</tr>
<tr>
<td>1+ Well-conducted meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a low risk of bias</td>
<td>A systematic review of randomised controlled trials or a body of evidence consisting principally of studies rated as 1+ directly applicable to the target population and demonstrating overall consistency of results</td>
</tr>
<tr>
<td>1– Meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a high risk of bias</td>
<td>A body of evidence including studies rated as 2++ directly applicable to the target population, and demonstrating overall consistency of results; or</td>
</tr>
<tr>
<td>2++ High-quality systematic reviews of case-control or cohort studies or high-quality case-control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal</td>
<td>Extrapolated evidence from studies rated as 1++ or 1+</td>
</tr>
<tr>
<td>2+ Well-conducted case-control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal</td>
<td>A body of evidence including studies rated as 2+ directly applicable to the target population and demonstrating overall consistency of results; or</td>
</tr>
<tr>
<td>2– Case-control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal</td>
<td>Extrapolated evidence from studies rated as 2++</td>
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<tr>
<td>3. Non-analytical studies, e.g. case reports, case series</td>
<td>Evidence level 3 or 4; or</td>
</tr>
<tr>
<td>4. Expert opinion</td>
<td>Extrapolated evidence from studies rated as 2+</td>
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Good practice point

Recommended best practice based on the clinical experience of the guideline development group.
DISCLAIMER

The British Society of Gynaecological Endoscopists produces guidelines as an educational aid to good clinical practice. They present recognised methods and techniques of clinical practice, based on published evidence, for consideration by gynaecologists and other relevant health professionals. The ultimate judgement regarding a particular clinical procedure or treatment plan must be made by the doctor or other attendant in the light of clinical data presented by the patient and the diagnostic and treatment options available. This means that BSGE guidelines are unlike protocols or guidelines issued by employers, not being intended to be prescriptive directions defining a single course of management. Departure from the local prescriptive protocols or guidelines should be fully documented in the patient’s case notes at the time the relevant decision is taken.

The Royal College of Obstetricians and Gynaecologists produces guidelines as an educational aid to good clinical practice. They present recognised methods and techniques of clinical practice, based on published evidence, for consideration by obstetricians and gynaecologists and other relevant health professionals. The ultimate judgement regarding a particular clinical procedure or treatment plan must be made by the doctor or other attendant in the light of clinical data presented by the patient and the diagnostic and treatment options available. This means that RCOG guidelines are unlike protocols or guidelines issued by employers, as they are not intended to be prescriptive directions defining a single course of management. Departure from the local prescriptive protocols or guidelines should be fully