Approach to the acute abdomen during pregnancy

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Tao submitted this article to the AMSJ as a final year medical student in 2010. She was the recipient of the University Medal for Medicine. The review was stimulated by a few memorable patient encounters during her Obstetrics and Gynaecology term at the Royal Hospital for Women, Randwick.

Many physiological changes in pregnancy may affect the presentation of abdominal pain in the pregnant patient. Rapid diagnosis and management is required to prevent dire complications for both mother and fetus. Most radiological investigations are not harmful to the developing fetus and can avoid unnecessary and potentially detrimental explorative surgery. The role of laparoscopy in the pregnant patient is increasingly being established, particularly in centres with this surgical expertise.

Introduction

Acute abdomen in a pregnant patient is a diagnostic and therapeutic challenge for the surgeon. The incidence of acute abdomen during pregnancy is one in 500-635. [1] The most common causes are: acute appendicitis (one in 500-2,000 pregnancies), acute cholecystitis (one in 1,600-10,000) and intestinal obstruction (one in 1,500-16,000). [2] Despite technological advances, preoperative diagnosis of acute abdominal conditions is often inaccurate. This appears to be due to both anatomical and physiological changes of pregnancy, and a general reluctance towards using radiographic imaging. [2-4] Evaluation of therapeutic choices for the gravid patient requires consideration of both maternal and fetal safety under the effects of anaesthesia and surgical manipulation. In recent years, laparoscopic treatment of the acute abdomen has become the standard procedure for selected groups of patients in some centres. [5] Nevertheless, whether laparoscopy improves upon laparotomy in achieving good obstetric and operative outcomes is still unclear. This review summarises the current literature on the diagnosis and surgical treatment of pregnant patients presenting with an acute abdomen.

General considerations

The presentation of a pregnant woman for non-obstetric surgery can be a stressful event for all involved. Approach to the surgical problem may be influenced by concerns for the effect of surgery and anaesthesia on the developing fetus and the potential to induce premature labour. [6]

A recent systematic review by Cohen-Karem *et al.* [7] reported the findings of 54 studies on selected maternal and fetal outcomes following a variety of non-obstetric surgical interventions. Of the 12,542 pregnancies included, one maternal death was reported, 5.8% resulted in a spontaneous miscarriage, 8.2% in premature delivery and 2% in a major birth defect. The authors concluded that surgery and general anaesthesia are not significant risk factors for spontaneous abortion and do not increase the risk for major birth defects, even if the operation was performed in the first trimester. However, when assessing the studies included in the systematic review individually, the highest rate of spontaneous abortion and premature delivery recorded was 17% [8] and 30% [9] respectively.

Our current knowledge about the influence of surgery on pregnancy is primarily based upon observational data and retrospective analyses. As with all studies without a control group, it is difficult to ascertain whether the outcomes measured are secondary to the intervention or the underlying disease process. Clearly, a prospective trial would be best to answer these questions, but this is unlikely given the circumstances of surgery in pregnancy. Furthermore, with the low incidence of surgery during pregnancy, it would indeed be logistically difficult to implement clinical trials large enough to satisfy the required statistical power. To that end, the evidence base is primarily composed of case reports and experimental animal studies, and controversies regarding best practice remain.

Acute abdomen: The clinical picture

An acute abdomen may be the result of gastrointestinal, gynaecological or urological pathology, as well as frank trauma, both blunt and penetrating. Surgical intervention is usually warranted – delays in diagnosis and treatment with resultant viscus rupture and widespread peritonitis can have dire fetal and maternal consequences. [10,11]

Nevertheless, the diagnosis of acute abdomen during pregnancy is challenging for a number of reasons:

1. Symptoms of nausea, vomiting, anorexia, dyspepsia, 'stomach' pain and constipation often accompany normal pregnancy. [2,3]
2. Classical signs of peritonism can be obscured by the expanding uterus which displaces other intra-abdominal organs and stretches the anterior abdominal wall. [12]
3. Haematological and biochemical results may be misleading due to a physiologic leukocytosis and dilutional anaemia of pregnancy. [4]

Radiological assessment

Radiological procedures on the gravid patient are taken reluctantly due to potential teratogenic risks and the associated medico-legal consequences of iatrogenic birth defects. [13,14]

Information on the dose-dependent effects of radiation on fetal health comes from animal studies, human observational studies and studies of atomic bomb survivors. [14] Ionising radiation can lead to cell death, carcinogenesis and mutations in germ cells. [16] During the first three weeks of pregnancy, radiation injury results in implantation failure or undetectable death of the embryo. [15,17] Effects of subsequent radiation injury depend on the timing of exposure and the sensitive period of various organs to teratogenesis. [17] The greatest risk to the developing central nervous system is between the fifth and eighteenth week of gestation, whereby radiation doses greater than 10 rad may cause a decrease in the Intelligence Quotient and doses greater than 100 rad may result in severe mental retardation. [18] As the pregnancy progresses, the concern shifts from teratogenesis to increasing the risk of childhood haematological cancer. The current figure suggests that radiation may increase the background incidence of cancers before the age of 20 (0.3-0.4%) by 0.06% per rad delivered to the fetus. [18,19]

Despite the known teratogenicity of ionising radiation, there is no evidence to indicate that current radiation dosage from common diagnostic studies is associated with an increase in birth defects. According to the American College of Radiology, 'No single diagnostic procedure results in a radiation dose that threatens the well-being of the developing pre-embryo, embryo or fetus.' [20] According to the National Council on Radiation Protection, 'Fetal risk is considered to be negligible at 5 rad or less when compared with the other risks of pregnancy, and the risk of malformation is significantly increased above control levels only at doses above 15 rad.' [21] Table 1 lists the radiation dosage of common diagnostic studies. Importantly, as there is a dosage range associated with many procedures, parameters may be altered by the radiologist to achieve the lowest effective radiation dose.

Table 1: *Estimated Fetal Exposure from some common radiologic procedures. [16]*

Procedure	Fetal Exposure
Chest X-ray (2 views)	0.02-0.7 mrad
Abdominal film (single view)	100 mrad
Intravenous pyelography	≥1 rad*
Hip film (single view)	200 mrad
Mammography	7-20 mrad
Barium enema or small bowel series	2-4 rad
CT scan of head or chest	<1 rad
CT scan of abdomen and lumbar spine	3.5 rad
CT pelvimetry	250 mrad

N.B. Conversions for absorbed doses:
1 rad = 1000 mrad; 100 rad = 1 Gy (Gray)
**Exposure depends on the number of films*

Ultrasound and magnetic resonance imaging (MRI) do not deliver ionising radiation and have not been shown to have any harmful effects on pregnancy. [15] Ultrasound is the investigation of choice for most gynaecological causes of acute abdomen such as adnexal mass and torsion. [15] Use of intravenous gadolinium as contrast material for MRI is controversial as it is capable of crossing the placenta with undetermined consequences. [22]

Value of diagnostic surgery

The value of exploratory surgery during pregnancy, largely for suspected appendicitis, has been the focus of a number of studies in the literature. The primary benefits of operative exploration are rapidity and diagnostic accuracy, in addition to the potential for immediate therapeutic intervention at the time of diagnosis. [15]

The pre-operative diagnostic accuracy of acute appendicitis during pregnancy ranges from 50-77%. [12,23-26] The proportion of those found to have negative appendicitis intraoperatively with unexpected pathology findings (for example, mesenteric adenitis or ovarian torsion) is approximately 10-20%, [12,23,24] with the remainder having no abnormality. In particular, the rate of negative appendicitis is considerably greater in pregnant women than in non-pregnant women (23% versus 18%). [23] The converse to a negative surgical diagnosis, however, is a delay in diagnosis resulting in potentially drastic complications. Perhaps, the combination of challenges in clinical diagnosis, and fear of maternal and fetal mortality with a complicated appendicitis has been used as justification for a more aggressive surgical approach towards pregnant women with suspected appendicitis.

The incidence of perforation is thought to be greater in pregnant than in non-pregnant women. [27] A 66% perforation incidence has been documented when surgery is delayed by more than 24 hours compared to 0% incidence when surgery is conducted prior to 24 hours after the initial presentation. [9] The decision is thus balanced on the associated risk of misdiagnosis with that of perforation.

McGory *et al.* [23] recently examined fetal outcomes in over 3,000 pregnant patients who had appendicectomy. Importantly, the study showed that the risk of fetal loss and early delivery was almost as high with negative appendicectomy as with complicated or ruptured appendicitis. The authors concluded that explorative surgery poses significant risks to the fetus and efforts to improve diagnostic imaging prior to surgery may decrease adverse fetal outcomes. However, the study was limited in that the dataset precluded analyses of those patients in whom no surgical procedure was attempted following a negative intraoperative diagnosis of appendicitis. In Saunders and Milton's [12] small series of 26 pregnant women with negative laparotomy findings for suspected appendicitis, those in whom no further surgery was performed were considerably more likely to continue their pregnancy undisturbed, compared to those who proceeded with appendicectomy as planned (89% versus 57%, respectively). Thus, there may be some value in minimally invasive, brief and/or simple diagnostic surgery for the acute abdomen during pregnancy.

Anaesthetic considerations

There are a number of anaesthetic risks unique to the pregnant patient. They can be divided into those that pose potential teratogenic effects on the fetus and those that arise from maternal physiologic changes, which in turn can affect uteroplacental blood flow. [6,14,28]

Available literature on the safety of anaesthetic agents is encouraging, without sufficient evidence to suggest a clear relationship between adverse fetal outcome and anaesthetic type. No anaesthetic, opioid, sedative-hypnotic or muscle relaxant appears to be more teratogenic or safer than another agent. [28] Mazze and Källén's [29] study on 5,405 pregnant women from three Swedish health registries found no increase in congenital anomalies with different types of anaesthesia used in surgery during pregnancy. Many authors are more inclined to believe that any morbidity to the fetus is primarily from the underlying disease, not the anaesthetic agent. [14,28] Nevertheless, virtually all anaesthetic agents have teratogenic potential at clinical concentrations. [6] For example, nitrous oxide has been shown to inactivate methionine synthetase through oxidation of vitamin B12, which in turn inhibits DNA synthesis, cell division and biochemical pathways in methylation reactions. [30,31]

While no clinical data currently link these cellular actions with teratogenic outcomes, their theoretical risk should not be completely disregarded. Several authors agree that surgery during the first trimester, the period of organogenesis, should be avoided if not emergent. [4,6,28]

Multiple cardiovascular and pulmonary physiologic changes occur in pregnancy which implicates anaesthetic management. To the anaesthetist, greater concern for the fetus arises from intra-operative maternal hypotension or hypoxia than from exposure to anaesthetic agents. Because of the increased risk of hypoxaemia, difficulties with intubation, acid aspiration and risks to the fetus, regional anaesthesia should be selected over general anaesthesia where possible. [6]

Laparoscopy versus laparotomy

Once considered an absolute contraindication during pregnancy [33], laparoscopy is now performed in certain centres for acute abdominal conditions on pregnant patients with apparently favourable results.

In comparison to laparotomy, there are several benefits for the pregnant patient, including: less fetal depression due to reduced postoperative opioid requirements, decreased maternal postoperative hypovolaemia, shorter hospital stay, early mobilisation which may minimise the increased thromboembolic risk associated with pregnancy, early return of gastrointestinal activity due to less bowel manipulation resulting in fewer postoperative adhesions and earlier return to full diet causing less nutritional stress to the fetus. [3,15,34,35]

The main concerns towards laparoscopy during pregnancy relate to the effects on uteroplacental perfusion from pneumoperitoneum, uterine injury from laparoscopic trocar insertion and the potential for

fetal hypercarbic acidosis. [15,34]

Physiologic responses to pneumoperitoneum

The cardiopulmonary stresses and subsequent physiologic adaptations during pneumoperitoneum are hypothesised to cause systemic hypertension and decreased cardiac output, ultimately leading to reduced uterine perfusion and increased risk of fetal hypoxia. [3,10,35] Whether this decrease in uterine blood flow is of danger to the fetus is somewhat contentious. Frequent intra-abdominal pressure fluctuations occur during maternal valsalva, coughing and straining, with no observable ill effects on fetal outcomes; [10] although these activities are not sustained for the length of time taken during an operation. It has been suggested that manual uterine retraction during open appendicectomy or cholecystectomy may have greater impact on uterine perfusion than that which occurs during pneumoperitoneum. [39]

Fetal uptake of carbon dioxide (CO_2) is another potential danger of laparoscopy. Studies on pregnant ewes and baboons have reported prolonged fetal hypercarbia, acidosis and increased lactate levels with maternal CO_2 insufflation. [3,40-43] Hunter *et al.* [41] described fetal hypertension and tachycardia, attributing them to fetal hypercarbia. Until more complete data is available, careful anaesthetic attention to maternal ventilation is vital.

Studies in the human

To date, over 500 cases of laparoscopy on pregnant women have been described. [44] Most have a focus on gastrointestinal causes of acute abdomen. All studies have been retrospective, and most reports come from centres and surgeons with special interest, experience and skills in laparoscopy, whose results may not reflect complication rates more generally.

There is some literature to suggest that the incidence of significant fetal and maternal adverse effects after laparoscopy is minimal and does not endanger a pregnancy any more than a laparotomy. [5,15,29,43,45-52] However, the majority of the evidence is based on single case reports and small series studies, which often do not include a comparative laparotomy group from which to draw meaningful conclusions. This is considered in conjunction with the observation that there is often a tendency to under-report unsuccessful cases. Nevertheless, several reports from Swedish health registries have provided safety comparisons between laparoscopy and laparotomy procedures in large samples of pregnant women.

Reedy *et al.* [43] compared 2,181 laparoscopies and 1,522 laparotomies performed on pregnant women of four to 20 weeks gestation during the period 1973-1993. Between the two procedures, they found no difference in birth weight, gestational duration, rates of intrauterine growth restriction, congenital malformations, stillbirths and neonatal deaths. An increased risk for infants to be born with low birth weight, prematurity and growth restriction was found in women who underwent surgery overall compared to the general population, although it could not be determined whether this increased risk was related to the anaesthesia, surgical procedure or the acute condition itself.

An earlier study of the same Swedish health registries reported similar findings on the increased risk of prematurity and low birth weight infants associated with surgery during pregnancy, but more importantly, showed that laparoscopy can be safely performed during any trimester of pregnancy. [29] Of a total of 868 laparoscopic cases performed during pregnancy, 768 occurred in the first trimester, 29 in the second and 71 in the third. Mazze *et al.* [29] reported no increased incidence of adverse outcomes when compared with laparotomy. A number of subsequent smaller studies have also suggested the safety of laparoscopy during all three trimesters. [52,53] This is in contrast to historic recommendations which limit 26-28 weeks as the upper limit of gestational age safe for laparoscopy. [4]

Despite these encouraging results, the Swedish registry studies are limited in that the database was designed only to study live births, disenabling the comparison of the rate of spontaneous abortion between laparoscopy and laparotomy. The association of spontaneous abortion with laparoscopy has been illuminated by a recent systematic review of 28 articles documenting 637 cases, [54] which found that fetal loss was significantly higher in women who had laparoscopic appendicectomy than women who underwent open appendicectomy (5.6% versus 3.1%), despite a higher rate of non-appendicitis among the laparoscopy recipients. The authors concluded that open appendicectomy is the safer option for pregnant women for whom surgical intervention is needed. This is in opposition to most previous reports.

Occasional reports, such as those above, raise caution regarding the use of laparoscopy during pregnancy. The absolute safety of laparoscopic surgery on the gravid human patient has yet to be confirmed. [34] Amos *et al.* [8] in 1996 reported laparoscopy on seven pregnant patients – three appendectomies and four cholecystectomies. Alarmingly, there were four fetal deaths, three within the first week of operation. The authors speculated that the adverse outcomes may have been related to the physiologic consequences of pneumoperitoneum. While the study has received criticism from other investigators regarding its methodology, it has aroused considerable caution in the surgical community regarding the safety of laparoscopy during pregnancy.

Finally, long term effects on the child after delivery have not been well investigated. One study following eleven children for a period of one to eight years did not find an increased incidence of developmental and physical abnormalities. [55]

Conclusion

The presentation of an acute abdomen during pregnancy requires a rapid approach to assessment and management. If truly emergent, the indication and timing for surgery should not differ from that of the non-pregnant population. Most radiological investigations are not harmful to fetal development and can be used safely to diagnose abdominal pathology. Appropriate use of diagnostic imaging may prevent unnecessary surgical exploration which has been associated with an increased rate of fetal loss. Some evidence suggests that laparoscopy can be safe and advantageous for both the mother and her fetus when performed by an experienced team. However, the evidence base lacks prospective trials and long-term studies. Altered maternal physiology, particularly under the influence of laparoscopic pneumoperitoneum, requires careful intra-operative anaesthetic monitoring. The advance in imaging technology, anaesthetic care and surgical techniques has influenced diagnostic and therapeutic algorithms, and management needs to account for the skills mix in individual hospitals.

Conflicts of Interest

None declared.

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