

# Anaesthesia for non-obstetric surgery in obstetric patients

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## ABSTRACT

Anaesthesia for pregnant patients presenting for non-obstetric surgery needs a thorough understanding of the physiological changes and altered pharmacokinetics of pregnancy. Considering the effects of surgery and anaesthesia on the foetus, only essential and emergency surgeries are performed during pregnancy. Surgical procedures in second trimester have the advantage of better foetal outcome. The primary concerns of maternal and foetal safety are achieved by a focused multidisciplinary team-based approach with respect to the surgical condition. Meticulous attention to preoperative patient counselling, airway management, haemodynamic stability, and thromboprophylaxis are the key factors in anaesthetic management. Choice of anaesthesia or anaesthetic drugs has minimal impact on the foetus provided utero-placental perfusion and uterine relaxation are maintained. Foetal monitoring when feasible and when done by a trained person enables to diagnose and treat the factors responsible for foetal heart rate variability. Anaesthetic technique needs to be modified according to the type of surgery.

**Key words:** Foetal asphyxia, non-obstetric surgery, preterm labour, teratogenicity

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## INTRODUCTION

Anaesthesiologists frequently encounter pregnant patients requiring non-obstetric surgery. The incidence of such surgical procedures varies from 0.75% to 2%.<sup>[1]</sup> Acute intra-abdominal infections [acute appendicitis (1:1500 pregnancies) and acute cholecystitis (1:1600 pregnancies),<sup>[2]</sup> ovarian cysts, and trauma are the most common indications for surgical procedures in pregnant patients. Diagnosis of surgical conditions is rendered difficult and sometimes delayed due to similarity of some symptoms that may be normal during pregnancy. Well-rounded healthcare delivery to the mother and her foetus is best achieved by close collaboration among the various specialists taking care of the mother. The care team includes obstetricians, anaesthesiologists, neonatologists, and the specific surgical specialists.

The surgical intervention exposes both the mother and the foetus to the risks of anaesthesia, while the disorder itself can impact the mother's health. The timing of surgery as related to the gestational age is another facet that must be taken into consideration.

The second trimester is considered safer for majority of surgical procedures. However, most procedures are performed during the first trimester (42%) followed by second (35%) and third trimesters (23%).<sup>[3]</sup> The safety of the mother and the foetus during the perioperative period depends on a thorough understanding of the maternal and foetal physiology by the anaesthesiologist and a comprehensive knowledge of the altered pharmacokinetics in pregnant patients.

## ANAESTHETIC IMPLICATIONS OF PHYSIOLOGICAL CHANGES OF PREGNANCY

The physiological changes that follow pregnancy bring about profound changes in the mother to accommodate

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for nourishing the growing foetus. Most changes give a physiological advantage to the foetus and a few extend support to the mother in case of blood loss [Table 1].

## ISSUES OF SPECIAL CONCERN IN PREGNANCY

### Maternal issues

#### Gastroesophageal reflux disease

Pregnant patients develop progressive increase in intragastric pressure and decreased lower oesophageal sphincter tone making them susceptible to excessive gastric reflux. Though gastric emptying remains unchanged, overall intestinal transit time gets prolonged. Transition from normal vagal tone to decreased tone occurs from second trimester onwards suggesting a progressive response of the autonomic nervous system to pregnancy.<sup>[4]</sup> These changes mandate the need for aspiration prophylaxis.

#### Airway

It is useful to know that fluid retention and weight gain in pregnancy may render mucosa of the upper airway

quite oedematous and prone to bleeding with even the slightest of trauma, such as with a hurried but missed attempt at laryngeal intubation.<sup>[5]</sup> Deliberate and careful intubation with a smaller endotracheal tube after a rapid sequence induction may spell a better strategy for successful intubation. Being well aware of the distinct possibility of rapid desaturation will help the anaesthesiologist to prepare for that first attempt at clear laryngeal visualisation and successful intubation. It needs no emphasis that intubation of a pregnant person be taken very seriously and should always call for a second set of hands if the possibility exists. It follows, therefore, that anaesthesiologists approach maternal intubation with emergency secondary airway equipment prepared and close at hand and follow the difficult airway rather quickly owing to the rapidity of desaturation and its implications to both mother and the foetus. Once the patient is successfully intubated and the endotracheal tube placement verified and secured, ventilation should aim to keep the mother's pCO<sub>2</sub> at levels normal for pregnancy.

**Table 1: Physiological changes of pregnancy and their anaesthetic implications**

Physiological changes	Anaesthetic Implications
<b>Cardiovascular system</b>	
Decreased BP, SVR	Increased incidence of hypotension after general and spinal anaesthesia
Lack of autoregulation of uterine vasculature	Foetal blood supply depends on maternal BP. Maintain normotension
Aortocaval compression after 20 weeks of gestation	Supine hypotension syndrome is common. Left lateral tilt (15°) to reduce compression
Gallop rhythm, left axis deviation, systolic murmur, minor ST-T changes	Misleads the clinician to a cardiac disease
Increased blood volume and cardiac output	Decompensation of cardiac valvular lesions
<b>Respiratory system</b>	
Reduced FRC (20%), Increased oxygen demand (20%)	Tendency for early desaturation. Careful preoxygenation is a must
Mild respiratory alkalosis (PaCO <sub>2</sub> 28-32 mmHg)	Maintain PaCO <sub>2</sub> at normal pregnancy levels
Increased minute ventilation	Faster inhalational induction
<b>Airway</b>	
Increased soft tissue in the neck, weight gain and breast engorgement	Difficult mask ventilation, laryngoscopy and intubation
Increase in Mallampatti Grading as pregnancy progresses	
Increased oedema of the airway and vocal cord	Difficult intubation. Smaller sized endotracheal tubes should be used
Increased vascularity of mucous membranes	Epistaxis with nasal intubation
<b>Blood and coagulation</b>	
Hemodilution with resting tachycardia	Delay in onset of classical signs of hypovolemia
Hypercoagulability	Perioperative DVT prophylaxis in high risk patients
<b>Gastrointestinal system</b>	
Reduced lower oesophageal sphincter tone	Consider all pregnant patients as full stomach. Mandates Rapid sequence induction
Distorted gastric and pyloric anatomy	
Increased gastric volume and acidity	Anti-aspiration prophylaxis and antacids as part of pre-operative preparation (after 16 weeks)
<b>Central nervous system</b>	
Engorged epidural veins	Increased incidence of bloody tap
Reduced epidural space volume	More extensive spread of LA
Increased CSF pressure	Reduced dosage requirements
Increased sensitivity to opioids and inhalational agents	Faster induction with inhalational agents

SVR=Systemic vascular resistance, BP=Blood pressure, FRC=Functional residual capacity, DVT=Deep vein thrombosis; LA=Local Anaesthetic

### Propensity for venous thrombosis

Pregnancy is associated with an increase in most of the clotting factors and these patients are at increased risk of venous thrombosis and thromboembolism.<sup>[6]</sup> Immobility in the postoperative period further predisposes to deep vein thrombosis (DVT). DVT prophylaxis is useful in prevention of thrombosis in these high-risk patients.

### Increased risk of bleeding

Pregnancy causes a decrease in vascular tone, and a dilutional thrombocytopenia leading to increased blood loss during surgery.<sup>[7]</sup> In addition, the risk of surgical bleeding is enhanced in specific disorders related to pregnancy such as in pre-eclampsia and in HELLP syndrome.

### Foetal issues

#### Teratogenicity

Anaesthetic drugs affect cell signalling, mitosis, and DNA synthesis, which are involved in cellular differentiation and organogenesis and by extension may alter the ongoing cellular processes in the foetus over the long term.<sup>[8]</sup> There seems to be no distinct evidence from current practice that anaesthetics are teratogenic. It stands to reason that the foetus is most sensitive to the disruption of cellular processes during the organogenesis (third to eighth weeks). Teratogenic drug exposure during this period may either cause foetal death or may not affect the developing foetus. During the period of organ growth, and not organogenesis, drug exposure may lead to growth restriction or to abnormalities of organ function. Data from observational evidence and various studies suggest that commonly used anaesthetics do not appear to be hazardous to the foetus.<sup>[9]</sup>

With no anaesthetic agent exhibiting a clear disadvantage to the foetus, the conduct of either regional or the general anaesthetic with minimal to mild perturbation of the maternal physiology seems to be the best course to pursue. Anaesthetic choice will also be determined by the actual surgical procedure itself.

#### Placental transfer of drugs

Some drugs used during anaesthesia may impact the foetus when they cross the placental barrier. While glycopyrrolate does not cross the placental barrier, neostigmine does and may cause foetal bradycardia and should not be assumed to be ongoing foetal distress but may require further foetal monitoring. Respiratory depression of the new-born is known when the mother

receives a large dose of intravenous (IV) narcotic immediately prior to the delivery of the foetus. Such drug effects from trans-placental foetal drug delivery are irrelevant when the pregnancy continues after the surgical event.

#### Foetal asphyxia

The foetus is quite sensitive to a decrease in utero-placental blood flow as this caters to the ability of the foetus to maintain its normally high metabolic rate. It is, therefore, paramount to ensure adequate utero-placental perfusion throughout the anaesthetic. Since utero-placental perfusion has no auto regulatory mechanism, it is sensitive to changes in maternal cardiac output and blood pressure. Aorto-caval compression by the gravid uterus is known to reduce uterine blood flow even in the presence of normal maternal blood pressure. Appropriate measures to maintain adequate blood pressure and avoidance of hypovolemia, hypercarbia, severe anaemia, maternal hypoxia, and uterine hypertonus are essential for good utero-placental perfusion. This is true with no regard to the chosen anaesthetic modality. Haemodynamic stability should be maintained by avoiding aortocaval compression and hypotension. Hypotension should be aggressively treated by left uterine displacement, boluses of IV fluids, and vasopressors.

#### Foetal loss

Foetal loss after surgical intervention is quoted at 5.8% in all trimesters of pregnancy; the incidence rose to 10.5% when the group included only pregnancy loss in the first trimester after surgery.<sup>[10]</sup> It is not easy to determine the exact incidence of foetal demise owing to the inability to determine if anaesthesia and/or surgery were the sole cause for pregnancy loss.

#### Preterm labour

During surgery late in pregnancy haemodynamic changes that may occur during an anaesthetic can increase the tendency of the uterus to contract prematurely leading to preterm labour. Increased uterine irritability is commoner in later gestational ages and can be precipitated by surgical manipulation, infection, and hypoxemia. So, uterine activity must be monitored after surgery. Drugs that increase uterine tone (e.g., ketamine) should be avoided. Tocolysis may become necessary if preterm labour is suspected but prophylactic tocolysis is not recommended.<sup>[9]</sup>

Therefore, the second trimester seems to be the best in terms of timing of semi-elective surgical

procedures during pregnancy. All indicators point to this being the ideal time for essential surgery that cannot be postponed, and the latter part of the second trimester would then be logically better as this ensures that the foetus is in the viable duration of pregnancy, if unfortunately, the pathology that led to surgery, the nature of the surgery or the anaesthetic, precipitates preterm labour. If the surgery is urgent, then optimisation of maternal physiology during anaesthesia helps in the well-being of both the mother and foetus. The time of surgery is dictated by the disorder requiring surgery at that juncture. If maternal surgery can be postponed till after childbirth, then it should be undertaken after all the physiological changes of pregnancy have returned to pre-pregnant status, which is at 6-week post-partum<sup>[11]</sup> [Flowchart 1].

Nitrous oxide inhibits methionine synthetase, and therefore, many avoid its use during non-obstetric surgery in the pregnant woman.<sup>[12]</sup> Ketamine causes increased uterine tone and foetal asphyxia and is best avoided in the early trimesters. Benzodiazepines (FDA Class D) have been associated with a cleft lip and palate in animal studies.<sup>[2]</sup> But, more recent, better controlled studies have not substantiated it.<sup>[10]</sup> A single dose of midazolam has not been associated with teratogenicity and is useful to provide preoperative anxiolysis.

## MONITORING

### Maternal monitoring

Standard monitoring should be utilised in all pregnant patients. Use of invasive monitoring modalities should be guided by the predisposing medical or surgical condition.

### Foetal monitoring

Routine foetal monitoring<sup>[13]</sup> is the norm in most circumstances after 18–20 weeks of gestation but intraoperative monitoring is not practical during abdominal surgery. In such instances, foetal monitoring is performed immediately prior to and after the surgery is complete. If the surgery is being undertaken when the foetus is in the nonviable gestational age noting the foetal heart rate (FHR) prior to and after the surgery is reassuring to the mother. Once the period of viability is achieved monitoring carries a more actionable significance. If the surgery is unavoidable or very prolonged and the gestational age spells viability to the foetus, continuous intra operative FHR monitoring may have the utility of helping to detect abnormal foetal variability that will help the anaesthesiologist

to take intrauterine foetal resuscitative measures.<sup>[14]</sup> But with continuous intraoperative monitoring of the foetus, a dual operative set up with an obstetric and neonatal crew on standby becomes a requirement. This arrangement will hasten prompt foetal delivery in the event of immediate threat to foetal life. Slowing of FHR could be a consequence of foetal hypoxemia, acidosis, hypothermia, maternal respiratory acidosis or severe alkalosis, drugs, or anaesthetic agents.

A deteriorating FHR despite counter measures to stabilise the mother and foetus will mandate urgent operative foetal delivery. This can only be achieved by careful planning and coordination among the maternal and foetal care team.

## ANAESTHETIC MANAGEMENT

This should take a system-based approach. In addition, significant attention needs to be paid to the duration of gestation, presence of foetal growth anomalies, and maternal disorders precipitated by pregnancy (e.g., pre-eclampsia).

### Maternal counselling and pre-operative preparation

It would be appropriate to take a team care approach in every situation possible to educate the family unit about miscarriage, preterm labour, and the prospects of neonatal intensive care depending on the duration of gestation of the pregnancy in question. It is well worth the time spent during the preoperative period to reassure the mother with respect to the safety of anaesthetics and of the postoperative pain management.

Preoperative involvement of all the members of the team caring for the neonate and the mother instils not only a sense of confidence but also goes a long way in allaying anxiety in the mother and the other members of the family that may be intimately involved with the well-being of the foetus and the mother.

### Premedication

Reassurance is the preferred method than resorting to preoperative medication for sedation prior to surgery. All mothers in the second and third trimesters must receive aspiration prophylaxis. Mothers with gastroesophageal reflux disease are administered this prophylaxis irrespective of gestational age.

### Anaesthetic choice

Cardinal principles of avoidance of hypoxia, hypercarbia, acidosis, hypothermia, hypoperfusion,



hypotension, and every attempt made to mitigate aorto-caval compression must be followed irrespective of the type of anaesthetic chosen.

Regional anaesthesia is preferred where possible owing to its minimal exposure of the mother and foetus to drugs.<sup>[1]</sup> Regional anaesthesia has the well-established advantage of completely circumventing maternal airway manipulation.

Appropriate maternal positioning during a general anaesthetic must include patient positioning for airway control as well as to optimise left uterine displacement. A head up tilt will aid in improving maternal functional residual capacity (FRC) and will also assist in moving away the enlarged breasts resulting from pregnancy that may interfere with securing the airway. It may also aid in improving the chances of preventing passive reflux at induction of anaesthesia.

IV cannulation in the lower extremity is preferably avoided for fear of DVT.

Preoxygenation with a well-applied mask will help saturate the already reduced maternal FRC and afford the anaesthesiologist an additional duration of safe apnoea and therefore should never be neglected.

Minimum alveolar concentration (MAC) values for volatile agents are reduced in pregnancy. They relax the uterus proportionally to the MAC exposure and increase uterine blood flow. But significant hypotension associated with higher MAC levels compromises uterine perfusion.

Most neuromuscular blocking drugs cross the placental barrier in extremely small amounts. The prolongation of the action of succinylcholine may not occur even though plasma choline esterase levels fall in pregnancy. Pain-induced sympathetic stimulation may decrease uterine blood flow and must be kept to a minimum both in magnitude and in duration.

Extubating criteria must be more stringent with the patient fully awake and following commands to prevent post extubating aspiration and hypoxemia.

#### Postoperative analgesia

Short-term exposure to narcotics is considered safe even though they cross the placenta barrier with continuation of pregnancy after surgery. Long-term intrauterine exposure to narcotics is well known to

cause significant withdrawal symptoms in the new born. Prolonged use of NSAIDs (>48 hours), especially ibuprofen, should be avoided after 32 weeks of gestation due to the risk of premature closure of ductus arteriosus.<sup>[15]</sup>

## TYPE OF SURGERY

### Laparoscopy

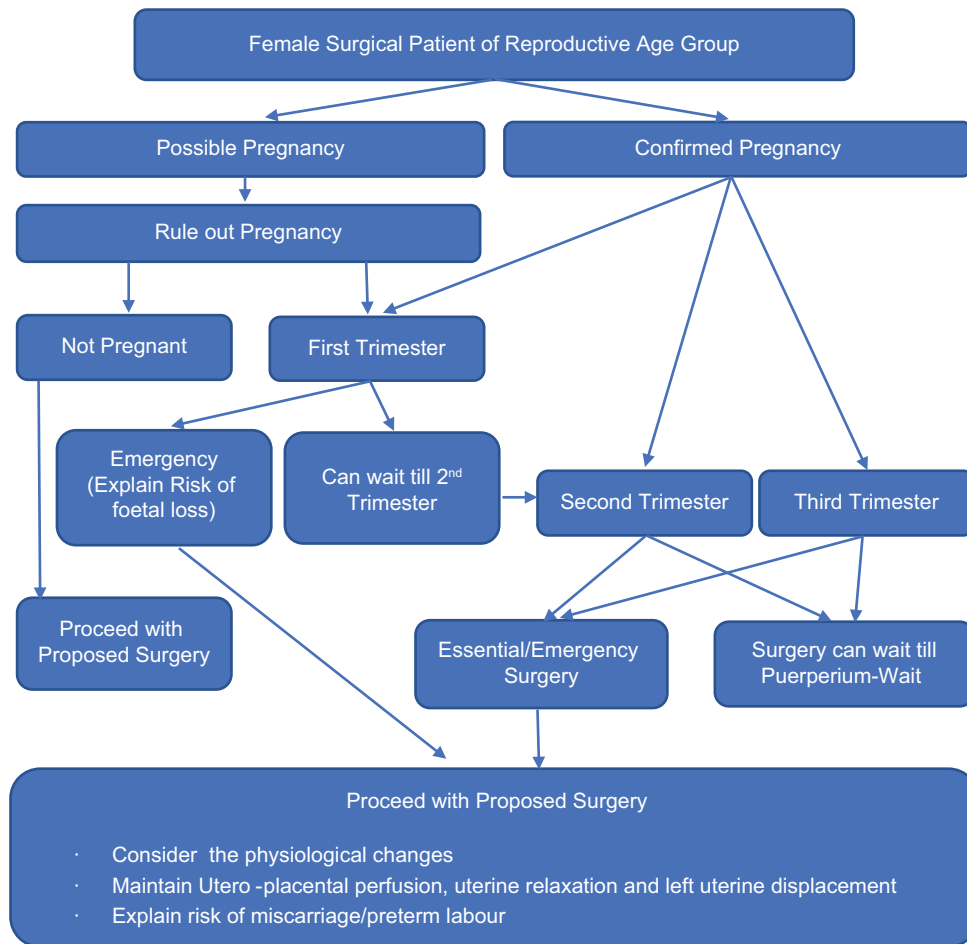
Retrospective study of foetal outcomes following laparoscopic surgery or laparotomy were compared in a large Swedish study involving 2 million parturients.<sup>[16]</sup> There was no difference in the incidence of premature delivery, growth restriction, or low birth weight between the two groups. Laparoscopy has the advantage of reduced postoperative pain, faster recovery, and lower thromboembolic events. It is advisable to perform the surgery in the second trimester with lower pneumoperitoneal pressures (8–12 mmHg).<sup>[1]</sup> Open technique to enter abdomen reduces the chances of injury while inserting the ports. Gradual and limited position changes will help maternal physiology to compensate better. Maintaining EtCO<sub>2</sub> at pregnant levels is vital in preventing foetal acidosis.

### Neurosurgery

Intracranial haemorrhage from ruptured aneurysms and arteriovenous malformations is increased by hyperdynamic cardiovascular changes of pregnancy and precipitated by hypertensive disorders of pregnancy.<sup>[17]</sup> Anaesthetic management of these patients needs control of haemodynamics, mild hypothermia, mild hypocarbia (PaCO<sub>2</sub> of 25–30 mmHg), and diuresis to reduce cerebral oedema. Hypocarbia and maternal alkalosis can cause foetal distress and must be addressed by managing ventilator parameters.

### Trauma

About 6%–7% pregnant patients present to the hospital as a consequence of trauma.<sup>[18]</sup> Though resuscitation of these patients must follow standard Advanced Trauma Life Support (ATLS) guidelines, the anatomical and physiological changes of pregnancy should be considered when managing their surgical conditions. Routine radiographical survey after trauma (cervical spine, chest, and pelvis with shielding) produces negligible exposure to the foetus.<sup>[19]</sup> Appropriate protective measures like covering the abdomen with lead apron and minimising the number of exposures should be followed. There is very little risk to the foetus when exposed to radiation dosage of <25 rads.<sup>[20]</sup>



**Flowchart 1:** Decision tree of non-obstetric surgery in a female surgical patient of reproductive age

### Extrauterine intrapartum treatment procedure

Frequently, EXIT procedures involve securing airways of neonates with cervical or oropharyngeal mass prior to complete foetal delivery.<sup>[20]</sup> A multidisciplinary approach involving anaesthesia for both mother and foetus, the paediatric ENT surgeon, neonatologist, and the obstetrician is essential for success of this procedure. The chief anaesthetic goals are adequate uterine relaxation and maintenance of utero-placental perfusion to prevent placental separation before securing the airway of the neonate. This must be balanced with maintaining maternal haemodynamics in the face of uterine bleeding from a relaxed open uterus. Avoidance of foetal hypoxemia as well as achieving foetal quiescence will assist in easing airway intervention of the foetus.

### Cardiac surgery

Severe mitral or aortic valvular obstruction during pregnancy should preferably be treated by percutaneous balloon valvuloplasty than open surgical intervention. Cardiopulmonary bypass (CPB)

during open surgical procedures adversely affect the foetus due to the nonpulsatile blood flow, inadequate perfusion pressures, inadequate pump flow, embolic phenomena to the utero-placental bed, and the release of renin and catecholamines. It is recommended to keep a high pump flow (2.5 litre), perfusion pressure (70 mmHg), and normothermia during CPB. A haematocrit of  $\geq 28\%$  optimises the oxygen carrying capacity and is beneficial to the foetus.<sup>[21,22]</sup>

### Resuscitation

Cardiopulmonary resuscitation in pregnant women should be done according to standard Advanced Cardiac Life Support (ACLS) guidelines including specifically, left uterine displacement to prevent aortocaval compression and improve maternal perfusion. Peri-mortem Caesarean delivery should be strongly considered in every mother in whom Return of Spontaneous Circulation (ROSC) has not been achieved after  $\approx 4$  minutes of high-class resuscitative efforts (Class IIa: level of evidence C).<sup>[23]</sup>

## SUMMARY

Pregnant patients undergoing non-obstetric surgery are best served by a multidisciplinary team of specialists. All female patients of reproductive age undergoing surgery should be evaluated for pregnancy. Elective surgeries in pregnant patients should preferably be done in the second trimester as the risk of foetal loss and teratogenicity are lower. All pregnant patients should receive anti-aspiration prophylaxis as part of their preoperative preparation. Meticulous anaesthetic techniques to maintain haemodynamic stability, utero-placental perfusion and uterine relaxation are key to sustaining pregnancy. Regional techniques are preferred provided haemodynamic stability is maintained and patient is comfortable. Perioperative foetal monitoring when feasible enables early diagnosis and improves foetal outcome.

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### Conflicts of interest

There are no conflicts of interest.

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