Anaesthesia in Pregnancy for Non-Obstetric Surgery

DR. SARBARI SWAIKA
ASSOCIATE PROFESSOR
BANKURA SAMMILANI MEDICAL COLLEGE
BANKURA

- The American College of Obstetrician and Gynecologists' Committee on Obstetric practice acknowledges that the issue of nonobstetric surgery during pregnancy is an important concern for physicians who care for women. It is important for a physician to obtain an obstetric consultation before performing nonobstetric surgery and some invasive procedures (eg. Cardiac catheterization or Colonoscopy) because obstetricians are uniquely qualified to discuss maternal physiology and anatomy that may affect intraoperative maternal-foetal well-being.

The American College of Obstetrician and Gynecologists Committee Opinion. Number 474. February 2011. Reaffirmed 2013

Issues approved by American Society of Anesthesiologists (ASA) and American College of Obstetricians and Gynecologists (ACOG) 2011

- *No currently used **anaesthetic agents** have been shown to have any **teratogenic effects** in humans when using standard concentrations at any gestational age*
- ***Foetal heart rate monitoring** may assist in maternal positioning and cardiorespiratory management, and may influence a decision to deliver the foetus*
- *Surgery should be done at an **institution** with **neonatal** and **paediatric** service*

Guidelines……

- *A pregnant woman should never be denied indicated surgery, regardless of trimester*
- *Elective surgery should be postponed*
- *If possible, non-urgent surgery should be performed in the second trimester when preterm contractions and spontaneous abortion are least likely*

Nonobstetric surgery during pregnancy, ACOG committee opinion, No. 474, Feb 2011, Reaffirmed 2013

Incidence

- 0.75% to 2% of pregnant women undergo surgeries
- Annual incidence - 75,000 – 80,000 (USA)
- Centralized data unavailable in India
- Most common indication - Acute abdominal infections
  - Appendicitis (1:2000)
  - Cholecystitis (8:10 000)

Indications

- ***Pregnancy related***
  - Cervical encirclage
  - Ovarian Torsion
  - Foetal surgery
- ***Not related to pregnancy***
  - Appendicitis, Cholecystitis
  - Bowel obstruction
  - Trauma
  - Malignancies
  - Cardiac procedures
  - Neurologic procedures

❖ ***Distribution of Surgery according to trimester :***

- 1st Trimester - 42%
- 2nd Trimester - 35%
- 3rd Trimester - 23%

Mazze RI, Ka¨ lle´n B. Reproductive outcome after anesthesia and operation during pregnancy: a registry study of 5405 cases. Am J Obstet Gynecol 1989; 161: 1178–85


understanding altered drug pharmacology
understanding maternal and foetal physiology
proper counseling to parturient
safe anaesthesia in pregnancy

Objectives

- Optimize or maintain normal maternal physiological function
- Optimize or maintain utero-placental blood flow and oxygen delivery
- Avoid unwanted drug effects on the foetus
- Avoid stimulating the myometrium (oxytocic effects) - uterine contractions, abortion
- To prevent hypotension, hypovolemia, hypoxia and hypothermia
- Avoid awareness during general anaesthesia
- Preferential use of regional anaesthesia

Walton NKD. Anaesthesia for non- obstetric surgery during pregnancy. Continuing Education in Anaesthesia, Critical Care & Pain 2006; 6: 2

PHYSIOLOGIC CHANGES DURING PREGNANACY

System	Physiological changes	Anaesthetic implications
Cardiovascular	↑ in CO up to 50%	
	↑ in Uterine perfusion to 10% of CO	Uterine perfusion not autoregulated
	↓ SVR, ↓ PVR, ↓ AP	Hypotension common under regional and general anaesthesia
	Aortocaval compression from 13 weeks	Supine hypotensive syndrome requires left lateral tilt
Respiratory	↑ Minute ventilation	Faster inhalation induction
	Respiratory alkalosis (Pa_{CO2} 3.7-4.2 kPa)	Maintain Pa_{CO2} at normal pregnancy levels
	↓ ERV, ↓ RV, ↓ FRC	
	↑ V/Q mismatch	
	↑ Oxygen consumption	
	Upward displacement of diaphragm	Potential hypoxaemia in the supine and Trendelenburg positions
	↑ Thoracic diameter	Breathing more diaphragmatic than thoracic
	Mucosal oedema	Difficult laryngoscopy and intubation; bleeding during attempts

CNS	↑ Epidural veins engorgement	Bloody tap more common
	↓ Epidural space volume	More extensive local anaesthetic spread
	↑ Sensitivity to opioids and sedatives	
Haematological	↑ Red cell volume 30%, ↑ WCC	
	↑ Plasma volume 50%	Dilutional anaemia
	↑ Coagulation factors	Thromboembolic complications
	↓ Albumin and colloid osmotic pressure	Oedema, decreased protein binding of drugs
Gastrointestinal	↑ Intragastric pressure	Aspiration risk
	↓ Barrier pressure	Antacid prophylaxis, RSI after 18 weeks gestation
Renal	↑ Renal plasma flow, ↑ GFR	Normal urea and creatinine may mask impaired renal function
	↓ Reabsorptive capacity	Glycosuria and proteinuria

Counseling and Reassurance

- Patient should be **reassured** about the safety of anaesthesia and the lack of documented associated teratogenicity
- **Warned** about the increased risk of 1st trimester miscarriage and premature delivery in later trimesters
- **Educate** the patient about the symptoms of premature labor and reinforce the need of left uterine displacement
- **Documentation** of details of the risk discussed should be maintained in patients records

FOETAL CONSIDERATIONS


Disease process/therapy related
Perturbation of uteroplacental circulation
Risks of foetus
Teratogenicity
Abortion/ pre-term delivery

Teratogenicity

- Teratogenicity is defined as the observation of any significant change in the function or form of a child secondary to prenatal treatment



- Between 31st -71st days of gestation, period of organogenesis, the embryo is most vulnerable to teratogenic effects

Documented Teratogens

- ***Radiation***

- Increased risk of malignant and genetic disease, cong. malformation &/or fetal death
- Effects are dose related
- Absorbed foetal dose for all conventional radiographic imaging is < 50 mGy
- Less than 50 mGy (milligrays) is safe
- Background radiation during the whole pregnancy is approximately 1.3 to 5.8 mGy

"No single diagnostic procedure results in a radiation dose that threatens the well-being of the developing embryo and fetus"

(American College of Radiology Practice Guidelines)

Diagnostic ultrasonography :

- ❖ Considered to be devoid of embryotoxic effects
- ❖ Potential side effects
  - ➢ Foetal hyperthermia – with prolonged scans
  - ➢ Post-natal neurobehavioral effects – with repeated exposures

Hande et al. Teratogenic effects of repeated exposures to X-rays and or ultrasound in mice. Neurotoxic Teratol 1995

❖ ***Maternal metabolic imbalance***

- Alcoholism, cretinism, diabetes, folic acid deficiency, hyperthermia, prolonged hypoxia, hypercarbia and severe hypoglycemia

❖ ***Infection***

- CMV, Herpes virus, Parvo virus B-19, Rubella virus, Toxoplasmosis

❖ ***Drugs***

Influencing Factors

- Species susceptibility
- Threshold or amount of exposure
- Duration and timing of administration
- Genetic predisposition

Teratogenic Drugs

- Alcohol
- Androgen
- Ace Inhibitors
- Antithyroid drugs
- Carbamazepine
- Chemotherapy agents
- Cocaine
- Warfarin
- Valproic acid
- Lithium
- Phenytoin
- Streptomycin
- Tetracycline
- Thalidomide
- Trimethadione
- Diethylstilbestrol

- The "Shepherd Catalogue," which lists the agents or factors that are proven to be teratogenic, does not include anaesthetic agents or any drug used routinely during the administration of anaesthesia.

Crawford JS, Lewis M. Nitrous oxide in early human pregnancy. Anaesthesia 1986;41:900- 5.

Anaesthetic Agents and Teratogenicity



- Anaesthetic agents like propofol, barbiturates, opioids, inhalational agents, neuromuscular blocking agents and local anaesthetics are safe in pregnancy
- Association between BZD and craniofacial defects and cardiac anomalies are debated
- Benzodiazepines (BZD) are not teratogenic and a single dose appears safe but use in the first trimester should be avoided
- 50% N_2O has weak teratogenic effects in rodents when used for more than 24 hours
- Current evidence does not support withholding N_2O in clinical practice

Behavioral teratology

- Accelerated neuronal apoptosis in immature rodent brain exposed to anaesthetic agents
- Behavioral and learning abnormality seen in absence of any observable morphological changes
- Effect on NMDA & GABA receptors in the CNS which are necessary for neuronal synaptogenesis, differentiation and survival
- This phase extends from 4th IU month to 2nd postnatal month in rodents
- ***Animals*** → prenatal administration of systemic drugs e.g., Barbiturates, meperidine, promethazine & halothane → behavioral changes
- ***Human*** → implication remains unknown

Prevention of pre-term labor

- Surgery, especially intra-abdominal procedures, increases the risk of preterm labor or abortion

- Perioperative FHR & HR variability monitoring may be helpful but controversial

- Prophylactic tocolytic therapy considered in the third trimester
  - abdominal surgeries involving uterine manipulations or
  - surgeries with high risk of premature labor i.e. cervical encirclage

- Tocographic monitoring during the first hours or days postoperatively to detect and treat preterm labor as early as possible

Tocolytic Drugs & Maternal and Foetal Cardiovascular Side Effects

Tocolytic agent	Maternal side effects	Foetal side effects
Magnesium	Hypotension and Cardiovascular collapse, pulmonary edema, sensitivity to NDMR	Loss of beat to beat variability
Beta-adrenergic drugs	Tachycardia, ↓ed SVR, hypokalemia, pulmonary edema	Foetal tachycardia
Nitroglycerin	↓ed preload with hypotension, pulmonary edema	
Prostaglandin inhibitors	Prolonged bleeding time	Premature closure of PDA
Atosiban (oxytocin antagonist)	Blunts Ca^{2+} influx in myometrium and inhibit contractility	

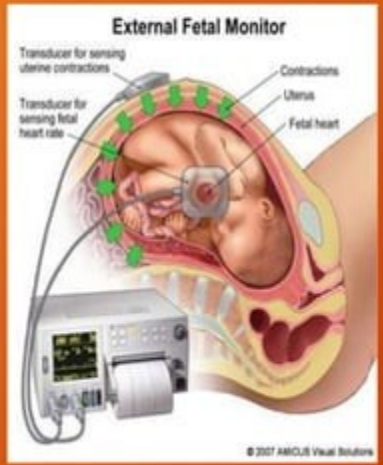
Uteroplacental Perfusion and Foetal Oxygentation

- Most serious risk during nonobstetric surgery is **Intrauterine asphyxia**
- Foetal oxygenation depends on maternal oxygen delivery and uteroplacental perfusion
- Maintenance of foetal well being :
  - *Maternal oxygenation*
  - *Maternal carbon dioxide tension*
  - *Uterine blood flow*

Avoidance of Foetal Asphyxia

- Prolonged maternal hypoxaemia → uteroplacental vasoconstriction → reduced uteroplacental perfusion → foetal hypoxaemia → acidosis → fetal death
- Excessive positive pressure ventilation → maternal hypocapnia → increased intrathoracic pressure → reduced venous return → reduced uterine blood flow
- Maternal hypotension of any cause should be treated immediately with i.v. fluid, vasopressors, blood products and adjustments of ventilation and position
- Hypocapnia results in uterine vasoconstriction → a shift in the maternal oxyhaemoglobin dissociation curve to the left → reduced oxygen release to the foetus
- Hypercapnia → foetal acidosis → myocardial depression → death
- Uterine hypertonus → increased uterine vascular resistance → decresed blood flow

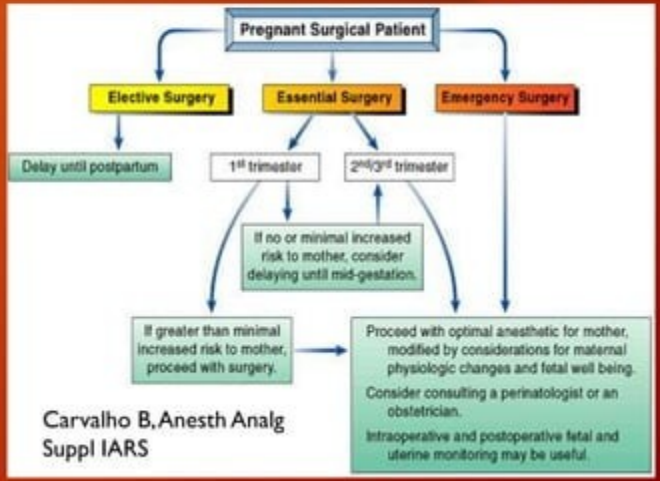
Foetal Monitoring



- Monitoring of FHR from 18-22 wks and HR variability from 25 wks onwards requires a skilled interpretation
- Difficulty in continuous monitoring & interpretation in both baseline FHR & HR variability
- Cardiotocography (CTG) monitoring used in viable foetus
- Monitoring enables optimization of maternal condition in signs of foetal compromise

Anaesthetic Considerations

- Elective surgery should not be performed at all during pregnancy
- Emergency surgery must proceed regardless of gestational age and the primary goal is to preserve the life of the mother
- Where feasible, surgery is often delayed until the second trimester to reduce the risk of both teratogenicity and miscarriage



Anaesthetic considerations in1st Trimester

- ***Maternal***
  - ↑ oxygen requirement
  - Modified drug pharmacokinetics
  - Careful airway manipulation

- ***Foetal***
  - Risk of teratogenicity
  - Impaired UBF

Anaesthetic considerations in 2nd and 3rd trimester

❖ ***Maternal***

- Aortocaval compression
- Prone to hypoxia
- Aspiration prophylaxis
- Preparation for difficult airway
- Avoid hyperventilation
- Increased risk of thromboembolic complications

❖ ***Foetal***

- Premature labor / IUGR
- Intrauterine asphyxia

❖ ***Surgery related***

- Disease related problem
- Diagnostic difficulties
- Prolonged exposure to anaesthetics
- Surgical manipulations – ↑ foetal risk
- Anatomic and surface landmarks unreliable

Pre-anaesthetic preparation

- Evaluation, Counseling and Reassurance
- Attention to be paid to airway examination
- Routine investigations, adequate arrangement of blood for major surgical intervention
- Consult obstetrician & discuss about the use of tocolytics
- Overnight fast
- Aspiration prophylaxis with H2-receptor antagonists and nonparticulate antacids
- Anxiolytic premedication- to allay anxiety and apprehension
- Transport in left lateral position
- O.T. preparation – drugs, machine, difficult airway cart, suction and monitors

Anaesthetic management…
Choice of anaesthesia

- Choice of Anaesthetic technique depends on-
  - Patient's present surgical status (site and nature of surgery)
  - Present gestational age of the foetus
  - Pregnancy induced physiological changes
  - Other coexisting comorbidities

- No technique has been proven to have superiority over the other in foetal outcomes

- Regional techniques may be preferable

- Safe anaesthetic management is more important than particular agent or technique

Anaesthetic management…
Monitoring

- Maternal monitoring :
  - Noninvasive / invasive blood pressure
  - Electrocardiography
  - Pulse oximetry
  - Capnography
  - Temperature monitoring
  - Use of peripheral nerve stimulator
  - Blood glucose levels

- Foetal monitoring :
  - External doppler device (FHR)
  - Tocodynamometer (Uterine contractility)

❖ ***General anaesthesia***

- Maintain left uterine displacment to prevent aortocaval compression
- Preoxygenation
- Rapid sequence induction (Thiopent. sod. & succinylcholine, cricoid pressure → tracheal intubation using cuffed E.T. tube)
- Maintenance : Muscle relaxant, an opioid and/ or a moderate conc. of inhalational agent (≤ 2 MAC) with high conc. of oxygen ($FiO_2 = 0.5$) is recommended
- The use of nitrous oxide should be limited during extremely long operations in first trimester by giving high conc of oxygen

- Opioids and induction agents decreases FHR variability to greater extent than volatile agents
- Ketamine increases uterine tone (in early pregnancy) and should not be used
- Positive pressure ventilation may reduce UBF
- Avoid hyperventilation to maintain end tidal CO_2 in normal pregnancy range
- Patients on magnesium for tocolysis – reduce dose of NMBs
- Reversal agent to be given slowly (increased release of Ach→ increased uterine tone and preterm labour)
- Extubation when fully awake after return of protective airway reflexes

❖ ***Regional anaesthesia***

❑ Advantages:

- Minimal foetal drug exposure
- Avoidance of complications of general anaesthesia
- If no sedative or narcotics are supplemented – no change in FHR variations to confuse interpretation
- Post operative analgesia

Regional anaesthesia

- Reduced LA requirement / LA Toxicity
- Careful aspiration and test dose
- Avoid hypotension i.e., adequate preloading, maintain left uterine tilt, choice of vasopressor
- Patients on magnesium are more prone to hypotension, often resistant to treatment with vasopressors

Anaesthetic Management…
Postoperative management

- Oxygenation in left uterine tilt
- Vitals monitoring
- Obstetrician consultation for FHR & uterine activity monitoring
- Pediatric consultation in case of premature labor
- Adequate pain relief with Nerve block, Local infiltration, Opioids, NSAIDs
- Tocodynamometry is useful in high risk patients as postoperative analgesia may mask awareness of early contractions and delay tocolysis
- Early mobilization or DVT prophylaxis if required

- ***NSAIDs can be used before 32 wks and Acetaminophen is safe***

SPECIAL SITUATIONS

Laparoscopy during pregnancy

❖ ***Guidelines issued by the Society of American Gastrointestinal Endoscopic Surgeons regarding laparoscopic surgery during pregnancy :***

- Use an open technique to enter the abdomen
- Monitor maternal end-tidal PCO2 (4–4.6 kPa range) with or without arterial blood gas to avoid fetal hypercarbia and acidosis
- Maintain low pneumoperitoneum pressure (1.1–1.6 kPa) or use gasless technique
- Limit the extent of Trendelenburg or reverse Trendelenburg position
- Initiate any position change slowly
- Monitor fetal heart rate and uterine tone when feasible

Neurosurgery in pregnancy

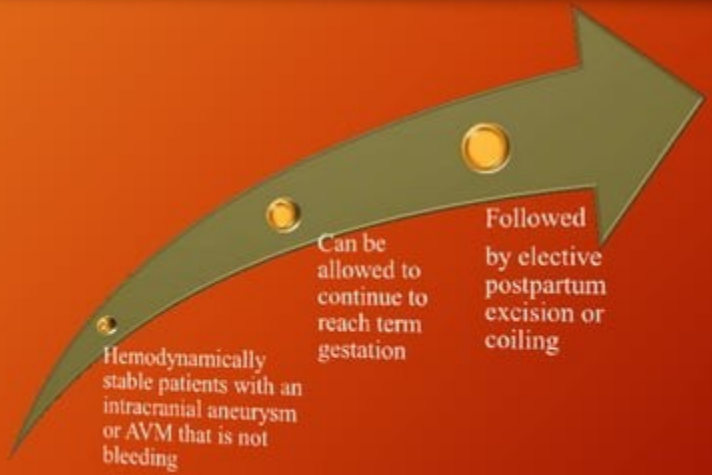


- **Indication**
  - Subarachnoid hemorrhage
  - Intracranial hemorrhage
  - Acute traumatic brain injury
  - Primary or metastatic brain tumor

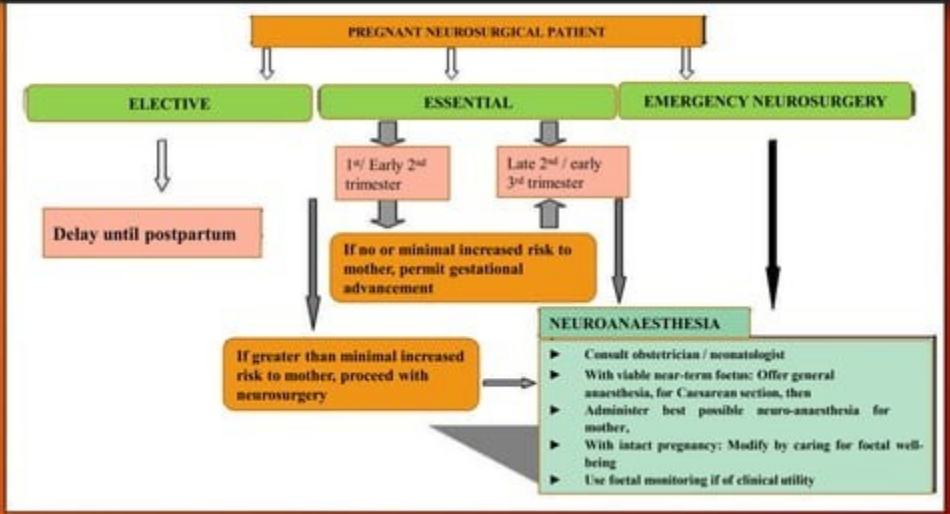
- All neurosurgical procedures during pregnancy must be considered as major interventions

Managed promptly by interventional endovascular treatment or intracranial surgery at any stage of pregnancy

Subarachnoid haemorrhage due to ruptured intracranial arterial aneurysms and arterio-venous malformations (AVM)


Hemodynamically stable patients with an intracranial aneurysm or AVM that is not bleeding
Can be allowed to continue to reach term gestation
Followed by elective postpartum excision or coiling

Timing of neurosurgery in relation to gestational age and tasks of neuroanaesthesia



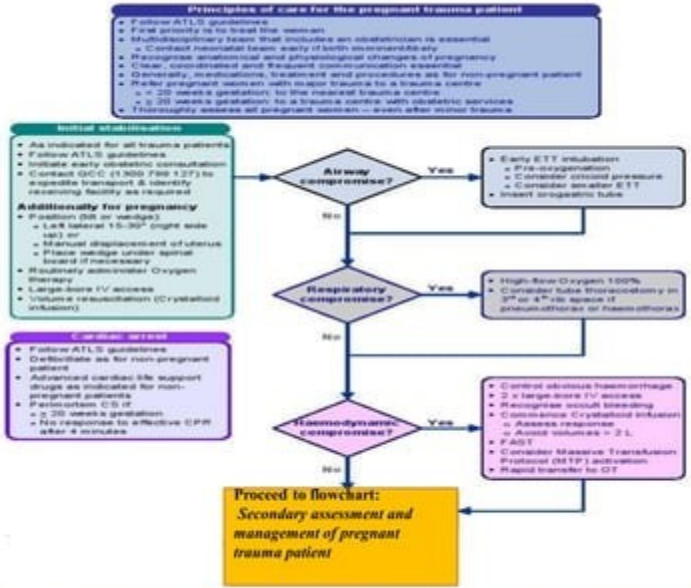
Management of Trauma in Pregnancy

- Incidence : 8% of all pregnancies
- Type: 1) Blunt , 2) Penetrating
- Effects
  - Direct foetal injuries
  - Placental abruption
  - Pre-term labor
  - Massive foeto-maternal hemorrhage
  - Uterine ruptre
  - Foetal loss

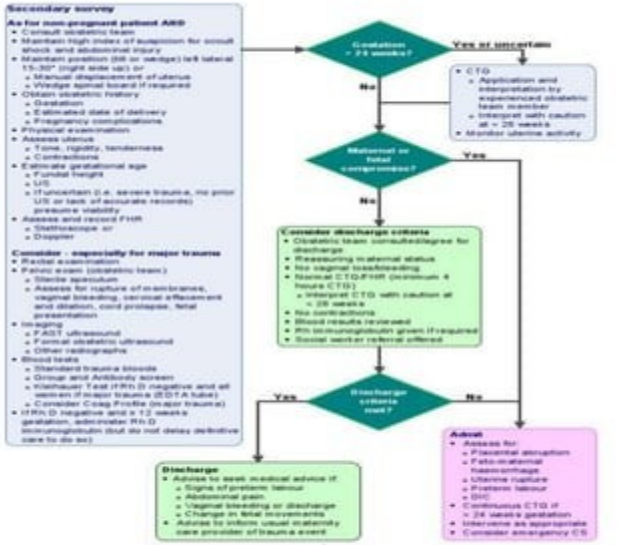
Trauma in Pregnancy. Queensland Clinical Guidelines Steering Committee (Australia).

GOAL OF TREATMENT

- First priority is resuscitation of mother
- Management in accordance to the Advanced Trauma Life Support (ATLS) guidelines
- Maintenance of utero-placental perfusion and fetal oxygenation
- A multidisciplinary team approach that includes early involvement of an obstetrician and neonatologist and trauma expert
- Medications, tests, treatments and procedures required for the woman's stabilisation not to be withheld because of pregnancy
- Less than 20 weeks of gestation → transfer to the nearest trauma centre
- Greater than or equal to 20 weeks of gestation → transfer to a trauma centre with obstetric services



Flow Chart: Initial assessment and management of the pregnant trauma patient



Flow Chart: Secondary assessment and management of the pregnant trauma patient

EFFECTIVE CPR

- Position the woman to reduce IVC compression
  - Left lateral tilt 15–30 degrees (right side up)
  - Place wedge under the spinal board if necessary
  - Effective chest compression at left lateral tilt
- Defibrillate as for the non-pregnant trauma patient – no significant shock is delivered to the fetus
- Remove CTG leads prior to defibrillation

Trauma in Pregnancy. Queensland Clinical Guidelines Steering Committee (Australia).

ROLE OF PERI-MORTEM CS

- CS initiated after CPR is considered as Perimortem CS
- May improve survival of either or both the woman and foetus but the resuscitative procedure aimed primarily in the interest of maternal survival
- Delay in initiating a perimortem CS has been linked to adverse outcomes
- Survival and neurologic outcome of the viable foetus is best if CS done within 4 to 6 minutes of cardiac arrest
- Intact foetal survival has not been demonstrated beyond 30 minutes of cardiac arrest

Cardiac Surgery during Pregnancy

- Incicence of herat disease in pregnancy : 1-3%
- Incidence of maternal death : 10-15%
- Higher morbidity and mortality with cardiac surgery
- First managed medically
- Surgery reserved for severe decompensation
- Percutaneous balloon valvuloplasty seems to be better alternative

CONDITIONS REQUIRING SURGERY

- Severe valvular disease
- Aortic aneurysm
- Aortic dissection
- Severe congenital anomaly
- Pulmonary thromboembolism
- Severe coronary artery disease

❖ Four major risk factors predict adverse maternal outcomes :

- history of transient ischemic attack, stroke, or arrhythmia
- NYHA heart failure classification of three or four before onset of pregnancy
- left-heart obstruction (e.g., mitral valve area <2 cm2, aortic valve area <1.5 cm2, peak left outflow gradient > 30mmHg)
- left ventricular (LV) ejection fraction <40%

- Predictors of Neonatal complications
  - NYHA heart failure class >2
  - Anticoagulation use during pregnancy
  - Smoking
  - Multiple gestation
  - Left heart obstruction

❖ Complications of cardiac surgery

- pulmonary oedema
- arrhythmias
- myocardial infarction
- stroke
- heart failure
- death

FOETAL PROTECTION STRATEGIES DURING CPB

- High pump flow rate (>2.5 L min^{-1} m^{-2})
- Increased perfusion pressure (> 70 mm Hg)
- Maintenance of maternal hematocrit 28%
- Limit hypothermia(< 32 degree)
- Monitor uterine tone and FHR
- Minimize CPB time
- Consider pulsatile perfusion
- Optimize acid-base, glucose, PaO2 & PaCO2

Anaesthesia for Foetal Surgery



- **Indication**
  - Hydronephrosis
  - Hydrocephalus
  - Sacrococcygeal teratoma
  - Meningomyelocele
  - Diaphragmatic hernia

- Surgery and anaesthesia carry risks to foetal death and morbidity
- Enhanced surgical and anaesthetic risk in the mother including haemorrhage, infection, airway difficulties and amniotic fluid embolism
- Since uteroplacental flow is influenced by vascular resistance therefore uterus must remain relaxed
- Kinking of umbilical cord must be avoided during changing position of the fetus to facilitate blood flow

Electroconvulsive Therapy (ECT)

- Psychiatric disease is an important cause of maternal mortality and morbidity
- Balance between psychotropic agents and risk of teratogenicity is important
- Discontinuation of treatment may lead to relapse and mood disorder
- ECT has been endorsed by APA as a treatment during all three trimesters
- Major complications:
  - Self limited FHR abnormality
  - Vaginal bleeding
  - Uterine contraction
  - Abdominal pain
  - Preterm labor/ Spontaneous abortion

Suggested Guidelines for ECT:

- Preoperative obstetric consultation
- Adequate hydration to be maintained
- Acid aspiration prophylaxis 20 mins before procedure (0.3 M sodium citrate)
- After 1st Trimester ET intubation is mandatory
- Left uterine displacement after 18-20 wks gestation
- FHR monitoring before and after ECT
- Tocodynametry to be performed within 60 mins of the procedure
- Uterine contractions and vaginal bleeding to be monitored after ECT

Conclusion

- To check pregnancy tests before anaesthesia & surgery
- To consider maternal risk associated with anatomical & physiological changes
- To consider foetal risk associated with teratogenicity, UBF & preterm labor
- Diagnosis of the pathology often become delayed ,increasing the foetal & maternal risk
- Maternal hypoxia, hypercarbia, hypotension, acidosis may pose greatest risk to the foetus
- No anaesthetic agent is proved to be teratogenic, N2O may only be harmful to animals
- It is not clear whether the adverse foetal outcome is due to prolonged use of anaesthetic or surgery itself
- Laparoscopic surgery is likely to be a useful modality for surgical intervention
- FHR & CTG monitoring may be useful

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THANK YOU