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Review Article

Anaesthesia for foetal surgery

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ARTICLE INFO

Article history:
Received 7 December 2014
Accepted 20 January 2015
Available online 24 February 2015

Keywords:
Foetal surgery
Anaesthesia
Exit procedures
Foetoscopic surgery

ABSTRACT

Anaesthesia for foetal surgery is one of the most exciting and challenging fields of anaesthesia. The anaesthetist is involved in the well being of two or more patients (mother and foetus or foetuses). Hysterotomy based procedures, Ex-utero intrapartum therapy (EXIT), minimally invasive foetoscopic procedures and micro-invasive image-guided procedures are done, utilizing placental support for foetal well being; while the mother can receive general anaesthesia, regional anaesthesia or local anaesthesia. Haemodynamic stability, vigilant monitoring, judicious fluid replacement, adequate maternal tocolysis, good intraoperative and postoperative analgesia are the anaesthetic goals. Ethical considerations for foetal surgery are like those involved in organ transplant, and should always be considered before planning such procedures, which involve multidisciplinary team work.

With advancement in prenatal diagnostic technologies especially ultrasonography, an increasing number of foetal anomalies are being diagnosed early in gestation. Some of these conditions may benefit from prenatal surgical intervention. Foetal surgery is a reasonable alternative for selected foetal anomalies that cause harm to the foetus before the adequate development of foetal lung maturity necessary for extra uterine survival.

Foetal surgery targets those foetal malformations which if allowed proceeding to the normal onset of labour and delivery will result in foetal demise or permanent disability but are potentially correctable in utero.

These procedures on the foetus or placenta are designed to alter the natural history of a foetal disease that is diagnosed in utero. During the procedure the foetus continues to be perfused by the placenta and umbilical circulation.

Foetal surgery is reasonable only[1]

- If the lesion is diagnosed accurately
- The lesion's severity is assessed correctly
- Associated congenital anomalies that contraindicate intervention are excluded
- Maternal risk is acceptably low and
- It is likely to be more successful than surgery performed after preterm or term delivery

There are three types of foetal surgical procedures which are usually performed at 18–26 weeks of gestation:

a. Open foetal surgery or hysterotomy during which the foetus is exteriorized for the surgical procedure and then placed back in the uterus to mature till term if possible.
b. Ex-utero intrapartum therapy (EXIT) previously called as airway management on placental support or operations on placental support are also hysterotomy based procedures

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http://dx.doi.org/10.1016/j.cmrp.2015.01.005

but are performed near term and are followed by delivery of the foetus. It is reserved for foetuses with expected post gestation airway or oxygenation compromise. Surgery is done after hysterotomy but prior to cord clamping. During this time foetal oxygenation is maintained by placental transfer of oxygen.

c. Minimally invasive procedures.

These are the most frequently performed procedures nowadays. The uterine cavity is accessed percutaneously with the help of needles or sheaths and visualization is aided non-invasively with the help of sonography or foetoscopes.

There has been an evolution of approach from open procedures to less invasive approach such as uterine endoscopy and more recently percutaneous procedures using endoscopes with diameter of 3 mm or less. This progression to micro-invasive foetoscopic approaches has been associated with reduction in mortality, less bleeding, less chances of preterm labour and preterm premature rupture of membranes; less incidence of chorio-amnionitis and amniotic leak. These procedures can be done under local anaesthesia with infiltration of abdominal wall or if necessary under regional anaesthesia (Table 2).

Foetal surgery is a specialized branch performed only at few centers worldwide. The indications for foetal surgery have increased with time (Table 1). But only two procedures are currently supported by randomized clinical trials. The first one is the open correction of myelomeningocele and second is endoscopic laser therapy for twin-to-twin transfusion syndrome.[2,3] The common indications for foetal surgery[1,4] are listed in Table 1.

Providing anaesthesia for foetal surgery is a unique challenge, because more than one patient needs to be considered. The foetus is treated as a patient in its own right while the parturient has been referred to as an innocent bystander, who is exposed to surgical and postpartum risk but receives no health benefits.[5] Therefore the mother should always be protected from undue risks (Table 2).

Table 1 – Indications for open/hysterotomy, minimally invasive foetal surgery and EXIT procedures.[1,4]

Type	Foetal lesion/anomaly	Reasons for treatment
Open	Congenital diaphragmatic hernia	Lung hyperplasia
	Congenital cystic adenomatoid malformation	Hydrops foetal, lung hypoplasia
	Myelomeningocele	Amniotic fluid neurotoxicity
	Sacrococcygeal teratoma	Hydrops foetalis
Minimally invasive	Twin–Twin transfusion syndrome	Laser ablation of vessels
	Twin reversed arterial perfusion	Radiofrequency ablation or ligation of cord of non viable twin
	Obstructive uropathy	Shunt insertion and valve ablation
	Cyanotic heart disease	Atrial septostomy
	Aortic/pulmonary stenosis	Valvuoplasty
	Congenital diaphragmatic hernia	Tracheal ballon occlusion
EXIT	Foetal cervical masses	Lymphangioma Teratoma Haemangioma Neuroblastoma Goitre
	Foetal lung masses	Bronchopulmonary sequestration
	Foetal mediastinal masses	Teratoma Lymphangioma
	EXIT to extra corporeal membrane oxygenation [ECMO]	Severe congenital diaphragmatic hernia with liver herniation into chest cavity Congenital heart disease
	Reversal of tracheal occlusion after tracheal clip or endoluminal balloon procedures	CDH
	Bridge to separation of conjoint twins	

1. Maternal anaesthetic aspects of foetal surgery

While planning anaesthesia for foetal surgical procedures. The broad challenges presented to the anaesthesiologist are[6]

1. Those related to any anaesthestic in a pregnant women
2. Techniques to prevent preterm labour
3. Maintenance of maternal homeostasis in the face of tocolytic techniques
4. Maintenance of foetal homeostasis
5. Provision of foetal analgesia during surgery

1.1. *Physiological changes during pregnancy*

Pregnancy related anatomical and physiological changes affect the anaesthetic management of woman presenting for foetal surgery. Patients presenting for these procedures often have polyhydramnios, where the second trimester uterus becomes as large as near term in a normal pregnancy, this increases the risk for caval compression, supine hypotension syndrome and uterine hypoperfusion due to decreased venous return. Left lateral tilted position is important during foetal surgery to avoid this complication especially when the foetus is placed back in the uterus after surgery.[7]

All these mothers require antibiotic prophylaxis, prophylaxis for bronchoaspiration and thromboembolic venous diseases.[8]

Minimum alveolar concentration (MAC) values for volatile anaesthetic are decreased by approximately 40% during pregnancy. Therefore while using inhalational agents hypotension at high concentrations should be anticipated. Besides there is increased sensitivity to local anaesthetic agent.

1.2. *Uterine relaxation*

For open foetal surgery and EXIT procedures, profound uterine relaxation is required for optimal surgical exposure of the foetus, for optimal placental gas exchange and prevention of preterm labour postoperatively.[7] This is achieved primarily by