Anaesthetic Management of Paediatric Endoscopic Procedures

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With the advent of specialized equipment, improvement in the technical skills, better "understanding" of smaller children and appreciation of the advantages over "open"procedures, the practice of laparoscopic surgery has increased in children. Anaesthetic implications and management of laparoscopy and endoscopy of upper and lower gastrointestinal tract are discussed in this article.

Laparoscopic Procedures

Laparoscopic procedures, diagnostic and therapeutic, are performed in children of all ages. Smaller the age, the safety margin is less and the physiological trespass is more likely.

Indications for laparoscopic procedures

Diagnostic	Therapeutic
Abdominal mass biopsy	Appendicectomy, cholecystectomy
Chronic abdominal pain	Adhesions lysis
Volvulus	Fundaplication
Biliary atresia	Nephrectomy, splenectomy
Staging of tumors and biopsy	Hernia repair
Meckel's diverticulum	Orchidopexy

The physiological effects and anaesthetic implications are related to:

- Inflating gas: effects of absorption into systemic circulation
- Pneumoperitoneum and intra abdominal pressure (IAP)
- Positioning
- Extra peritoneal insufflation of gases (intrathoracic, subcutaneous, mediastinal)
- Age specific physiological characteristics of the patient (infant, neonate, preterm etc.) Surgical condition

Carbon dioxide (CO_2) is the most commonly used gas for insufflation. It is absorbed into systemic circulation increasing both arterial partial pressure ($PaCO_2$) and end tidal CO_2 tension ($ETCO_2$). The $PaCO_2 - ETCO_2$ difference is also

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increased. This requires higher minute volume (50-75%) to maintain normocarbia.

Hypercarbia increases heart rate and blood pressure, sensitizes the myocardium to catecholamines and increases cerebral blood flow. Extra peritoneal insufflation can cause subcutaneous emphysema, pneumothorax and pneumo mediastinum.

The other gases that have been tried for insufflation are nitrous oxide, air and inert gases (helium and argon).But nitrous oxide and air support combustion. In addition, absorption of all these gases can cause gas embolism with adverse haemodynamic consequences.

PATHOPHYSIOLOGICAL EFFECTS

The adverse effects result from a combination of increased IAP, positioning, absorption of CO_2 and inherent physiological characteristics of infants and neonates affecting respiratory functions, haemodynamic stability, renal function and cerebrovascular dynamics.

Respiratory effects : Increased IAP causes cephalad displacement of diaphragm which is worsened by Trendelenbergs position. This reduces pulmonary and thoracic compliance, increases peak airway pressure and reduces functional residual capacity(FRC) leading to ventilation perfusion (V/Q) mismatch which can be further adversely affected by general anaesthesia, positive pressure ventilation and position. Clinically, these changes can result in atelectasis and hypoxia.

In a newborn, since trachea is short, upward displacement of diaphragm can push the carina up and may result in endobroncheal intubation.

Cardiovascular effects: Infants and neonates are characterized by low systemic vascular resistance and blood pressure, immature myocardium with rate dependent cardiac output, high oxygen consumption and high cardiac output. During laparoscopy, there is a tendency for rhythm disturbances, hypotension and hypertension due to the effects of pneumoperitoneum, hypercarbia, stretching of peritoneum during insertion of trochar, bleeding and effects secondary to respiratory changes.

When IAP increases more than 6cmH_2O (less than 10cmH_2O) in infants, venous return and cardiac output (CO) increase due to transfer of blood from splanchnic venous field. Further increase in IAP reduces aortic blood flow leading to reduction of CO, causes compression of splanchnic vessels, activation of sympathetic reflex response and release of humoral vasoconstrictor mediators. Haemodynamic and respiratory effects are minimized by restricting IAP and maintaining normal intravascular volume. The physiological and haemodynamic changes are most intense in the initial period of insufflation.

Current recommendation is to maintain IAP<6 cm H_2O in neonates and infants less than 4 months and IAP<10cm H_2O in infants to minimize the effects on cadiorespiratory functions.

Cerebral blood flow and intracranial pressure (ICP): During laparoscopy, ICP can be increased due to hypercarbia, increased IAP, Trendelenberg position and pneumoperitoneum. This increase is independent of $PaCO_2$ and $ETCO_2$ changes and can be unresponsive to hyperventilation.

OTHER EFFECTS

Oliguria can develop during CO_2 insufflation due to reduction in glomerular filtration rate, activation of neurohumoral factors, hypotension etc. Aggressive hydration does not always prevent oliguria and exact reason for renal dysfunction during pneumoperitoneum is not known.

Hypothermia can develop with prolonged insufflation with CO_2. Large body surface area of infants and dry anaesthetic gases also contribute to temperature loss.

Injury to various superficial nerves and brachial

plexus is possible due to stretching and compression. Due care should be taken to prevent nerve injury.

PERIOPERATIVE MANAGEMENT

Preanaesthetic evaluation, preparation and premedication

History, clinical examination and relevant investigations form the cornerstones of preanaesthetic evaluation. Issues specific to paediatric age group should be evaluated and include congenital heart disease, respiratory infection, evaluation of the airway, fluid and electrolyte status, respiratory infection etc.

Preoperatively, hypovolemia should be corrected to minimize risk of hypotension. Cross matched blood may be requested for if the procedure is likely to result in blood loss.

Premedication is "customized" depending on age, weight, general condition and surgical needs. Anticholinergic premedication, preferably intramuscular, 30 to 45 minutes prior to surgery is associated with reduced incidence of adverse perioperative cardiovascular and airway related events.

General anaesthesia with endotracheal intubation with controlled ventilation is the technique of choice, especially in infants and neonates. Though LMA has been safely used in older children, it does not protect against aspiration in presence of pneumoperitonium and Trendelenbergs position. Induction and intubation by intravenous or inhalational method is a matter of choice unless dictated by patient's preexisting condition (difficult airway, risk of aspiration). Sevoflurane is the agent of choice for inhalation induction, intubation and maintenance because of hemodynamic stability and low risk of hepatotoxicity. Hyperventilation and increase in minute ventilation is required to eliminate absorbed CO_2. Nitrous oxide is preferably avoided to prevent bowel distension.

Monitoring includes precardial and oesophageal stethoscope, pulse oximeter, capnography, NIBP, continuous ECG, temperature, urine output and peripheral nerve stimulator. Intra arterial blood pressure, CVP, blood gas analysis and Transoesophageal echocardiography may be indicated in specific situations. Due to CO_2 absorption, $ETCO_2$ is usually 8 mmHg higher than $PaCO_2$. Temperature monitoring is essential for early detection of hypothermia which can develop due to prolonged insufflation of cold, nonhumidified CO_2, large surface area, low subcutaneous fat and air conditioning of OR. Appropriate preventive measures must be taken. The fluid used for irrigation must be warmed and should be isotonic. Orogastric or nasogastric tube and urinary catheter are also essential to deflate the bowel and keep the bladder empty.

At the end of the surgery, evacuation of remaining CO_2 and adequate reversal of neuromuscular blockade should be ensured before extubation .Anti emetic drug should be administered after induction of anaesthesia for prevention of PONV (ondensetron100μg/kg or dexamethasone 150μg/kg intravenously).

Post operatively, oxygen supplementation may be required. Pain relief can be provided by caudal block (for procedures below the umbilical level), infiltration of portal entry sites, parenteral opioids and NSAIDS (to be avoided in small infants and neonates).

Summary of anaesthetic management of paediatric Laparoscopy

- Anaesthetic challenges in paediatric laparoscopic procedures are related to age, pneumoperitoneum, IAP, effects of gas absorbed into circulation and inadvertent extra peritoneal insufflation.
- Increases peak airway pressure, reduced lung compliance and ventilation perfusion mismatch are the potential adverse consequences on

respiratory system, predisposing to hypoxia. This can be worsened by low FRC, high closing capacity, high metabolic rate of neonates and small infants.

- Arrhythmia and hypotension are the most important adverse cardiac events, caused by hypercarbia, anaesthetics, hypovolemia, effects of pneumoperitoneum on inferior vena cava and splanchnic circulation.
- Worsening of ICP and renal dysfunction have been observed in susceptible individuals.
- Pneumothorax, pneumomediastinum and subcutaneous emphysema can develop following extarperitoneal insufflation of CO_2
- Anticholinergic premedication, endotracheal general anaesthesia with IPPV, increased minute volume, use of sevoflurane, adequate reversal and administration of antiemetics constitute important aspects of anaesthetic management. Postoperative pain can be taken care of with systemic opioids, NSAID, infiltration of portals of entry etc.

ANAESTHETIC MANAGEMENT OF GASTROINTESTINAL ENDOSCOPY

GI endoscopies are performed in children for diagnostic and therapeutic purposes. These can be upper GI endoscopy (gastroscopy and duodinoscopy) and lower GI endoscopy (colonoscopy and sigmoidoscopy).

Upper GI endoscopy procedures involve sharing of the airway region with the surgeon; require immobility during the procedure and return of airway protective reflexes at the end of the procedure. In addition, the procedures are often performed in endoscopy rooms where the facilities for anaesthetic management may be less than satisfactory.

Preanaesthetic evaluation should focus on the effects of the suspected disease on the various organ systems particularly liver, possibility of hypovolemia or significant blood loss and age related issues. Relevant investigations depend on the clinical condition.

General anaesthesia with endotracheal intubation and controlled ventilation with short or intermediate acting muscle relaxants is recommended. Antiemetics may be required.

Use of sedation for upper GI endoscopy is not advisable because:

Airway is shared with the surgeon.

Difficult to maintain the protective reflexes (to prevent aspiration) while maintaining the patient immobile (to facilitate procedure) which requires deep sedation.

Deep sedation is associated with loss of reflexes and possibly haemodynamic instability. Should any complications develop, it is difficult to ventilate or intubate the patient without interrupting the procedure. Coughing, laryngospasm and delayed recovery are the other potential problems associated with sedation.

However, sedation may be used in older and cooperative children. Standard NPO guidelines should be followed and vigilant monitoring (**see below**) is essential. In addition, spraying the oral cavity with xylocaine before introducing the endoscope helps to suppress reflexes.

Problems related to location can be tackled by familiarizing with place, prior checking the equipment, preanaesthetic evaluation and preparation of patient and following institutional protocols rigorously. Monitoring of SpO_2, continuous ECG and blood pressure is mandatory.

Lower G I endoscopy can be carried out under sedation. Different drugs or combination of drugs are used. Propofol, midazolam and ketamine individually or in different combinations are used. They can be given by intermittent bolus injections or continuous infusion. IV administration may be preceded by oral

sedative premedication (trichlofos, midazolam, ketamine etc) depending on age of the child and level of anxiety.

Guidelines are available for safe sedation. Important aspects of safe sedation practice are (key words highlighted):

- Proper patient selection and Preanaesthetic evaluation-**Medical History and airway evaluation**
- **Informed consent**
- **Standard fasting guidelines**
- Familiarity with the location (if it is outside the OT) and presence of trained assistant
- Availability of resuscitation equipment, suction, emergency drugs and oxygen therapy equipment-**age and size appropriate equipment**
- Choice of **drug(s)** for sedation: affected by age, degree of analgesia required, duration of the procedure, presence of co-existing diseases, familiarity with the drug etc. Careful calculation of dose and dilution is very important, especially in smaller children.
- **Monitoring: Baseline (preinduction)** values, monitoring during the procedure, which should be continued till complete recovery. Monitoring **oxygen saturation, ECG and blood pressure** are mandatory and have proved to enhance safety by detecting complications early.
- Supplementation of oxygen during the procedure also enhances the safety though **it is not a substitute for vigilant monitoring.**
- Documentation of pre procedural condition, baseline values, intraoperative values and any incidents, recovery and details of all drugs given – **Time based record keeping**
- **Recovery facility**
- **Back up equipment in OT and recovery area**
- **Standard discharge criteria**
- Development of **institutionalized protocol** and strict adherence to the same. Any critical incident should be discussed and corrective steps should be implemented to prevent the same.

COMMON DRUGS USED FOR SEDATION

Trichlofos is a good sedative by oral route in the dose of 100mg/kg, 45 min to one hour prior to procedure. It does not provide analgesia.

Propofol is ideal for procedural sedation, can be given by intermittent bolus or infusion. Loading dose is 1mg/Kg followed by infusion of 50-75µg/kg/min. Suppression of airway reflexes, excellent recovery and rapid return to 'street fitness' and antiemetic property are the major advantages. Pain on injection and hypotension (especially if there is hypovolemia) are the disadvantages.

Midazolam can be given by oral (0.5 to 0.75 mg/kg, onset in 45 min), nasal and IV (75 to 100µg/kg) routes. Advantages are rapid onset, no pain on injection, anxiolysis, short duration of action and minimal haemodynamic effects. Lack of analgesia is the main disadvantage and recovery may be delayed after large doses.

Ketamine can be given by oral(6mg/kg, onset in 45 min), rectal (0.3mg/Kg, rapid onset), intramuscular(3-4mg/Kg, onset in 5-10 min) or intravenous(0.5-1.0mg/Kg) routes. It is a potent analgesic and causes prolonged sedation following IM injection. Coughing, increased muscle tone and increased airway secretions are the major disadvantages.

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