Anaesthetic Considerations in Paediatric Laparoscopic Surgeries

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Summary:

Extremes of age represent an anaesthetic challenge due to age specific anatomical and physiological changes. Laparoscopic surgery is quite common even in paediatric age group considering its benefits over open surgery[1,2]. Implications of laparoscopic surgery on the anaesthetic management of paediatric age group should be well considered. Choice of anaesthesia and management depends on the underlying cardiorespiratory status and the implications of pneumoperitoneum created. Success depends on predicting the effect on every system, strategy to deal with and an open communication with the team.

Although Laparoscopy is known for the last 100 years it has become popular only in the last two decades. Minimal Invasive Surgery (MIS) as it is popularly known offers advantage of smaller inscision, minimal risk of infection, shorter hospital stay and better clinical information. Hurdles include cost, lack of surgical and anaesthetic expertise, duration of surgery and the effects of pneumo peritoneum on neonates and infants. This article describes the physiological alterations during laparoscopic procedure and anaesthetic implications. Further we discuss the advantages as well as disadvantages of Minimal Invasive Surgery.

Common Laparoscopic procedures performed in paediatric age group are listed in Table 1[3,4,5]. Combination of very fine devices, precise movement, experience have allowed surgeons to perform Laparoscopic procedures in children. As in adults paediatric laparoscopy also started with appendectomy and cholecystectomy. Minimal Invasive Surgery generally includes Thoracoscoy, Abdominal and Urological procedures.

Table 1: Common Laparoscopic Procedures in Children

Appendectomy
Hernia Repair
Diagnostic Laparoscopy
Nissens Fundoplication
Spleenectomy
Cholecystectomy
Nephrectomy
Pyloromyotomy

Phsiological Effects of Pneumoperitoneum

Pneumoperitoneum created exerts its effects due to the intra-abdominal pressure as well as due to the absorbtion of carbon dioxide. Due to the increased peritoneal surface area to mass ratio, decreased muscle mass the physiological effects are enhanced in neonates and children.

Respiratory Effects

Due to raised intra-abdominal pressure there is cephalad movement of the diaphragm. This leads to a decrease in Functional Residual Capacity and alveolar collapse[6]. There is intrapulmonary shunting and hypoxemia. Infants desaturate faster due to these effects and hence ventilatory mechanics and intra-abdominal pressure needs constant monitoring. Inflation pressure of 12 mm of Hg in case of infants less than 5Kg and 15 mm of Hg in case of more than 5 Kg is ideal. There is decrease in lung compliance and increased chances of bronchial mainstem intubation. Bilateral air entry check is a must during any change in ventilatory mechanics or desaturation.

Cardiovascular Effects:

The intra-abdominal pressure is the major determinant of the cardiac changes[7]. Myocardial contractility, preload and Systemic vascular resistance are all effected. Preload is decreased due to decreased venous return, which in turn decreases cardiac output. Increased afterload or systemic vascular resistance also leads to a decreased cardiac output. Position like the reverse Trendelenberg can lead to decrease in venous return, care should be taken that these patients are not dehydrated or intravenous fluid is given to maintain venous return[8].

Babies less than three months old can maintain their cardiac output only by increasing their heart rate and not contractility as their myocardial fibres are immature and should be well prepared for any such event.

The cardiovascular changes associated with laparoscopic surgery depend upon the intra-abdominal pressure attained, the amount of CO2 absorbed, the patient's intravascular volume status, the ventilatory technique, surgical conditions, and the anaesthetic

agents used. Patient positioning, hypercarbia, and the use of positive pressure ventilation can further compromise the cardiovascular function[9]. The anaesthesiologist should also be aware of the fact that vagally mediated reflex bradycardia or even asystole can occur during insufflation, especially in infants and small children.

The intra-abdominal pressure should be maintained at 5-10 mm of Hg in toddlers and infants, pressure of 10-15 mm of Hg in older children[14]. Maintaining these pressures will minimize the cardiovascular effects of pneumoperitoneum in children which are seen at lower pressures in children. Carbon dioxide flow should be maintained at 1ltr/min or lower to maintain the above pressures.

Renal Effects:

Due to raised abdominal pressures there is compromise on the blood flow to the kidneys. There is decreased urine output during laparoscopic procedures but once the pneumoperitoneum is relieved the urine output is maintained. The kidney injury markers are also released during laparoscopic procedures indicating injury to the kidney[13].

Central Nervous System:

There is raised Intracranial pressure[16] during laparoscopic procedures due to the decreased venous return and Trendelenberg position. These effects increase with the increased duration of the procedures.

Temperature:

Greater chances of hypothermia in case of neonates and children. The degree of hypothermia again depends on the duration of laparoscopic procedure. There is decrease in temperature of 0.01 degree Celsius of surgical time in minutes. Warming of the Carbon dioxide gas used for insufflations can solve this problem.

Disadvantages in Children:

Even the smallest instruments seem larger for these small patients and thus add on the technological difficulties. Instruments well adapted for laparoscopy in children are not available easily in the market.

Because of non-availability the surgeons are left with no choice but to use large instruments which makes it more difficult. These technological difficulties leads to difficulty in precise movements. Duration of surgery is important as longer duration in laparoscopy then in open surgery can cause more cardiorespiratory problems.

Hypothermia can occur due to leak in the instruments. The carbon dioxide causes hypothermia due to evaporative loss and higher the flow to compensate for leaks can cause low temperature. This problem can be compensated by warming the carbon dioxide used. Evaporative losses can be minimized by avoiding leaks.

Contraindications:

Pre-existing cardiovascular instability or in case of penetrating trauma its difficult to perform minimally invasive surgery. Pulmonary problems like emphysematous bullae or compromised lung its difficult to produce a pneumoperitoneum. Rest of the conditions like raised intracranial pressure, hypothermia, compromised gastrointestinal perfusion are relative contraindications.

Anaesthetic Management for Laparoscopic procedure in children:

Preoperative assessment of the cardiorespiratory status, airway difficulty (congenital anomaly), any recent respiratory infection have to be evaluated. Laboratory investigations are done specific to the patient condition and in relation to the procedure. Premedication depends on the institute protocol and individual patient condition. Oral midazolam[10] 20-40 minutes before the procedure is the preferred anxiolytic. Anticholingeric agent can be added to decrease oral secretion or to prevent reflex bradycardia.

Anaesthetic induction can be either inhalational or intravenous. Choice varies with individual but inhalational induction is preferred in smaller children and intravenous in the older ones. Intravenous access is preferred in the upper limbs as access is easy and can be monitored easily. Cuffed endotracheal tubes minimize the leaks.

Maintenance of anaesthesia is by sevoflurane and oxygen. Intermediate acting neuromuscular blocking agents are used. The main challenge is to maintain respiratory parameters during laparoscopy in children and neonates. Monitoring the peak inspiratory pressures and end tidal carbon dioxide are important. Increased minute ventilation by 25-30% and an increase in Fi02 may be required. Application of PEEP may be required to counteract the basal atelectasis. Intermittent release of pneumoperitoneum may be required if oxygenation is not maintained inspite of ventilatory changes and optimization of cardiac output. Pneumothorax[8] and C02 embolism may occur. If C02 embolism occurs pneumoperitoneum should be released. Agents decreasing cardiac output should be discontinued. C02 embolism is rare and if occurs reverses quickly due to increased solubility of C02.

After completion of surgery the C02 gas should be completely evacuated[11] to prevent postoperative pain, nausea. Neuromuscular blockade should be reversed and antiemetic agents should be given.

Postoperative analgesia in the form of local infiltration and regional block in the form of caudal block[12] can be given. Rectal suppositories or Oral analgesics in the form of Paracetamol and Diclofenac can be given. Nociceptors are stimulated by high pressures, chemicals released, extremes of temperature. Endoneural ischaemia of the phrenic and peritoneal nerves due to abdominal stretching also causes pain.

Team Work:

Good team work and proper communication between surgeon, anaesthetist and nursing staff is a must for success of any procedure. Intermittent interruption of pneumoperitoneum, maintaining of adequate insufflation pressure, adequate muscle relaxation and position changes are joint responsibilities of the team.

Conclusion:

Laparoscopic surgery is of more technique than technology. An institute is required to provide the right set of instruments, adequate training of the staff and tolerate new learning curves for success of paediatric laparoscopy. Selection of a patient who is going to benefit from Minimal Invasive surgery is very important. Children are not miniature adults and hence their physiology and effects of pneumoperitoneum on the cardiorespiratory system should be well known and a strategy to deal with those effects.

References:

1. Zitsman JL. Current concepts in minimal access surgery for children.Pediatrics 2003;111:1239-1252.
2. Firilas AM, Jackson RJ, Smith SD. Minimally invasive surgery: the pediatric surgery experience. J Am Coll Surg 1998;186:542-544.
3. Sfez M. Anaesthesia for laparoscopic surgery in pediatrics. Ann Fr Reanim 1994;13:221-32.
4. Holcomb GW 3rd, Olsen DO, Sharp KW. Laparoscopic cholecystectomy in the pediatric patient. J Pediatr Surg 1991;26:1186-1190.
5. Laine S, Rantala A, Gullichsen R, Ovaska J. Laparoscopic vs conventional Nissen fundoplication. A prospective randomized study. Surg Endosc 1997;11:441-444.
6. Richardson JD, Trinkle JK. Hemodynamic and respiratory alterations with increased abdominal pressure. J Surg Res 1976;20(Abs):A401-4.
7. Gentili A, Iannettone CM, Pigna A, Landuzzi V, Lima M, Baronuni S. Cardiocirculatory changes during videolaparoscopy in children: an echocar-diographic study. Paediatr Anaesth 2000;10:399-406.
8. Tobias JD. Anaesthesia for minimally invasive surgery in children. Best
9. Pract Res Clin Anaesthesiol 2002;16(1):115-130.
10. Huettemann E, Sakka SG, Petrat G, Schier F, Reinhart K. Left ventricular regional wall motion abnormalities during pneumoperitoneum in children. British J Anaesth 2003;90:733-6.
11. Feld LH, Negus JB, White PF. Oral midazolam preanesthetic medication in pediatric outpatients. Anesthesiology 1990;73:831-834.
12. McHoney M, Corizia L, Eaton S, et al. Carbon dioxide elimination during laparoscopy in children is age dependent. J Pediatr Surg 2003;38:105-110; discussion 110..
13. Tobias JD, Holcomb GW111, Lowe S, Hersey S, Brock JW111. Caudal epidural block for analgesia following herniorrhaphy with laparoscopy in chil-dren. J Laparoendosc Surg 1994;4:117-20.
14. Koivusalo AM, Kellokumpu I, Ristkari S, Lindgren L. Splanchnic and renal deterioration during and after laparascopic cholecystectomy: a comparison of the carbon dioxide penumoperitoneum and the abdominal wall lift method. Anesth Analg 1997;85:886-891.
15. Bannister CF, Brosius KK, Wulkan M. The effect of insufflation pressure on pulmonary mechanics in infants duriPaediatric Anaesthesia 2003;13:785-9.thesiology in laparoscopic surgery in infancy.
16. Wahba RW, Mamazza J, Ventilatory requirements during laparoscopic chole-cystectomy. Can J Anaesth 1993;40:206-10.
17. Huettemann E, Terborg C, Sakka SG, Petrat G, Schier F, Reinhart K. Preserved CO2reactivity and increase in middle cerebral arterial blood flow velocity during laparoscopic surgery in children. Anesth Analg 2002; 94:255-8.