Original Paper

EFFECTS OF PNEUMOPERITONEUM DURING LAPAROSCOPIC SURGERY IN YOUNG CHILDREN

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Abstract

This observational study of effect of pneumoperitoneum during laparoscopic surgery in 36 patients below 5 years of age (mean age 2.66 ±1.23 yrs) was carried out in Combined Military Hospital, Dhaka over a period of 2 years. The aim of the study was to evaluate the effects of pneumoperitoneum in this age group. Intraabdominal pressure ceiling was fixed at 12 mm of Hg. Mean duration of pneumoperitoneum was 25 ± 3.21 minutes. Amount of CO_2 absorption was assessed by rise of end tidal CO_2 ($ETCO_2$) (+21.21%). Effect of pneumoperitoneum and hypercarbia reflected by rise of pulse rate (+16.96%), systolic blood pressure (+12.19%), diastolic blood pressure (+14.58%) and pulmonary airway pressure (+25%). Oxygen saturation reduced a little bit; but came to baseline within a few minute after completion of the procedure. Electrocardiogram showed sinus rhythm in all but one patient. Requirement of postoperative analgesia was minimum. Mean hospital stay was 4±0.21 days. Postoperative side effects or complication was negligible (only two cases of postoperative vomiting). This study supports the safety and better outcome of laparoscopic technique even in young children provided there is good planning and vigilance.

Key words: Laparoscopic surgery, pneumoperitoneum, children.

Introduction

With the advancement of technology and professional skill laparoscopic surgery gradually replacing most of the traditional surgical techniques involving patients of all ages. In children maintenance of anaesthesia during laparoscopic surgery presents double challenge as it is required to tackle the problem related to laparoscopy as well as homeostatic vulnerability related to age of the patient. It is the degree of rise of intra abdominal pressure and amount of gas (CO_2) absorbed super added by anatomical and pathological peculiarity of young children which dictates the outcome of this technique.

Materials and Methods

This observational study was carried out in Combined Military Hospital (CMH) Dhaka between the periods of August 2007 to June 2009. A total of 36 children of American Society of Anaesthesiology (ASA) grade I & II below the age of five years were included in this study irrespective of sex and surgical indication scheduled for laparoscopic surgery. Preanaesthetic checkup was done 24 hours prior to surgery and the procedure was explained to patients' parents and written consent obtained from them. Patients with cardiovascular, respiratory, renal, hepatic or neuromuscular disease or patients having raised intracranial pressure or coagulopathy were excluded from the study.

Similar standard anaesthetic technique was applied for each patient. Data (pulse, systolic and diastolic blood pressure, oxygen saturation, pulmonary airway pressure, end tidal CO_2 and ECG rhythm) were collected five times in perioperative period. Time periods were indicated as follows:

t_o = Before induction (baseline)
t_1 = After induction
t_2 = 05 min after insufflation
t_3 = Before desufflation
t_4 = 05 min after desufflation

For pneumoperitoneum CO_2 was used with a flow of 3 liter/minute. Higher limit of intra abdominal pressure (IAP) was fixed at 12 mm of Hg and total gas volume required to attain satisfactory pneumoperitoneum was less than one liter.

Peroperative and postoperative events, complication, parents/patients perspective were also noted and analyzed.

Results

Amongst 36 patients 28 were male and 08 were female. Age of the patient ranged from 45 days to 05 years (Mean 2.66 ± 1.23 years), mean weight of the patient was 11.37 ± 3.27 kg. Thirty one patients were of ASA grade I and 05 were of ASA grade II. Surgical indication was repair of inguinal hernia in 32 cases and one of each for repair of femoral hernia, encysted hydrocele of cord, percutaneous nephrostomy for hydronephrosis and pyelomyotomy for hypertrophic pyloric stenosis (table-I).

Haemodynamically patients were stable other than

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Table- I: Demography of patients (n=36).

Variables		Frequency / Amount
Sex	Male (number)	28 (77.8%)
	Female (number)	08 (22.2%)
Mean (±SD) age in years		02.66 ± 1.23
Mean weight (kg)		11.37 ± 3.27
ASA grade	I (number)	31
	II (number)	05
Indication of surgery	Inguinal Hernia (number)	32
	Other (number)	04

Table- II: Peri operative monitoring (n=36).

Time	Pulse (min)	SBP (mm of Hg)	DBP (mm of Hg)	SPO_2 (%)	PAP (cm of H_2O)	$ETCO_2$ (mm of Hg)	ECG
t_0	112±6.4	82±6.2	48±5.1	99±0.4	12±1.6	33±3.1	SR
t_1	123±8.2	91±4.7	54±3.8	99±0.6	13±2.5	33±2.4	SR
t_2	124±5.1	94±4.1	54±3.6	98±1.2	15±3.1	36±4.2	SR
t_3	131±6.2	92±3.8	55±4.5	98±1.4	15±3.4	40±5.6	SR
t_4	104± 4.8	86±5.2	48±4.7	99±0.8	12±2.4	35+3.2	SR
% of change t_3 -t_0	+16.96%	+12.19%	+14.58%	---	+25.00%	+21.21%	---

* SR = Sinus Rythm.

expected fluctuation during intubation and reversal. After peritoneal insufflation till desufflation both pulse and blood pressure (systolic and diastolic) were higher than baseline level (+12.19% & +14.58% respectively) but within normal limit and came to baseline level after desufflation. All patients maintained good oxygen saturation (SPO_2 more than 97%) all through the perioperative period. Pulmonary airway pressure (PAP) was raised (+25%) after pneumoperitoneum and came to baseline level after desufflation. In 21 patient end tidal CO_2 ($ETCO_2$) raised gradually more than 40 mm of Hg (up to 46 mm of Hg) after peritoneal insufflation with CO_2 but came to normal (35-40 mm of Hg) within a few minute by increasing minute ventilation by 10-15%. Percentage of rise of $ETCO_2$ on average is 21.21%. During intubation and reversal 33 patient showed tachyarrhythmia on ECG monitor. One patient had sinus arrhythmia peroperatively, subsided after 100% oxygenation at the end of surgery (table-II).

Mean duration of pneumoperitoneum was 25.13 ± 3.17 min. All patients were given antiemetics (Inj Metclorpromide HCl.15mg/kg IV) before induction. Even then two patients vomited in recovery room and five had nausea. For post operative analgesia paracetamol suppositories proved to be sufficient in most of the patient. Only 07 patient complained mild pain at operation site on first post operative day (POD). 31 patients were discharged on 2nd POD (mean hospital stay 4±0.21 days). Five were discharged on 4th POD because of minor surgical complications like scrotal oedema. Otherwise postoperative period were smooth and uneventful. Parents of all patients were satisfied with both the surgical and anaesthetic technique applied.

Discussion

As compared to the adult literature there is paucity of data in paediatric patients of the effects of pneumoperitoneum. Simple translation of the adult data is not wise because of the unique and different physiology of paediatric patient specially that of infants and toddlers. The abdominal wall is very compliant in children compared to that in adults. So the insufflating pressure required to facilitate surgery is lower in children[1]. In children modification of principal parameters are influenced by the increase in intra-abdominal pressure (IAP) not by its duration[2].

In children IAP more than 15 mm of Hg leads to a fall in cardiac output but the mean arterial pressure (MAP) is maintained by increasing systemic vascular resistance (SVR). The haemodynamic effects are also altered by the underlying cardiovascular status, intravascular volume, patients' position and anaesthetic protocol used[3]. An increase in IAP and direct pressure to the abdominal aorta may elicit a redistribution of cardiac output with an increase in blood flow to the upper part of the body including brain and a decrease to the lower part of the body[1].

Gueugniaud et al[4] showed by using non invasive continuous oesophageal aortic blood flow (ABF) echo doppler monitoring in infants that inductions of pneumoperitoneum resulted in a significant decrease in ABF (67% ± 9%) and stroke volume (68±10%) and a significant increase in systemic vascular resistance (162% ± 34%). These changes had no clinically deleterious effects in healthy infants and completely reversed after peritoneal desufflation. But special care and manipulation of technique is required in infants with compromised cardiovascular status[5].

Hsing et al[5] showed that CO_2 is absorbed more quickly in

younger children (0-2 yrs) than the children aged 2-5 years. CO_2 absorption is more prominent in retroperitoneal procedure as compared to transperitoneal procedures and continues for a short period after desufflation[5,6]. Absorption of CO_2 leads to a rise in $PaCO_2$ and $ETCO_2$ levels along with a decrease in serum pH level. Hypercarbia in turn leads to an increase in the heart rate and blood pressure mediated by sympathetic nervous system. It also sensitizes the myocardium to the arrhythmogenic effects of catecholamine especially with volatile anaesthetic agents[5,6].

Neonates and smaller children who have low FRC and high O_2 consumption are therefore more prone to developing hypoxemia during laparoscopy. In infants there is an additional risk of right bronchial intubation due to cephalic displacement of diaphragm[7]. Bannister et al[8] noted at peak insufflation (15mm Hg) PAP increased by about 18%, average expiratory tidal volume decreased by 33%, average $ETCO_2$ increased by 13%, average dynamic compliance decreased by 48% and oxygen saturation dropped in 41% of patients. Manner et al[9] demonstrated a 17% decrease in lung compliance with Trendelenburg positioning, with further 27% decrease by IAP of 12 mm of Hg. The PAP concomitantly increased by 19% with the Trendelenburg position and by 32% with pneumoperitoneum. After 10 min of laparoscopy 10-20% of expired CO_2 derives from the exogenous CO_2[10].

Resinoso Barbero et al[11] concluded that capnography proved to be an excellent guide to adjust ventilation during CO_2 insufflation in infants and children. Regardless the duration of procedure minute ventilation may need to be increased by 25-30% to maintain normocarbia[3]. However Laffon et al[12] suggested in favour of blood gas analysis specially in prolong cases or in infants with heart lung pathology as $ETCO_2$ can overestimate $PaCO_2$ (by up to 8.8 mm of Hg) and consequently result in hyperventilation. Positive end expiratory pressure (PEEP) can be used to prevent hypoxemia and offset its detrimental effect. Despite these potentially detrimental effects consistent benefits with regard to postoperative pulmonary function are seen after laparoscopic surgery especially in children with compromised cardiorespriatory function[3]. Hypercarbia and elevated IAP increase cerebral blood flow and intracranial pressure (ICP). Raised IAP causes a higher intracaval pressure which transmits into the lumbar veins and decreases CSF absorption which can also contribute to the elevated ICP[13]. Direct renal vein compression leading to renal vascular insufficiency[14] or direct renal parenchymal compression[15] may be the cause of decrease in glomerular filtration rate (GFR) and oliguria during laparoscopy which are usually reversible.

Although laparoscopy is known to be associated with reduced insensible losses and reduced heat losses, prolonged CO_2 insufflation in neonates and small children can lead to hypothermia. So it is advocated to use preheated CO_2 especially for smaller children and for high flow insufflation[16].

Conclusion

Minimally invasive laparoscopic surgery does not equate with minimally invasive anaesthesia in children. Knowledge of the associated pathophysiological changes, good planning, vigilance and multidisciplinary effort is essential to safely guide these patients through the potentially deleterious intraoperative changes to reap the full benefits associated with laparoscopic technique.

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