Original Article

Respiratory Changes under Spinal Anaesthesia for Laparoscopic Gynaecological Procedures- a comparison with General Anaesthesia

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Abstract

Background: *Laparoscopic surgery has become a frequently applied technique for a wide field of indications. The procedure has become the gold standard for many procedures, with some of the most common being gynecological procedures and appendectomy. Laparoscopic procedures that are widely used in gynecological surgery are commonly applied under general anesthesia (GA). Now a days spinal anaesthesia (SAB) has become a routine technique for healthy patients. It is currently presumed that spinal anaesthesia can compromise respiratory muscle function during carbon dioxide (CO2) pneumoperitoneum and causes some respiratory changes.*

Objective: *This study was designed to compare the respiratory effects of CO2 pneumoperitoneum under spinal anaesthesia with general anaesthesia for short duration (<1hr) laparoscopic gynaecological procedures.*

Methods: *A total number of sixty female patients, thirty in each group of ASA grade I & II were enrolled for the study. Group I patients received lumber SAB with 15 mg heavy bupivacaine and 25 mcg fentanyl. Group II patients received standard general anaesthesia with propofol, halothane and fentanyl. Baseline heart rate, blood pressure, respiratory rate, ETCO2 & SPO2 were noted in all patients. Arterial blood gas analysis was done at time 0, 20 and 40 min after initiation of pneumoperitoneum. Continuous ECG, pulse oximetry, noninvasive blood pressure, and ETCO2 were monitored during the procedure. Any per operative and post-operative side effects were recorded and managed.*

Results: *There were no observed changes in the respiratory rate. In group I, ETCO2 increased in a stepwise manner over the first 10 min and reached a plateau between 15th and 30th min and declined after deflation of pneumoperitoneum. Arterial CO2 tension also increased at 20 min with significant changes (p=0.000) in arterial to end tidal carbon dioxide tension. ETCO2 and arterial carbon dioxide tension changes were almost similar in both groups.*

Conclusion: *Arterial and end-tidal CO2 tension changes during lower abdominal laparoscopic surgery under SAB remain within physiological limits and comparable to the CO2 tension under GA. SAB may be adopted in ASA physical status I and II patients with proper preoperative counseling. Hence it is a safe alternative to GA with minimum respiratory alterations.*

Keywords: *Laparoscopic gynaecological procedures, Sub arachnoid block, General anaesthesia, Respiratory changes.*

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Introduction:

Now a days Laparoscopic Surgery is a common practice in modern surgical technique. Laparoscopic surgery includes postoperative advantages of less pain, fewer pulmonary complications, short hospital stay, early return to daily activities and low cost[1]. General Anaesthesia (GA) is considered the anaesthetic technique of choice for laparoscopic procedures including laparoscopic gynaecological procedures[2]. Many anesthesiologists and surgeons frequently prefer general anesthesia for the reason that it allows control of airways and ventilation and promotes muscular relaxation and prevents aspiration. Another reason for this popularity is that patients who are awake during such procedures do not tolerate the adverse effects from the pneumoperitoneum well[3, 4]. However, some centers have been using spinal anesthesia as their first preference in laparoscopic surgery for a long time [3]. The literature shows that spinal anesthesia is usually used in laparoscopic abdominal surgery, which includes cholecystectomy, diagnostic laparoscopy and appendectomy[5]. Some small series discussed spinal anesthesia as the sole anesthetic procedure in gynecological laparoscopic surgeries[4]. Regional anaesthesia as a sole technique was initially advocated for cases who were considered high-risk candidates for general anaesthesia[6,7]. However, nowadays, it is also opted as a routine technique for healthy patients[8,9] . Studies have demonstrated that surgeries like laparoscopic cholecystectomy can safely be performed under spinal anaesthesia[10]. Regional anaesthesia in laparoscopic surgery offers some advantages like decreased nausea/vomiting and less post-operative pain. However, anxiety and other problems related to pneumoperitoneum like shoulder tip pain causes discomfort to the patients during these procedures under spinal anaesthesia. These problems can be overcome by providing proper sedation and analgesia.

SAB may be a safe and effective technique for short duration laparoscopic gynaecological procedures by avoiding extreme Trendelenburg position, by providing supplementary sedation and analgesia and by keeping abdominal pressure 8-10 mmHg. The length of surgery and surgeons experience is also an important factor for the success of the surgeries[11]. In this study, attempts have been taken to compare respiratory changes under SAB with GA for lower abdominal laparoscopic gynaecological procedures.

Materials and Methods:

This was a prospective comparative study. Sixty ASA grade I and II female patients were randomized into two groups by card sampling method with thirty patients in each group. Institutional Ethical Committee approval and informed written consent was obtained from all patients. All patients underwent laparoscopic gynaecological procedures in Combined Military Hospital Dhaka from March to August 2021. Inclusion Criteria Were (1) Patients aged between 15-45 yrs. (2) Patients with ASA grade I and II. (3) Patients scheduled for short duration (<60 min) laparoscopic gynaecological procedure. Exclusion Criteria Were (1) Patient's refusal (2) Patients hypersensitive to local anaesthetics (3) Short stature, i.e. height below 148 cm (4 feet 9 inch). (4) Overweight patients (Weight >110 kg) (5) Patients with coagulation disorders, on anticoagulants (6) Patients with skin sepsis in lumbar region (7) Patients with pre-existing neurological disorders or spine deformation (8) Cases belonging to ASA grade III and above.

Group I patients received lumber SAB and Group II received GA with propofol, halothane and fentanyl. After pre-operative fasting for 6 hours, with all asceptic precaution, group I patients were administered spinal anaesthesia in the sitting position using 27G Quincke Babcock spinal needle at L2- L3 inter space. A combination of 15mg (3ml) 0.5% hyperbaric bupivacaine and 25 microgram (0.5 ml) fentanyl was administered in the lumbar subarachnoid space. As soon as the sensory block reached T5 dermatome (level of sensory block was tested by pin prick stimulus) the patients were placed in dorsal lithotomy position with 15 degree head down tilt when the abdomen was prepared for veress needle insertion. Baseline heart rate, blood pressure, respiratory rate & SPO2 were noted in all patients. A soft sealing transparent face mask with ETCO2 sensor was then secured over the patient's face in a comfortable and air tight manner in group I patients and ETCO2 sensor was fixed in between the endotracheal tube and the breathing circuit (Bain) in group II patients. Pneumoperitoneum was created by insufflating CO_2 gas. Intra-abdominal pressure was adjusted to have a comfortable working field {mean 10 (±2) cm H_2O}. Group I patients who complained of neck pain, shoulder tip pain or both and for anxiety and abdominal discomfort inj Midazolam 2 mg and Tramadol 100 mg was administered slowly intravenously (IV). Patient has felt pain even after Midazolam and Tramadol administration, inj Ketamine 25 mg was administered slowly. In both groups bradycardia below 50/min was managed with inj Atropine 0.6 mg. Hypotension at any time during or after surgery was managed with inj Ephedrine 5-10 mg intravenously intermittently upto a maximum 25 mg. In the post-operative period pain was assessed using Visual Analogue Scale (VAS) and treated with inj Diclofenac sodium 50 mg intramuscularly. In both the groups, a 20-gauze polyurethane catheter was established in the left radial artery temporarily for periodical sampling of arterial blood. Blood gas analysis was done at time 0, 20 and 40 minutes after pneumoperitoneum. Pulse oximetry, noninvasive blood pressure and ETCO2 were recorded using multiparameter monitor every 5 minutes' interval and ECG monitored continuously during the procedure. In the post-operative period ECG, pulse oximetry, noninvasive blood pressure was recorded at 10 minutes' interval. Any intra operative and post-operative complications were observed and managed accordingly. All results were expressed as mean ± standard deviation (SD) or in frequencies (percentage) as applicable. All results were compiled and analyzed using Student's 't' test.

Results:

Demographic profile of the patients in both the groups were comparable (Table I). Respiratory rate between the groups were almost similar (Table II).There was no desaturation during per operative and post-operative period in both groups (figure 1). In group I, End tidal carbon dioxide (ETCO2) increased in a stepwise manner over the first 10 min from 31.98 ± 4.11 mmHg to 37.53 ± 6.29 mmHg (p=0.000) and reached a plateau between 15th and 30th min and declined after deflation of pneumoperitoneum (Figure 2). Arterial CO_2 tension showed a significant increase at 20 min from 38.01± 4.74 mmHg to 43.88±3.95 mmHg (p=0.000) (Table III). There was a significant increase in arterial to end tidal carbon dioxide tension from 6.03±4.55 mmHg to 6.35±4.01mmHg (p=0.000) (Table III). In-group II, almost similar significant changes occurred in arterial CO_2 tension, end tidal CO_2 tension and arterial to end tidal CO_2 tension from baseline to 20 minutes after pneumoperitoneum values (Table III). All the observed changes were well within physiological limits. No patient had desaturation (Figure 1) or respiratory insufficiency.

Table – I: *Personal characteristics and duration of surgery*

Variable	Group I SAB(n=30)	Group II GA(n=30)	P value
Age(years)	26.20±4.55	26.03±4.58	0.883^{NS}
Height (cm)	155.97±4.05	155.23±2.84	0.404^{NS}
Weight (kg)	59.72±6.36	57.80±6.78	0.213^{NS}
Duration of surgery(min)	43.13±9.26	42.97±9.39	0.950^{NS}
ASA Class	19/11	21/9	

Values are expressed as mean ± SD. Significant P <0.05 (between two groups)

Student's 't' test was done to find out the differences between the groups

Table- II: *Comparison of respiratory rate*

Period	Group-I SAB(n=30)	Group II P value GA(n=30)	
Pre-operative Op	16.53± 1.76	17.33± 1.94	0.105^{NS}
Per operative Op	17.00±2.01	16.00	-
Post-operative Op	17.00±2.00	17.00±3.12	0.203^{NS}

Values are expressed as mean ± SD. Significant P <0.05 (between two groups)

Student's 't' test was done to find out the differences between the groups.

Figure 1: *Comparison between per operative and post operative SPO2 in two groups*

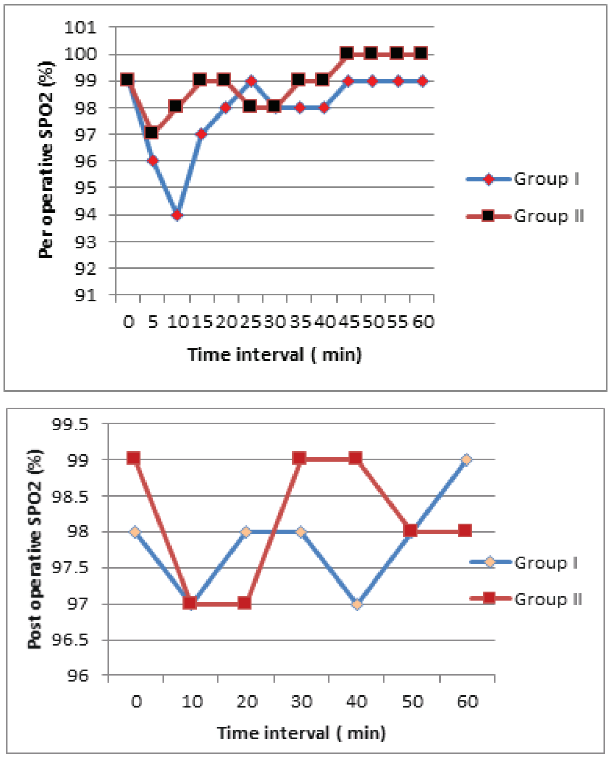


Table III : *Partial pressure of CO2 in arterial blood and End tidal CO2 Tension Changes*

Variables	Study group	Baseline (time 0) (mm Hg)	After 20 min (mmHg)	P value
$PaCO_2$	Group I	38.01±4.74	43.88±3.95	0.000^S
	Group II	37.27±4.50	42.29±4.83	0.000^S
$ETCO_2$	Group I	31.98±4.11	37.53±6.29	0.000^S
	Group II	30.58±4.21	35.47±5.61	0.000^S
(a-E) CO_2	Group I	6.03±4.55	6.3 5±4.01	0.000^S
	Group II	6.69±4.38	6.82±4.12	0.000^S

Values are expressed as mean ± SD. Significant P <0.05 (between two groups)

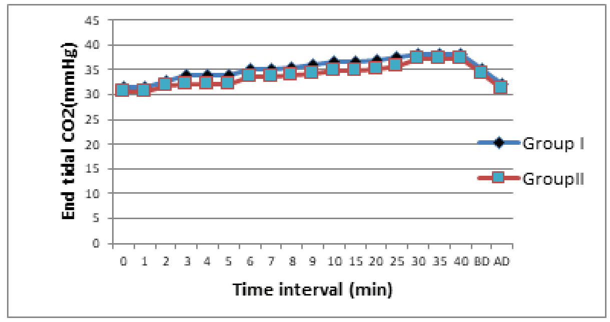
Student,s 't' test was done to find out the difference between groups.

PaCO2 - arterial carbon dioxide tension

ETCO2 - end tidal carbon dioxide tension

(a-E) CO2 –arterial to end tidal carbon dioxide tension difference

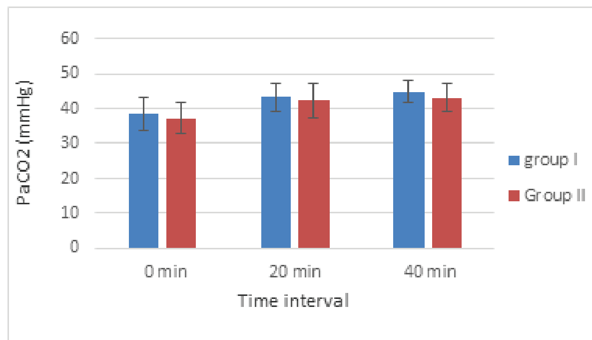
Figure 2: *Changes in End Tidal CO2 plotted over time between two groups.*



*BD-Before deflation of pneumoperitoneum

AD- After deflation of pneumoperitoneum

Figure 3: Arterial blood gas analysis shows changes in Partial



Pressure of CO2 plotted over time between two groups.

Discussions :

Previously spinal anaesthesia was routinely deferred for laparoscopic surgery because of thought of its suppressive effects on the respiratory muscle function under increased abdominal pressure. This study was conducted to find out respiratory alterations under spinal anaesthesia in comparison to GA. In this study it has been shown that spinal anaesthesia with local anesthetics and narcotic combination can be safely utilized without respiratory suppression. There was no change in the respiratory rate with increasing ETCO2 as the patient had adequate respiratory reserve. The ventilatory response to hypercapnia is well preserved under spinal anaesthesia. Ciofolo et al[12] in their study on laparoscopy under epidural anaesthesia demonstrated that the arterial carbon dioxide level was kept unchanged by increased minute ventilation and respiratory rate during CO_2 pneumoperitoneum. The explanations could be the intrathecal fentanyl shifting the CO_2 response curve to the left. The deafferentation effect of spinal anaesthesia and the attending sedation cannot be ruled out from our present study design.

In this study the $ETCO_2$ was increasing till 15 min in a step wise manner and stabilized thereafter without any further increase till decompression of the pneumo peritoneum. Tan et al13 in their study demonstrated that absorption of CO_2 from the peritoneal surface in humans during conventional laparoscopy stabilized around 40 ml / min in 15 min and there was no demonstrable increase in 30 min. Lister et al14 in their animal study demonstrated that, under general anaesthesia the CO_2 elimination increased linearly when the intra peritoneal CO_2 insufflation pressure increased from 0 to 10 mmHg and it did not increase any further despite increasing the CO_2 insufflation pressure to 25 mmHg. In this study, the arterial carbon dioxide increased at 20 min with a significant change in arterial to end tidal CO_2 difference from the pre pneumoperitoneum base line (table III). Lundh et al15 showed with multiple inert gas elimination technique, the ventilation perfusion (V/Q) and FRC to closing capacity ratio was unchanged under epidural anaesthesia of third thoracic dermatome. Similarly in our study population, unremarkable arterial to end tidal CO_2 difference possibly indicate the V/ Q ratio and FRC was maintained by the preserved diaphragmatic activity.

In conscious patient with pneumoperitoneum for lower abdominal laparoscopic surgery under spinal anaesthesia, the preserved inspiratory diaphragmatic activity maintains ventilation and the gas exchange within physiological limits. This prospective, randomized comparative study between subarachnoid block and general anaesthesia concludes that spinal anaesthesia using mixtures of bupivacaine and fentanyl can be used as a safe alternative to general anaesthesia for short duration laparoscopic gynaecological procedures with minimum respiratory embarrassment even during pneumoperitoneum. But for the experience of shoulder tip/ neck pain or discomfort, patient requires supplementary sedation and analgesia.

Conclusion

Arterial and end-tidal CO_2 tension changes during lower abdominal laparoscopic surgery under SAB remain within physiological limit and comparable to the CO_2 tensions under GA. SAB may be adopted in ASA physical status I and II patients with proper preoperative counselling. Hence it can be applied as a safe and alternative technique to GA with minimum respiratory alterations.

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