European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 09, Issue 08, 2022

ORIGINAL RESEARCH

Study Of The Effects Of Various Insufflating Agents During General Anaesthesia And Correlation Of Acid Base And Gas Blood Changes During Laparoscopy To Determine Ideal Insufflating Agent Amongst CO2, O2 And N2O

Dr Rahul Laxmishankar Singh[1], Dr. Kamala Kanta Das[2]

[1]Associate Professor, Department of General Surgery, IQ City Medical College And Hospital, Durgapur, West Bengal, India.
[2]Associate Professor, Department of Anaesthesiology, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur, West Bengal, India (Corresponding Author)
Received Date: 12/11/2022 Accepted Date: 27/12/2022

ABSTRACT

Background: Laparoscopy involves the visualization of abdominal and pelvic organs after creating an artificial pneumoperitoneum. Present study was aimed at to study effects of various insufflating agents during general anaesthesia and correlation of acid base and blood gas changes during laparoscopy to determine ideal insufflating agent amongst CO_2, O_2 and N_2O at a tertiary hospital. Material and Methods: Present study was single-center, comparative study, conducted in female patients from age group of 20-40 years in ASA Class – I/ II undergoing diagnostic laparoscopy and laparoscopic tubal ligation. 105 patients were divided in three groups of 35 patients each as Group- I (oxygen as the insufflating agent), Group II (Nitrous oxide as the insufflating agent) & Group III (carbon dioxide as the insufflating agent).Results: Mean age, body weight & types of procedures were comparable among all groups & no significant statistical difference was noted. The blood gas analysis showed a rise in PaO_2 and O_2 saturation, due apparent rise mainly to the FiO_2. Though the PaO_2 is adequate to meet in increased the tissue oxygen demand it is inconsistent with the FiO_2 (33%) delivered. The post operative and oxygen saturation came back to their pre-operative values. The $PaCO_2$ was significantly higher intra-operatively in all the three groups, with a numerically high value in Group III. The $PECO_2$ followed the trend of $PaCO_2$ and the fall of pH was consistent with the rise in $PaCO_2$. Though the rise of the $PaCO_2$& fall in pH was statistically significant, they did not reach hazardous level. The Group I had the highest incidence of nausea and vomiting (88.57 %) followed by Group II (14.28 %). Conclusion: Nitrous oxide appears to be the most suitable amongst the three gases; Oxygen, Nitrous oxide and carbon dioxide, with general anaesthesia.

Keywords: laparoscopy, pneumoperitoneum, nitrous oxide, carbon dioxide, general anaesthesia.

Corresponding Author: Dr. Kamala Kanta Das, Associate Professor, Department of Anaesthesiology, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur, West Bengal, India.
Email: doctorkkdas@gmail.com

INTRODUCTION

Laparoscopic surgeries are preferred over open surgeries due to various advantages such as reduced operative time, less intra and post-operative complications, less post-operative pain

and a shorter hospital stay and for which now a days many surgeons are adopting this procedure. Laparoscopy involves the visualization of abdominal and pelvic organs after creating an artificial pneumoperitoneum (instillation of gas into the peritoneal cavity), which is necessary to enhance the visualization of the abdominal cavity & its contents.[1] Since the inception of the technique different insufflating agents have been used such as air, oxygen, carbon dioxide and nitrous oxide.[2] Air as an peritoneal insufflating agent was soon abandoned with ensuing danger of air embolism following the experiments on animal models.[3,4] The acid-base and blood gas values are influenced by the ventilatory pattern and intraperitoneal absorption of gases. There have also been the incidences of cardiac arrhythmias following peritoneal insufflation with carbon dioxide as well as nitrous oxide.[5] For laparoscopic surgeries, ideal anaesthetic technique should provide amnesia such that the patient has no recollection of discomfort and analgesia for anaesthetic induction, surgery and emergence from anaesthesia. The procedure should be safe, with a minimum risk of cardiac arrhythmias, pulmonary embolism, hypotension, hypoxia, hypercarbia and aspiration of gastric contents.[6] General ansesthesia is the most widely acceptable technique for laparoscopic surgeries. Present study was aimed at to study effects of various insufflating agents during general anaesthesia and correlation of acid base and gas blood changes during laparoscopy to determine ideal insufflating agent amongst CO_2, O_2 and N_2O at a tertiary care hospital.

MATERIAL AND METHODS

Present study was single-center, comparative study, conducted in Department of Anaesthesiology, Gouri Devi Institute of Medical Sciences and Hospital, Durgapur, West Bengal, India. Study duration was of 2 years. Study approval was obtained from institutional ethical committee.

Inclusion criteria

Female patients from age group of 20-40 years in ASA Class – I/ II undergoing diagnostic laparoscopy and laparoscopic tubal ligation, willing to participate in present study

Exclusion criteria

Patients having cardiovascular and respiratory disorders & pregnant females.

Study was explained to patients in local language & written consent was taken for participation & study. All patients were evaluated and assessed pre- anaesthetically including modified Allen's test for patency of radial and ulnar arteries.[7] They were subjected to investigations such as hemogram (Haemoglobin Percentage, Total Leucocyte Count, Differential Leucocyte Count), Urine analysis for the presence of sugar and microscopic examinations, X-Ray Chest & ECG. 105 female patients, who were in good health apart from gynaecological conditions necessitating laparoscopy were considered for present study. The patients were divided into three different groups comprising of 35 patients each based on insufflating agents used for pneumoperitoneum – the different insufflating agents used to produce pneumoperitoneum

Group I - Oxygen as the insufflating agent

Group II - Nitrous oxide as the insufflating agent

Group III - Carbon dioxide as the insufflating agent

All patients were premedicated with morphine 5 mg intramuscular for body weights up to 50 kg and 7.5 mg Intramuscular for body weights above 50 kg and Glycopyrrolate 0.2 mg intramuscular one hour before the induction of anaesthesia. The left radial arteries were cannulated with 21 G catheter in each patient before the induction of anaesthesia using sterile and aseptic technique, The patency of ulnar arteries was also determined prior to the cannulation. After pre-oxygenation for three minutes anaesthesia was induced with a sleep dose of Thiopentone and tracheal intubation was performed under Pancuronium bromide

induced muscular relaxation in a dosage of 0.1 mg/kg body weight. The patients were artificially ventilated with 66% Nitrous oxide and 33% Oxygen by Medisys ventilator. The tidal volume was maintained at 10 ml/kg body weight with a respiratory rate of 12 per minute. The anaesthesia maintained with Nitrous oxide, oxygen & intermittent incremental doses of Morphine and Pancuronium bromide. The non depolariser muscle relaxants were reversed with intravenous injection of Neostigmine (2.5 mg) & Glycopyrrolate (0.4 mg) at the end of the procedure.

Arterial Blood samples were collected for the measurement of acid base and Blood gas values at the time of premedication (control), at 5 minutes after pneumoperitoneum, at 5 minutes after Trendelenburg with already existing pneumoperitoneum of 10 minutes & at 30 minutes post-operatively in the recovery room. The Parameters like blood pressure (Systolic, diastolic and mean) pulse rate, CVP, IAP, oxygen saturation, end tidal partial pressure of carbon dioxide, electrocardiogram was simultaneously recorded.

Data were collected and compiled using Microsoft Excel. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

This study was undertaken to discover effects of the different pneumoperitoneal insufflating agents on three groups of 35 patients each as Group- I (oxygen as the insufflating agent), Group II (Nitrous oxide as the insufflating agent) & Group III (carbon dioxide as the insufflating agent). Mean age, body weight & types of procedures were comparable among all groups & no significant statistical difference was noted.

Table 1: General characteristics

	Group I No. of cases (%) / Mean ± SD	**Group II No. of cases (%) / Mean ± SD**	**Group III No. of cases (%) / Mean ± SD**	**P value**
Mean age (years)	27.37 ± 3.98	28.94 ± 4.22	27.31 ± 3.43	0.081
Mean weight (kgs)	54.9 ± 7.17	53.78 ± 7.73	54.12 ± 7.61	0.092
Procedure				0.085
Laparoscopic tubal ligation	17 (48.57 %)	13 (37.14 %)	18 (51.43%)	
Diagnostic laparoscopy	18 (51.43%)	22 (62.86 %)	17 (48.57 %)	

PaO_2. In Group - I PaO_2 recorded a rise of 55.28 mm Hg in 5-minute sample and 68.85 mm Hg in 10 minute sample from their pre operative values. The post operative sample recorded fall of 4.99 mm of Hg which was statistically insignificant. A rise of 49.55 mm Hg in 5-minute sample and 72.29 in 10-minute sample was recorded as compared to the pre-operative sample in Group II. The post-operative value recorded a statistically insignificant fall by 3.1 mm Hg. The 5 minute and 10-minute sample recorded a rise of 61.01 mm Hg and 67.64 mm Hg respectively in Group III compared to the pre-operative sample. The post operative sample recorded a statistically insignificant fall of 0.12 mm Hg.

Table 2: PaO_2 (mm Hg)

Group	**Pre- operative**	**5 min after insufflation**	**10 min after insufflation**	**Post- operative**
I	108.33 ± 18.13	163.61 ± 23.44	177.18 ± 22.99	103.34 ± 19.82
II	107.56 ± 10.43	157.114 ± 22.26	179.85 ± 20.93	104.46 ±11.41

III	109.92 ± 11.34	170.93 ± 25.20	177.56 ± 23.00	109.80 ± 20.63
p value		< 0.05	< 0.05	> 0.05

$PaCO_2$: In Group - I rise of 5.39 mm Hg and 5.73 mm Hg was noticed in 5 minute and 10-minute samples as compared to that of the pre-operative sample. The post-operative sample recorded a rise of 4.49 mm Hg. The Group - II recorded a rise of 2.4 mm Hg and 3.3 mm Hg in 5 minute and 10-minute samples from the pre operative value. In post-operative sample the $PaCO_2$ rise was 2.06 mm Hg. In Group - III the 5 minute and 10-minute sample recorded an increase of 4.4 mm Hg and 9.23 mm Hg from the pre-operative sample where as the post-operative sample recorded a rise of 4.92 mm Hg. All changes were significant among all groups & significant statistical differences were noted.

Table 3: $PaCO_2$ (mm Hg)

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	34.45 ± 2.63	39.84 ± 5.60	40.18 ± 5.05	38.93 ± 3.05
II	36.17 ± 5.55	38.57 ± 5.04	39.48 ± 3.48	38.23 ± 2.54
III	36.10 ± 3.76	40.50 ± 5.18	45.63 ± 6.35	41.03 ± 4.17
p value		< 0.05	< 0.05	< 0.05

pH: The pH of Group I recorded a fall by 0.041 and 0.035 in 5 minute and 10-minute samples as compared to the pre-operative value. But the post-operative sample read fall by only 0.017 which is statistically insignificant. In Group - II the fall in 5 minute and 10-minute samples were 0.03 an 0.024 from the pre-operative sample whereas the post-operative sample recorded a fall of 0.021. In Group III the fall in pH were 0.041 and 0.07 in 5 minute and 10-minute samples from their pre- operative value. The post-operative value recorded a fall by 0.023 in pH. All changes were significant among all groups & significant statistical difference was noted.

Table 4: pH

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	7.37 ± 0.027	7.33 ± 0.047	7.33 ± 0.051	7.35 ± 0.053
II	7.36 ± 0.028	7.33 ± 0.049	7.34 ± 0.051	7.34 ± 0.031
III	7.36 ± 0.030	7.32 ± 0.044	7.29 ± 0.047	7.34 ± 0.036
p value		< 0.05	< 0.05	< 0.05

HCO_3: Group- I records a rise of 0.41 mmol/L in 5-minute sample and 0.81 mmol/L in 10 minute sample from their pre-operative value. The postoperative value, recorded a rise of 0.828 mmol/L. In Group II a fall of 0.034 m mol/L was recorded in 5-minute sample & a rise of 0.76 m mol/L & 0.94 m mol/L was recorded in 10 minute and post-operative sample respectively, which were insignificant. Group III recorded rise in HCO_3 by 1.10 m mol/L in 5-minute sample, a fall of 0.31 m mol/L in 10 minute sample and rise by 0.27m mol/L in post-operative sample from the pre-operative sample. All changes were comparable among individual groups & no statistically significant difference was noted.

Table 5: HCO_3 (mmol/L)

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	19.92 ± 1.27	20.33 ± 1.96	20.73 ± 1.67	20.74 ± 1.18
II	20.37 ± 1.15	20.34 ± 2.05	21.13 ± 1.43	21.31 ± 1.37
III	20.65 ± 1.73	21.75 ± 1.90	20.34 ± 1.99	20.92 ± 1.74

p value		> 0.05	> 0.05	> 0.05

Base excess: In Group I the base excess dropped by 0.21 mol/L in 5-minute sample, 0.36 m mol/L in 10 minute sample and 0.28 m mol/L in post-operative sample as compared to the pre operative values. The fall of base excess from the pre operative sample was 0.19, 0.31, 0.27 m mol/L in 5-minute, 10 minute, post operative samples in Group II. Group - III recorded fall of the base excess by 0.27, 0.36, 0.43 mmol/L in 5 minute, 10 minutes and post operative as compared to the pre-operative. All changes were comparable among individual groups & no statistically significant difference was noted.

Table 6: Base excess (m mol/L)

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	-3.94 ± 1.04	-4.15 ± 1.40	-4.30 ± 1.53	-4.23 ± 1.14
II	-3.85 ± 0.91	-4.04 ± 1.63	-4.16 ± 1.69	-4.12 ± 1.26
III	-3.75 ± 1.38	-4.02 ± 2.02	-4.11 ± 1.77	-4.19 ± 1.55
p value		> 0.05	> 0.05	> 0.05

Percentage oxygen saturation: The oxygen saturation in Group-1 recorded a rise 1.72 % and 1.97 % in 5 minute and 10-minute samples where as post-operative sample recorded a statistically insignificant fall of 0.69 % form the pre operative sample. In Group-II the rise from pre-operative sample was 2.13 % and 2.24 % in 5 minute and 10-minute samples but the post-operative sample recorded an insignificant fall of 0.34 %. All changes were significant among group I & II, statistically significant difference was noted. Group-III recorded 2.07 % and 2.08 % rise in 5 minute and 10-minute samples and a fall of the 1.09 % in post-operative sample as compared to the pre operative sample. All changes were comparable among individual group & no statistically significant difference was noted.

Table 7: Percentage oxygen saturation

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	97.27 ± 1-31	98.99 ± 0.92	99.24 ± 0.72	96.58 ± 1.47
II	97.06 ± 1.35	99.15 ± 0.52	99.3 ± 0.73	96.72 ± 1.27
III	97.21 ± 1.69	99.20 ± 0.34	99.29 ± 0.32	96.12 ± 1.30
p value		< 0.05	< 0.05	> 0.05

End tidal carbon dioxide: A rise of 5.62, 5.43, 4.07 mm Hg in 5-minute, 10 minute and post operative sample of Group I was recorded as compared to the pre-operative sample. The Group II recorded a rise of 2.95, 4.47, 3.24 mm Hg in end tidal carbon dioxide in 5 minute, 10 minute and post operative samples as compared to the pre-operative value. The Group III recorded a rise of 4.54, 9.58, 4.81 mm Hg in the 5 minute, 10 minute and post operative sample respectively as compared to the pre-operative value. All changes were significant among group I, II & III, statistically significant difference was noted.

Table 8: End tidal carbon dioxide

Group	Pre-operative	5 min after insufflation	10 min after insufflation	Post-operative
I	34.36 ± 2.57	39.98 ± 5.34	39.79 ± 5.29	38.43 ± 3.07
II	35.59± 3.25	38.54± 5.45	40.06 ± 3.92	38.83 ± 3.05
III	35.74± 3.72	40.28 ± 5.09	45.32± 5.77	40.55± 4.18
p value		< 0.05	< 0.05	< 0.05

Post-operative nausea and vomiting: The Group I had the highest incidence of nausea and vomiting (88.57 %) followed by Group II (14.28 %). The Least incidence was observed in Group - III. (5.71 %)

Table 9: Post-operative nausea and vomiting

	Nausea and vomiting (n=35)	**Percentage**
Group I	31	88.57
Group II	5	14.28
Group III	2	5.71

DISCUSSION

The peritoneal space is closed, collapsible body cavity which normally contains only little serous fluid. Following the introduction of a gas into the cavity there are two immediate effects: firstly, the pressure within the cavity is raised to level which depends on the volume of gas introduced and the compliance of the cavity and secondly gaseous interchange begins to take place between the gas and the blood-tissue environment.[8] During this period the gas in the cavity tends to equilibrate with the gases in the blood.

Hodgson et al.,[8] have further enumerated in their study that pneumoperitoneum also alters the pulmonary mechanism since the intra-abdominal pressure increases to 15-20 mm Hg. Respiratory impedance measurements have shown a marked elevation of diaphragm and clinically they have found it impossible, in very obese patients, to maintain controlledventilation at the 'pre pneumoperitoneum minute volume', unless the intra-abdominal pressure is deliberately reduced. In some other patients they have found it necessary to increase the inflation pressure by 15-20 cm H_2O to compensate this fall in compliance resulting from limitation of diaphragmatic movements. A steep Trendelenburg position further restricts the ventilation.

Smith et al.,[9] studied cardiovascular effects or intraperitoneal insufflation of carbon dioxide in patients anaesthetised and artificially ventilated during laparoscopy. A step wise increase of intra-abdominal pressure up to a maximum of 25 cm H_2O was accompanied by increased airway pressure, increased intrathoracic pressure, raised central venous pressure, raised femoral venous pressure and by signs of cardiovascular stimulation with tachycardia and hypertension.

Mortew et al.,[10] have elicited a rise in intra-thoracic pressure concomitant with elevated intra- peritoneal pressure suggested by a significant increase in positive airway pressure needed to maintain a constant tidal volume during insufflation and by increased respiratory oscillations visible in central pressure monitoring and arterial pressure records. A marked decrease in central venous pressure, arterial systolic pressure and pulse pressure with a concomitant fall in cardiac output was noticed when intra-abdominal pressure was raised to 30 mm Hg.

The rise of PaO_2 and O_2 saturation in both sets of samples was mainly due to the increased inspired oxygen concentration (FiO_2) which was raised to 33 % during anaesthesia. By increasing FiO_2 from 21 % to 30 % there will be an increase in alveolar partial pressure of oxygen by at least 6.4 mm Hg at any level of ventilation.[11] At a minute volume of 10 liters/minute the alveolar concentration is expected to rise up to 200 mm Hg in the perfect lung condition. The corresponding intra-arterial partial pressure oxygen is expected to rise up to 185-190 mm Hg of in this age groups.

This targeted value of PaO_2 was not achieved probably mainly due to two reasons. Firstly, anaesthesia perse is known to cause ventilation-perfusion inequality. Secondly the reduction compliance resulting from a raised intra-.abdominal pressure and consequent

limitation of diaphragmatic movement in addition to the Trendelenburg position is likely accuse ventilation-perfusion inequality predominantly in lower lobes.[8]

By analysing the $PaCO_2$& $PE'CO_2$ we can understand the changes are due to the combined effect of absorption of the gases from the peritoneal and ventilation perfusion mismatch due to the large surfaces for absorption and the raised intra-abdominal pressure, the maximum rise in the 5-minute sample was seen in Group - I followed by Group III and Group II. In 10 minute, sample the maximum rise was seen in Group - III followed by Group I and Group II. This denotes the rapid absorption of carbon dioxide from the peritoneal surface into the systemic circulation. The concomitant fall in pH marks the presence of relative acidosis in all the groups in both these sets of samples, most pronounced in the 10-minute sample of Group III.

The postoperative $PaCO_2$ and $PE'CO_2$ data reflect that the carbon dioxide load imposed during the laparoscopy pre operative carbon dioxide that laparoscopy values. A large amount of accumulated carbon is excreted through the lungs.[12] The $PaCO_2$ did not rise at any occasion to a dangerously high-level to produce hypercarbia. This is probably due to the maintenance of a constant tidal volume on the face of reduced lung compliance. This is in agreement with the findings of Hodgson et al.,[8] and Fernandez et al.,[13]. Robert et al.,[14] also kept the $PaCO_2$ within safe limits by adequate control of ventilation with an oxygen enrichment of 50%. Since the post operative PaO_2 and O_2 saturation were within safe limits there was no requirement of oxygen therapy in the recovery room. This is in contrary to the findings of Vegfors et al.,[15] who have recommended the post operative oxygen therapy for at least 2 Lit/min. in the immediate post operative period.

In our study we did not encounter any hazardous hypoxaemia, hypercarbia or oxygen desaturation probably due to the adequate oxygenation during the procedure & controlled ventilation with a constant tidal volume on the face of an increased intra-abdominal pressure. There was no dysarrhythmia, which is a likely feature of hypercarbia.[5] Though the procedure appears safe in our study it should be undertaken with great care and vigilance. An increase in intra abdominal pressure and associate decrease in intrathoracic volume has deleterious effect on pulmonary gas exchange during spontaneous respiration.[5,16]

Kelman et al.,[17] Mortew et al.,[10] and Johannsen et at.,[17] have recommended the continuous monitoring of intra-abdominal pressure and to limit it to 30 cm H_2O (22.08 mm Hg). In our study we have also undertaken continuous monitoring of intra-abdominal pressure through a manometer attached to the gas delivery system and maintained at 20 mm Hg. Laparoscopy offers advantages to both patient and surgeons. It involves considerable alteration in the respiratory and cardiovascular homeostasis, and should not be regarded as yet another minor investigation. It would be most unfortunate should this most useful procedure fall into disrepute because occurrence of avoidable tragedies.

CONCLUSION

We conclude from the present study that the controlled ventilation with adequate and constant tidal volume is the most ideal technique for laparoscopy. Nitrous oxide appears to be the most suitable amongst the three gases, Oxygen, Nitrous oxide and carbon dioxide, with general anaesthesia. The operating surgeon should be advised to empty gases from the abdomen before taking out the trocar to help reduce the post operative nausea and vomiting.

REFERENCES

1. Hulka F Jaroslar. Edition, Chapter Text book of Laparoscopy. First 1:14, Chapter 2: 33 - 34.

2. Fishburne I Considerations John. Anaesthesia complications and for laparoscopy. techniques. Journal of Reproductive Medicine 1978; Vol-21: No.1: 37 40.
3. Thomas D Graff, Neil R Arbegast, Otto C Phillips, Leroy A as C Harris, Todd comparative study of M air Frazier. Gas and carbon embolism: dioxide. embolic agents in the systemic venous system. American Journal of Obstetrics and Gynaecology 1959; 259 264.
4. Marshall R L, Jebson P JR, Davie IT, Scott D B. Circulatory effect of CO2 insufflation of peritoneal cavity for laparoscopy. the British Journal of Anaesthesia 1972; 44: 680 685.
5. Scott D B, Jullian D G. Observations ON cardiac arrhythmias during laparoscopy. British Medical Journal 1972; 1: 411 - 413.
6. Ivankovich Anthony D, Albrecht, Harold Cardiovascular J David J Miletich, Ronald Heyman, effects Roger F F Bonnet. intraperitoneal of insufflation with carbon dioxide and Nitrous oxide in the dogs. Anaesthesiology 281 287. 1975; Vol 42, No.3.
7. Oh T E, Davis N J. Radial Artery cannulation. Anaesthesia and Intensive Care 1975; 3, 12 - 18.
8. Hodgson C, Mc Clelland RMA, Newton J, Some effects of peritoneal insufflation of CO_2 at laparoscopy. Anaesthesia 1970; Vol 25: No.3:382-390. 52.
9. Smith I, Swap G H. Nanette L M, Benzie R J, Cardiovascular effects of peritoneal insufflation of carbon dioxide for laparoscopy British Medical Journal 1971; 3: 410 -411.
10. Motew Ronald M, F Anthoni Albrecht, Scommmegna. D Ivankovich, Joseph Bieniarz, BeharoozZahed, Antonio Cardio vascular effects and acid base blood gas changes during laparoscopy. American Journal of Obstetrics and Vol.115 No.7: 1002 -1012.
11. Nunn JF. Applied Respiratory Physiology. Third Edition,Chapter 10, 242 - 248.
12. Desmond J, Gordon R A. Ventilation in patients anaesthetized for laparoscopy.CanadianAnaesthesiologists. Society Journal 1970; Vol. 17: No.4
13. Fernandez L, Opez de Heierro Mc, Nalich Vidal M, CanndasPovira J M, Nalda Felipe M A. Changes in concentration of co2, 02, pH, HCO3 and base excess in patients subjected to gynaecological laparoscopic examination under general anaesthesia. AnaesthesiolReanim 1981; 28 (1): 15 20.
14. Baratz Robert A, H Karis. Blood gas studies during laparoscopy under general anaesthesia. Anaesthesiology 1969; 463 464.
15. Vegfors M, Cederhouin J, Lennmarken C, Lofter: 0 M JB. Should oxygen be administered after laparoscopy in healthy patients? Acta Scandinavica Anaesthesiolgica 1988; 32 (4): 350 - 352.
16. Alexander G D, Noe F E, Brown E M. Anaesthesia for pelvic laparoscopy: Anaesthesia and Analgesia (Cleve) 1969; 48: 14-18.
17. Kelman Nanette tension GR, Swapp GH, Smith I, Benzie R J, L M. Cardiac out-put and arterial blood gas during laparoscopy. British Journal of Anaesthesia 1972; 44: 1155 1161.
18. Johannsen G, Andersen M, Juhl B. The general anaesthesia during laparoscopy Anaesthesiologica on effects of the haemodynamic events with CO2 insufflation. Scandinavica 1989; 33: 132.