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ORIGINAL ARTICLE

A COMPARATIVE STUDY OF EFFECTS OF PRESSURE & VOLUME CONTROLLED VENTILATION IN LAPAROSCOPIC SURGERY

Abhishek Kumar[1], Major General H. S. Nanda[2]

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ABSTRACT: BACKGROUND: The historical milestone in evolution of laparoscopic surgery have been comprehensively detailed by Gaskin et al.[1] The advent of laparoscopic cholecystectomy was the catalyst that aroused the interest of general surgeon worldwide in laparoscopy and closed abdominal surgery.[2-5] The major responsibility of anaesthesiologist is to maintain haemodynamic & respiratory parameters within normal limits during pneumoperitoneum. The creation of pneumoperitoneum by insufflation of the abdominal cavity with CO_2 and assumption of trendelenburg position have several haemodynamic & respiratory consequences. This study was undertaken to compare effects of pressure controlled ventilation & volume controlled ventilation in laparoscopic surgery in view of haemodynamic and respiratory parameters. **AIMS:** To find out the better mode between volume & pressure controlled ventilation regarding changes in haemodynamic and respiratory parameters in laparoscopic surgery. **METHODS & MATERIALS:** We observed 140 patients undergoing laparoscopic surgery in general anesthesia with endotracheal intubation of ASA Grade I & II. 70 patients were assigned in each mode of ventilation by the method of presealed envelope drawn by an independent observer. Haemodynamic and respiratory parameters were recorded after tracheal intubation (T0) and then after creation of pneumoperitoneum at every 10 min upto 80 min. The tidal volume was kept @7ml/kg in volume controlled mode and in pressure controlled mode the pressure was kept in such a way that it reaches the tidal volume @7ml/kg. Data was analysed by SpSS software ver.15. $p<.05$ was considered significant. The haemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure & mean arterial pressure were recorded. The ventilatory parameters end tidal carbon dioxide ($EtCo_2$), peak & plateau pressure were recorded at prepneumo-peritoneum, at pneumoperitoneum and post pneumoperitoneum. **RESULTS:** The incidence of variation in haemodyanamic and respiratory parameters were observed least changes in pressure controlled ventilation as compared to volume controlled ventilation in laparoscopic surgery undergoing general anesthesia. The p Values was <.05 at all-time points which is statistical significant. **CONCLUSION:** Pressure controlled ventilation was better mode of ventilation than volume controlled ventilation in laparoscopic surgery in view of respiratory and haemodynamic variation.

KEYWORDS: laparoscopic surgery, volume controlled ventilation, pressure controlled ventilation, haemodyanamic and respiratory parameters.

INTRODUCTION: The historical milestone in evolution of laparoscopic surgery have been comprehensively detailed by Gaskin et al.[1] The advent of laparoscopic cholecystectomy was the catalyst that aroused the interest of general surgeon worldwide in laparoscopy and closed abdominal surgery.[2-5]

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The publication of Steptoe[6] in 1967 about the technique of laparoscopy for use in gynecological practice was adopted widely by practitioners and was followed by several reviews outlining the anaesthetic considerations for these procedures.[7-8] The creation of pneumoperitoneum by insufflation of the abdominal cavity with CO_2 and assumption of trendelenburg position have several haemodynamic & respiratory consequences.

Today "laparoscopy" describes a procedure during which contents of the intraperitoneal cavity or of the extraperitoneal space are examined and manipulated for diagnostic or therapeutic intervention. Since 1987, when the first laparoscopic cholecystectomy was successfully performed by Phillipe Mouret, this has become the gold standard. By 1992, a National Institutes of Health Consensus Statement endorsed laparoscopic cholecystectomy as a legitimate tool in the surgeon's armamentarium for the treatment of symptomatic cholelithiasis. The benefits of minimal access technique include less pain, early mobilization, minimal scar and shorter hospital stay, which have further increased its applications.

Volume controlled mode is the most popular method for the intra-operative use but increased airway pressure often necessitates changes to set tidal volume & respiratory rate to maintain effectiveness. Pressure controlled mode potentially provides greater control over airway pressure of its decelerating inspiratory flow pattern.[9]

Pressure controlled ventilation may be associated with increased mean airway pressure.[10-12], that in turn may improve oxygenation.[10,13,14] Therefore, it is decided to compare the effects of the two ventilation modes with respect to haemodynamic & ventilatory parameters and to observe that which mode of the ventilation is better.

AIMS OF STUDY: Study & compare pressure and volume controlled ventilation regarding hemodynamic parameters i.e. Heart rate, Systolic blood pressure, Diastolic blood pressure & Mean arterial pressure Study & the ventilatory parameters i.e. End tidal Co_2, Peak pressure & Plateau pressure.

MATERIAL & METHODS: After approval from Institutional ethical committee, the study was conducted in Department of Anaesthesiology at Sri Ram Murti Smarak Institute Of Medical Sciences, Bareilly, U.P during the period from Nov. 2012 to June 2014, in 140 patients, ASA grade I & II, of either sex and 18-60 years age group, undergoing elective laparoscopic surgery under general anaesthesia. Informed written consent was obtained from all the patients. All the patients were subjected to thorough pre-anaesthetic evaluation and relevant laboratory investigations. A standard anaesthetic protocol was used in the groups of patients. We included patients in age range of 18- 60 years of either sex. Patients belonging to ASA grade I & II. Patients having BMI less than 30. Available informed written consent. Patients with all routine investigations within normal limits. Patient refusal, with known allergy, with neuromuscular disorders, anticipated difficult intubation, known systemic disorders like cardiovascular, pulmonary, hepato renal, or metabolic diseases & emergency surgeries were excluded.

Patients were divided in 2 groups (Volume controlled group & pressure controlled group) by using the method of presealed envelope drawn by an independent observer and were subjected to receive either volume controlled ventilation or pressure controlled ventilation. In volume controlled group the tidal volume was kept @ 7ml/kg. In pressure controlled group, the pressure was kept such that it reaches the required tidal volume.

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Materials that were used were Anesthesia workstation, Intravenous cannula 18G, Intravenous fluids- lactated ringer, normal saline, colloids, Monitoring equipments- Pulse Oximeter, ECG- monitor, Non-invasive blood pressure (NIBP) monitor, capnography. Drugs- Glycopyrrolate, ondensetron, Fentanyl, Propofol, Succinylcholine, Vecuronium, Oxygen, Nitrous oxide, Isoflurane, Neostigmine. Equipments for endotracheal intubation Disposable syringes 10ml, 5ml, 2ml & drugs and equipments necessary for resuscitation.

ANAESTHETIC PROCEDURE: On the day of surgery, patients were wheeled in the operation theatre. All monitors such as non-invasive blood pressure (NIBP), pulse oximeter and electrocardiogram (ECG) were connected to the patient. Intravenous line was secured using 18 G intravenous cannula and slow intravenous infusion of normal saline was started. All patients were pre-oxygenated for 3 minutes. Patients were premedicated intravenously with Injection Glycopyrrolate (0.005mg/kg), Injection Ondansetron (0.15mg/kg), Injection Fentanyl (2µg/kg) &Injection lidocaine (1.0mg/kg).

INDUCTION OF GENERAL ANAESTHESIA: Induction of general anaesthesia was done with Injection Propofol (2mg/kg) intravenously till the loss of eye lash reflex. Injection Succinylcholine (1.0mg/kg) was given intravenously. It was followed by oro-tracheal intubation using well lubricated endotracheal tube of appropriate size. After securing the endotracheal tube properly, the chest was auscultated to ensure bilateral equal air entry. The ratio of inspiratory to expiratory time was kept (1:2). A mixture of nitrous oxide, 1% v/v Isoflurane in 35% oxygen was kept in both the modes of ventilation.

INTRAOPERATIVE: All patients were continuously monitored for Spo_2, Systolic blood Pressure, Diastolic blood pressure & Mean arterial pressure, heart rate (HR) and end tidal CO_2, peak and plateau pressures. The pneumoperitoneum was created by carbon dioxide at the pressure of 13 mm of Hg in both the modes of ventilation in supine position. Patients were tilted head up 15 to 20 degrees and same position was maintained throughout the procedure. After the completion of surgery, residual neuromuscular blockade was reversed with neostigmine (0.05mg/kg) & glycopyrrolate (0.005mg/kg). Patients were transferred to recovery room after extubation.

DATA RECORDING:

Hemodynamic Parameters: Data were recorded at various time intervals. First at Pneumo-peritoneum (PnP) and then after every 5 min up to 40 minutes.

Ventilatory Parameters: Data were recorded at various time intervals and for Etco2 it was recorded first at Pneumoperitoneum and then after 5min up to 35 minutes at every 5 min interval.

Peak & Plateau pressure were recorded at three intervals, first at baseline i.e. before pneumoperitoneum creation, second at pneumoperitoneum and third at post pneumoperitoneum.

DATA ANALYSIS: The data was recorded on microsoft excel worksheet. The analysis of the data and application of statistical tests was carried out with help of SPSS software, ver. 15 IBM Corporation. Data was compiled, analyzed and presented as mean & standard deviation. The student unpaired T test was applied.

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RESULTS: The study included 140 patients into two groups i.e. volume controlled mode and pressure controlled mode of 70 patients each. Two patients was excluded from our study as these patients were converted to open surgery. In each mode of ventilation, patient characteristics were kept quite similar in both groups. All the haemodynamic parameters such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (M. A. P) in pressure controlled mode showed least variation when compared to volume controlled mode parameters at all-time points.

The heart rate was observed in both modes of ventilation and observed that it showed least variation in pressure controlled mode (Table 2, 3 & Fig. 5), systolic blood pressure (Table 4, 5 & Fig. 6) and diastolic blood pressure (Table 6, 7 & Fig. 7) also showed least variation in pressure controlled mode and mean arterial pressure also showed the same result in pressure controlled (Table 8, 9 & Fig. 8).

The respiratory parameters which we have taken was $EtCo_2$ which also showed the least haemodynamic variation in pressure controlled mode (Table 10, 11 & Fig 9). The Peak pressures at baseline, pneumoperitoneum & post pneumoperitoneum which also showed that pressure controlled ventilation was better (Table 12, 13, 14, 15, 16, 17 and Fig. 10, 11 & 12).

OBSERVATIONS:

Data	Volume controlled group	Pressure controlled group
Age (yrs)	33.314±10.80	37.457±11.74
Weight (kg)	64.814±8.92	63.900±8.47
Height(cms)	163.543±8.65	162.143±7.04
Bmi (kg/m^2)	24.128±1.72	24.100±7.04

Table 1: Mean & standard deviation of patient characteristics subjected to volume control & pressure control ventilation

The table 1 & Fig 1, 2, 3, 4 shows Mean±SD of patient characteristics who were subjected to receive either volume controlled or pressure controlled ventilation. The difference in patient characteristics (age, weight, height & BMI) were statistically not significant.

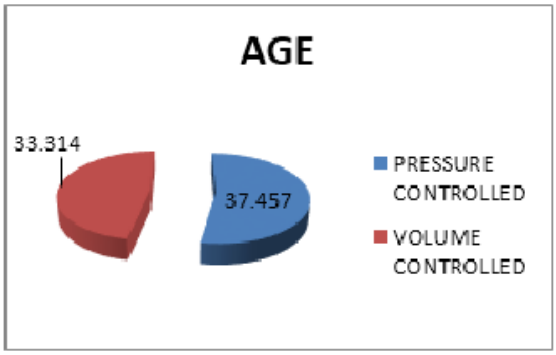

Fig. 1: Pie Chart Showing Age of Patients in Each Group

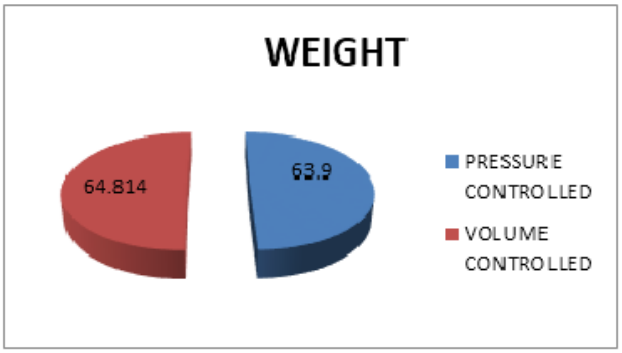

Fig. 2: Pie Chart Showing Mean Weight of Patients in Each Groups

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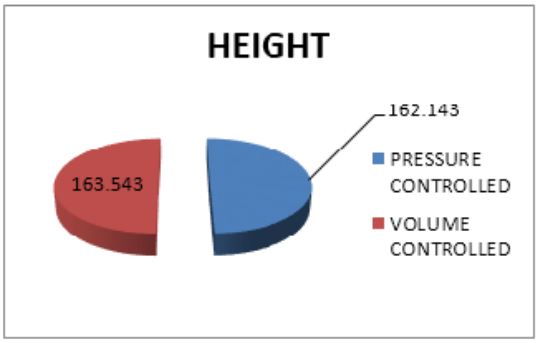

Fig. 3: Pie chart showing mean height (Cms.) in each group

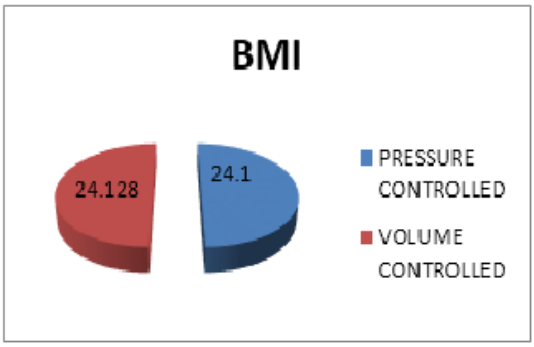

Fig. 4: Pie chart showing BMI (kg/m²) of patient in each group

Sl. No	Time points	Volume control (mean±s.d)	Pressure control (mean±s.d)
1	T 0 (Pneumoperitoneum)	85.7±8.52	79.3±8.08
2	T 1 (5 Minutes)	95.47±9.79	93.23±9.96
3	T 2 (10 Minutes)	93.99±10.89	93.214±11.485
4	T 3 (15 Minutes)	92.61±10.77	89.829±11.225
5	T 4 (20 Minutes)	92.16±10.64	89.214±11.098
6	T 5 (25 Minutes)	94.16±12.10	90.829±12.109
7	T 6 (30 Minutes)	92.67±10.44	88.885±10.112
8	T 7 (35 Minutes)	92.57±9.49	90.214±10.524
9	T 8 (40 Minutes)	93.16±10.81	90.443±11.5113

Table 2: Mean & standard deviation of heart rate in volume control & pressure control group at various time points

The table 2 & Fig 5 shows Mean & standard deviation for heart rate for pressure controlled and volume controlled ventilation which shows that heart rate was less for pressure controlled ventilation compared with volume controlled ventilation.

Sl. No.	Time points	Probability of independent "t" test	p- value/ significance
1	T 0 (pneumoperitoneum)	.0000*	p<.01(significant)
2	T 1(5 minutes)	.0018*	p<.01(significant)
3	T 2(10 minutes)	.0068*	p<.01(significant)
4	T 3 (15 minutes)	.0013*	p<.01(significant)
5	T 4 (20 minutes)	.0011*	p<.01(significant)
6	T 5 (25 minutes)	.0011*	p<.01(significant)
7	T 6 (30 minutes)	.0311*	p<.01(significant)
8	T 7 (35 minutes)	.0017*	p<.01(significant)
9	T 8(40 minutes)	.0015*	p<.01(significant)

Table 3: Comparsion b/w pressure control & volume control for heart rate at various time points (by "unpaired/ independent" t test)

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*shows a significant difference at .01 level of significance. The table 3 shows the comparison between pressure controlled ventilation & volume controlled ventilation for heart rate at various time intervals which reveals that a significant difference was present at.01 level of significance.

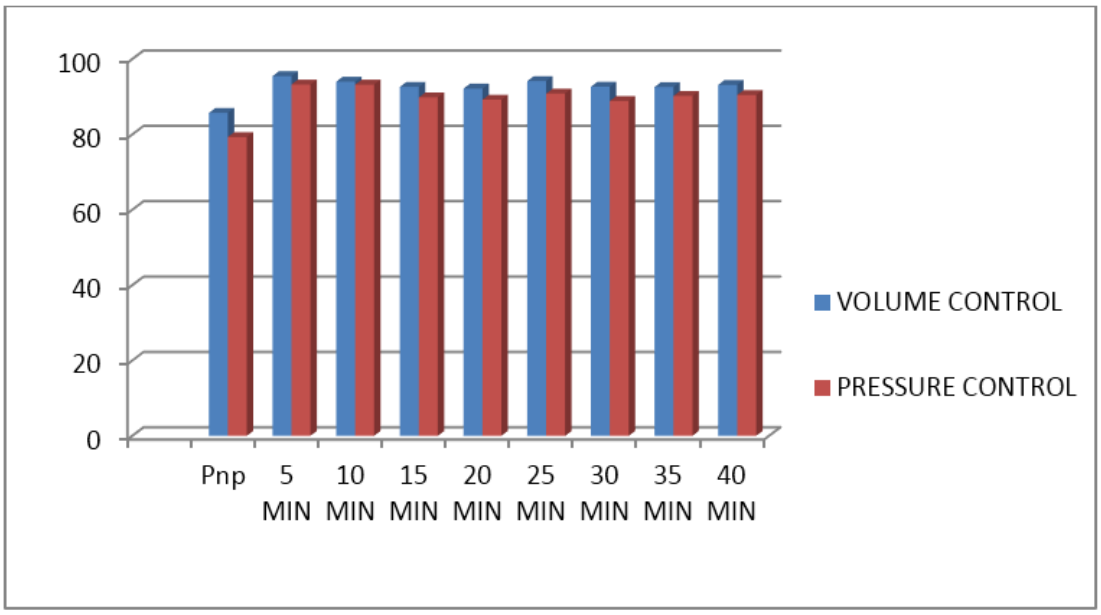

Fig. 5: The bar graph showing comparison between volume controlled and pressure controlled group for heart rate

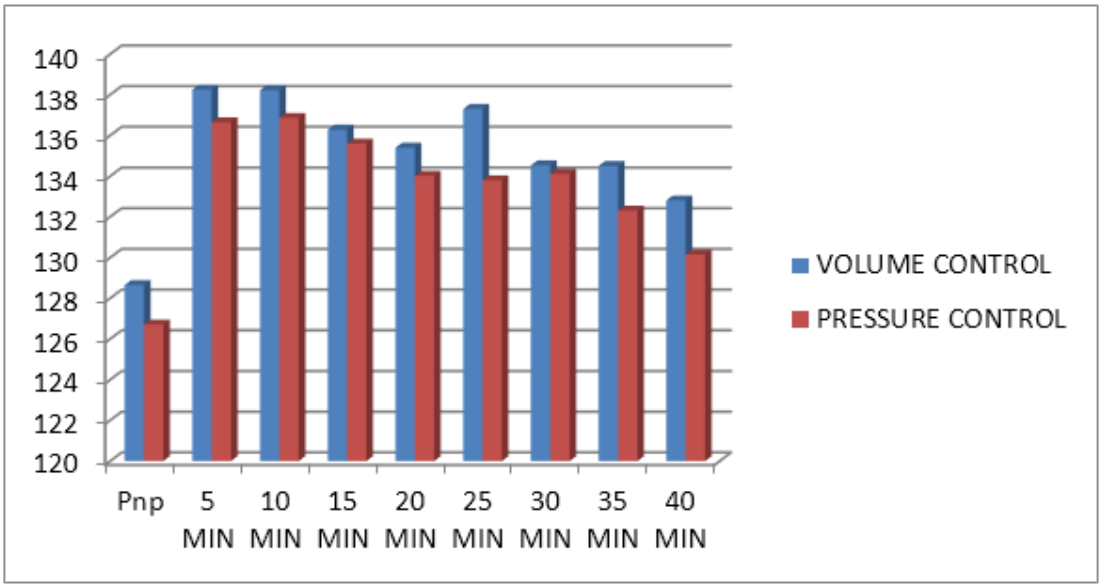

Fig. 6: The bar graph showing comparison between volume controlled and pressure controlled group for systolic blood pressure

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Sl. No.	Time points	Volume control (mean ±s.d)	Pressure control (mean ±s.d)
1	T 0 (pneumoperitoneum)	128.65±10.28	126.71±10.33
2	T 1 (5 Minutes)	138.26±9.94	136.657±9.808
3	T 2(10 Minutes)	138.23±10.93	136.857±10.99
4	T 3 (15 Minutes)	136.29±9.59	135.6±10.224
5	T 4 (20 Minutes)	135.4±10.20	134.029±10.415
6	T 5 (25 Minutes)	137.31±9.20	133.8±17.493
7	T 6 (30 Minutes)	134.54±10.21	134.113±10.163
8	T 7 (35 Minutes)	134.51±10.08	132.31±17.60
9	T 8 (40 Minutes)	132.81±16.97	130.15±19.059

Table 4: Mean & standard deviation of systolic blood pressure in volume control & pressure control group at various time points

The table 4 & Fig. 6 shows mean & standard deviation for systolic blood pressure for pressure controlled and volume controlled ventilation which shows that systolic blood pressure was less for pressure controlled ventilation compared with volume controlled ventilation.

Sl. No.	Time points	Probability of independent "t" test	p- value/ Significance
1	T 0 (pneumoperitoneum)	.0027*	p<.01(Significant)
2	T 1 (5 Minutes)	.0034*	p<.01(Significant)
3	T 2(10 Minutes)	.0046*	p<.01(Significant)
4	T 3 (15 Minutes)	.0068*	p<.01(Significant)
5	T 4 (20 Minutes)	.0043*	p<.01(Significant)
6	T 5 (25 Minutes)	.0014*	p<.01 (Significant)
7	T 6(30 minutes)	.0081*	p<.01 (Significant)
8	T 7(35 Minutes)	.0037*	p<.01 (Significant)
9	T 8(40 Minutes)	.0038*	p<.01 (Significant)

Table 5: Comparison b/w pressure control & volume control for systolic blood pressure at different time points (by "unpaired/ independent" t test)

*Shows a Significant Difference at.01 Level of Significance. The table 5 shows the comparison between pressure controlled ventilation & volume controlled ventilation for systolic blood pressure at various time intervals which reveals that a significant difference was present at.01 level of significance.

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Sl. No.	Time points	Volume control (mean ±s.d.)	Pressure control (mean ±s.d.)
1	T 0 (Pneumoperitoneum)	78.257±7.51	76.4±7.681
2	T 1 (5 Minutes)	87.43±10.16	85.57±8.90
3	T 2(10 Minutes)	89.31±11.88	87.4±11.07
4	T 3 (15 Minutes)	85.83±8.68	83.37±8.74
5	T 4 (20 Minutes)	84.51±10.02	82.429±9.26
6	T 5 (25 Minutes)	87.34±11.21	84.63±11.05
7	T 6 (30 Minutes)	86.37±11.20	83.14±10.31
8	T 7 (35 Minutes)	84.6±10.44	83.37±9.39
9	T 8 (40 Minutes)	87.2±10.17	84.31±10.46

Table 6: Mean & standard deviation of diastolic blood pressure in volume control & pressure control group at various time points

The table 6 & Fig. 7 shows mean & standard deviation for diastolic blood pressure for pressure controlled and volume controlled ventilation at various time points which shows that diastolic blood pressure was less for pressure controlled ventilation compared with volume controlled ventilation.

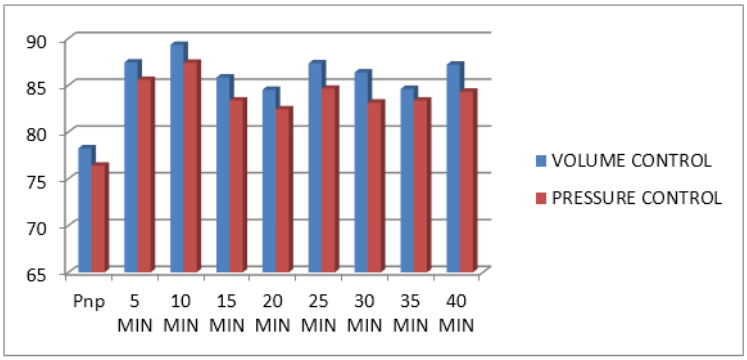

Fig. 7: The bar graph showing comparison between volume controlled and pressure controlled group for diastolic blood pressure

Sl. No.	Time points	Probability of independent "t" test	p- value/ significance
1	T 0 (Pneumoperitoneum)	.0015*	p<.01(Significant)
2	T 1 (5 Minutes)	.0025*	p<.01(Significant)
3	T 2 (10 Minutes)	.0032*	p<.01(Significant)
4	T 3(15 Minutes)	.0097*	p<.01(Significant)
4	T 4 (20 Minutes)	.0021*	p<.01(Significant)
5	T 5 (25 Minutes)	.0015*	p<.01(Significant)
6	T 6 30 Minutes)	.0078*	p<.01(Significant)
7	T 7 (35 Minutes)	.0046*	p<.01(Significant)
8	T 8 (40 Minutes)	.0010*	p<.01(Significant)

Table 7: Comparison b/w pressure control & volume control for diastolic blood pressure at different time points (by "unpaired/ independent" t test)

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*Shows a significant difference at.01 level of significance. The table 7 shows the comparison between pressure controlled ventilation & volume controlled ventilation for diastolic blood pressure at various time intervals which reveals that a significant difference was present at.01 level of significance.

Sl. No.	Time points	Volume control (mean ±s.d)	Pressure control (mean ±s.d)
1	T 0 (pneumoperitoneum)	95.1±7.90	93.81±6.22
2	T 1(5 Minutes)	102.37±10.26	100.89±9.40
3	T 2(10 Minutes)	105.64±11.44	103.83±10.723
4	T 3(15 Minutes)	102.64±8.29	100.89±8.24
5	T 4(20 Minutes)	101.57±9.57	99.67±9
6	T 5(25 Minutes)	104.03±9.55	101.57±9.53
7	T 6(30 Minutes)	102.14±10.52	99.89±9.67
8	T 7(35 Minutes)	99.93±9.25	99.2±8.54
9	T 8(40 Minutes)	103.4±9.94	100.86±10.03

Table 8: Mean & standard deviation of mean arterial pressure in volume control & pressure control at various time points

The table 8 & Fig 8 shows mean & standard deviation for mean arterial pressure for pressure controlled and volume controlled ventilation group which shows that mean arterial pressure was less for pressure controlled ventilation compared with volume controlled ventilation.

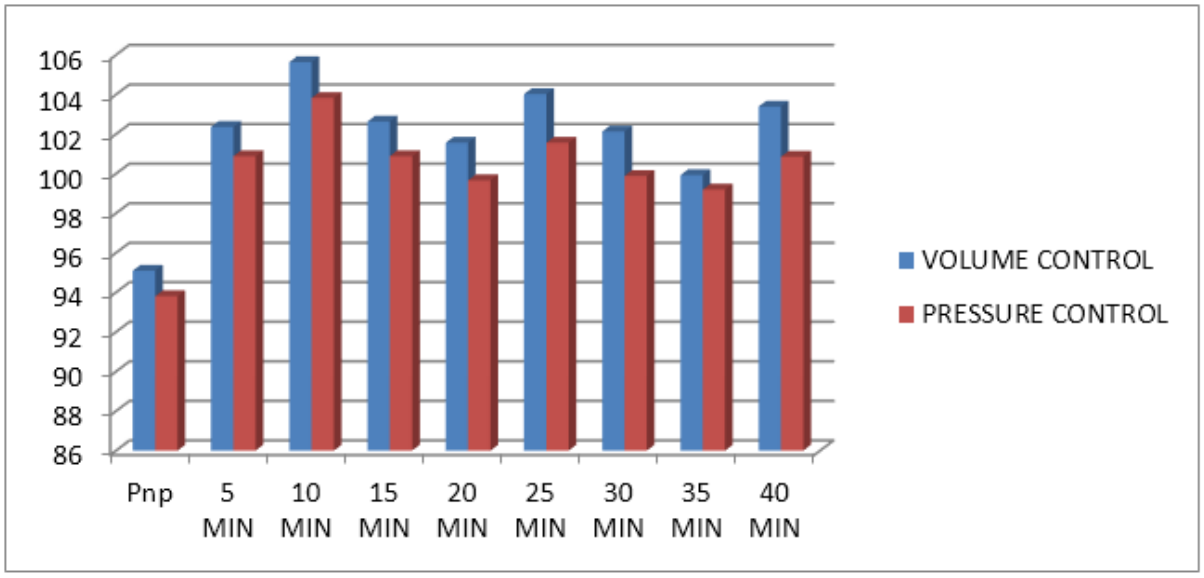

Fig. 8: The bar graph showing comparison between volume controlled and pressure controlled group for mean arterial pressure

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Sl. No.	Time points	Probability of independent "t" test	p- value/ Significance
1	T0 (Pneumoperitoneum)	.0019*	p<.01 (Significant)
2	T 1 (5 Minutes)	.0037*	p<.01 (Significant)
3	T 2(10 Minutes)	.0034*	p<.01 (Significant)
4	T 3 (15 Minutes)	.0021*	p<.01 (Significant)
5	T 4 (20 Minutes)	.0023*	p<.01 (Significant)
6	T 5 (25 Minutes)	.0013*	p<.01 (Significant)
7	T 6 (30 Minutes)	.0019*	p<.01 (Significant)
8	T 7 (35 Minutes)	.0063*	p<.01 (Significant)
9	T 8 (40 Minutes)	.0013*	p<.01 (Significant)

Table 9: Comparison b/w pressure control & volume control for mean arterial pressure at various time points (by "unpaired/ independent" t test)

*Shows a significant difference at.01 level of significance. The table 9 shows the comparison between pressure controlled ventilation & volume controlled ventilation group of mean arterial pressure at various time intervals which reveals that a significant difference was present at.01 level of significance.

Sl. No.	Time points	Volume control (mean ±s.d.)	Pressure control (mean ±s.d.)
1	T0 (Pneumoperitoneum)	34.01±2.42	28.69±2.6
2	T 1 (5 Minutes)	36±2.74	34.39±3.27
3	T 2(10 Minutes)	35.21±2.77	33.46±2.76
4	T 3 (15 Minutes)	35±2.39	33.89±2.42
5	T 4 (20 Minutes)	34.43±4.76	33.01±4.39
6	T 5 (25 Minutes)	34.93±2.60	33.63±2.98
7	T 6 (30 Minutes)	35.29±2.57	33.63±2.28
8	T 7 (35 Minutes)	35.01±2.68	33.84±2.26

Table 10: Mean & standard deviation of end tidal co2 in volume control & pressure control group at various time points

The table 10 & Fig. 9 shows mean & standard deviation for end tidal carbon dioxide for pressure controlled and volume controlled ventilation group which shows that end tidal carbon dioxide was less for pressure controlled ventilation compared with volume controlled ventilation.

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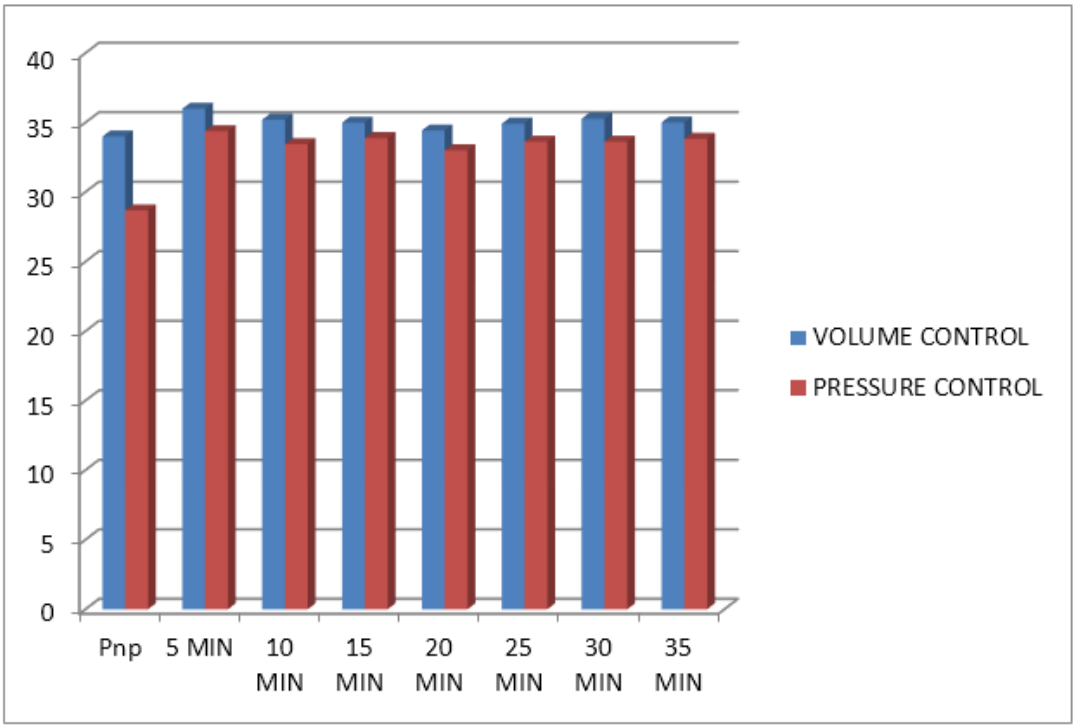

Fig. 9: The bar graph showing comparison between volume controlled and pressure controlled ventilation group for end tidal co_2

Sl. No.	Time points	Probability of independent "t" test	P- value/ significance
1	T0 (Pneumoperitoneum)	.0000*	P<.01 (Significant)
2	T 1(5 Minutes)	.0019*	P<.01(Significant)
3	T 2(10 Minutes)	.0003*	P<.01(Significant)
4	T 3(15 Minutes)	.0068*	P<.01(Significant)
5	T 4(20 Minutes)	.0069*	P<.01(Significant)
6	T 5(25 Minutes)	.0068*	P<.01(Significant)
7	T 6(30 Minutes)	.0001*	P<.01(Significant)
8	T 7(35 Minutes)	.0059*	P<.01(Significant)

Table 11: Comparison b/w pressure control & volume control for end tidal co_2 at various time points (by "unpaired/ independent" t test)

*shows a significant difference at.01 level of significance.

The table 11 shows the comparison b/w pressure controlled ventilation & volume controlled ventilation for end tidal carbon dioxide at various time intervals which reveals that a significant difference was present at.01 level of significance.

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Sl. No.	Pressure	Mean ± s.d.	
		Pressure controlled ventilation	Volume controlled ventilation
1.	Peak pressure	13.214±1.128	18.3±1.739
2.	Plateau pressure	12.971±1.006	15.543±2.198

Table 12: Mean & standard deviation of peak & plateau pressure at baseline for pressure controlled and volume controlled ventilation

The table 12 & Fig 10 shows mean & standard deviation of baseline peak & plateau pressure for pressure controlled and volume controlled ventilation which shows that peak & plateau pressure was less for pressure controlled ventilation compared with volume controlled ventilation.

Sl. No.	Pressure	Probable values of independent "t" test	P- value
1.	Peak	.0003*	P<.01 (significant)
2.	Plateau	.0010*	P<.01 (significant)

Table 13: Comparison b/w pressure controlled ventilation & volume controlled ventilation for peak & plateau pressure at base line

*shows a significant difference at.01 level of significance.

The table 13 shows the comparison between pressure controlled ventilation & volume controlled ventilation group for peak & plateau pressure at base line which reveals that a high significant difference was present in peak & plateau pressure at.01 level of significance.

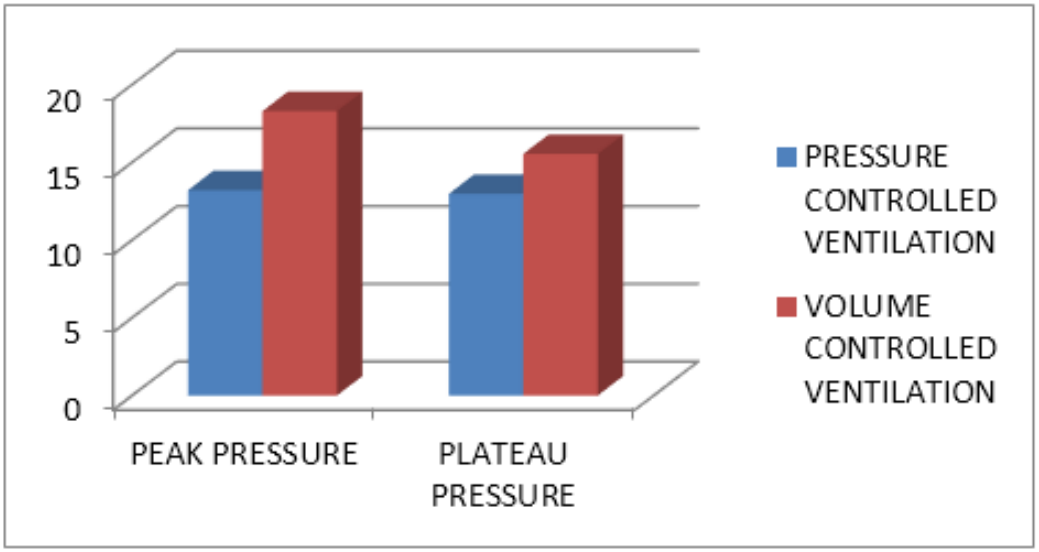

Fig. 10: The bar graph showing comparison between volume control & pressure control group for peak & plateau pressure at baseline time interval

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Sl. No.	Pressure	Mean ± s.d.	
		Pressure controlled ventilation	Volume controlled ventilation
1	Peak	17.586±1.070	21.586±3.215
2	Plateau	18.457±1.674	21.857±2.286

Table 14: Mean & standard deviation of peak & plateau pressure at pneumoperitoneum for pressure controlled and volume controlled ventilation

The table 14 & Fig. 11 shows mean & standard deviation of peak & plateau pressure at pneumoperitoneum for pressure controlled and volume controlled ventilation which shows that peak & plateau pressure was less for pressure controlled ventilation compared with volume controlled ventilation.

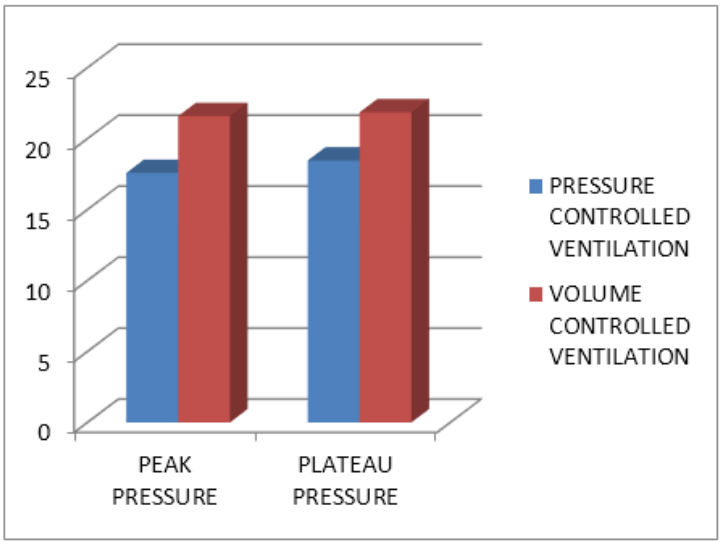

Fig. 11: The graph showing comparison between volume & pressure controlled group for peak & plateau pressure at pneumoperitoneum

Sl. No.	Pressure	Probable values of independent "t" test	P- value
1	Peak	.0000*	P<.01 (significant)
2	Plateau	.0000*	P<.01 (significant)

Table 15: comparison b/w pressure controlled ventilation & volume controlled ventilation for peak & plateau pressure at pneumoperitoneum

*shows a significant difference at.01 level of significance.

The table 15 shows the comparison between pressure controlled ventilation & volume controlled ventilation for peak & plateau pressure at pneumoperitoneum which reveals that a high significant difference was present in peak & plateau pressure at.01 level of significance.

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Sl. No.	Pressure	Mean ± s.d.	
		Pressure controlled ventilation	Volume controlled ventilation
1	Peak	15±1.474	19.214±1.999
2	Plateau	14.2±1.790	15.829±2.713

Table 16: Mean & standard deviation of peak & plateau pressure at post pnemoperitoneum for pressure controlled and volume controlled ventilation group

The table 16 & fig 12 shows mean & standard deviation of peak & plateau pressure at post pneumoperitoneum which shows that pressures was less in pressure controlled ventilation compared with volume controlled ventilation.

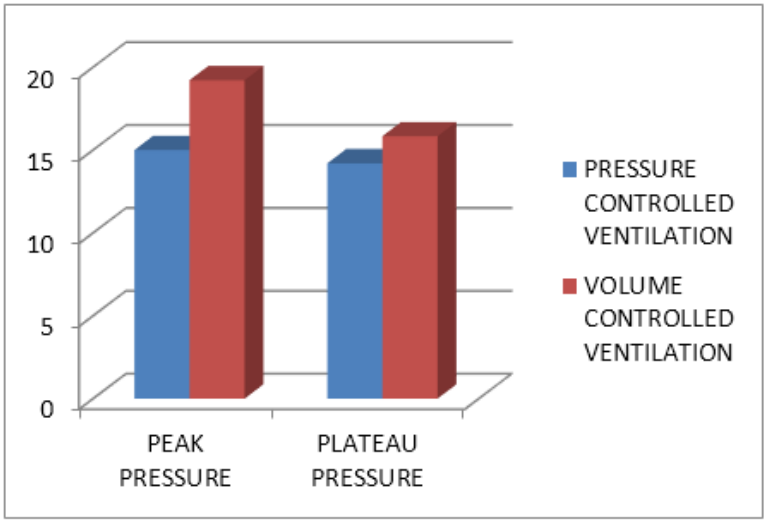

Fig. 12: The graph showing comparison between volume & pressure controlled group for peak & plateau pressure at post pneumoperitoneum

Sl. No.	Pressure	Probable values of independent "t" test	P- value
1	Peak	.0002*	P<.01 (Significant)
2	Plateau	.0001*	P<.01 (Significant)

Table 17: Comparison b/w pressure controlled ventilation & volume controlled ventilation for peak & plateau pressure at post pneumoperitoneum

*shows a significant difference at.01 level of significance.

The table 17 shows the comparison between pressure controlled ventilation & volume controlled ventilation for peak & plateau pressure at post pneumoperitoneum which reveals that a high significant difference was present in peak & plateau pressure at.01 level of significance.

DISCUSSION: The study was carried out on 140 patients divided into two equal groups belonging to ASA grade I & II in the age range of 18 to 60 yrs of either sex scheduled for elective laparoscopic surgeries.

In present study the age in yrs in volume control group was (Mean ± SD) 33.31±10.80 & in pressure control group was 37.46±11.74.In this study the weight in kg in volume control group was (Mean ± SD) 64.81±8.92 & pressure control group was 63.90 ± 8.47. In this study height in cms in volume control group was (Mean ± SD) 163.54±8.65 whereas in pressure control group was 162.14± 7.05. In our study the BMI in volume control group was (Mean ± SD) 24.128±1.72 and in pressure control group was 24.100±7.04. (Table 1)

The demographic profile i.e. age, weight, height & BMI were comparable in both the groups.

The hemodynamic as well as respiratory parameters in volume control group were compared to pressure control group at various time intervals.

HEART RATE: In our study, it was observed that heart rate was less with the pressure controlled ventilation group at various time intervals (Table 2) which was statistically significant. (Table 3). The study conducted by Kwak et al.[15] in which the heart rate was less in pressure controlled ventilation with volume controlled ventilation but was not statistically significant. In our study, the heart rate at 30 min after creation of pneumoperitoneum was 92.67±10.44 & 88.88±10.112 in volume & pressure controlled group but in the study done by Kwak et al.[15] it was 101±16 in volume controlled ventilation and it was 91±14 in pressure controlled group.

The result of the study conducted by Kwak et al.[15] did not coincide with our study. The variation in the result may be due to pediatric population and small sample size. The studies done by Levya et al.[16], Dion et al.[17] & Gupta et al.[18] also observed no statistical significant difference but clinically the heart rate was less in pressure controlled group compared to volume controlled group.

SYSTOLIC & DIASTOLIC BLOOD PRESSURE: In our study, both systolic and diastolic blood pressure was less in pressure controlled ventilation than the volume controlled ventilation (Table 4 & 6) and the p values were significant. (Table 5 & 7). M Dion et al.[17] performed a study and observed that the average systolic blood pressure in volume control group was 99±10 and in pressure control group was 98±11. So, it is observed in pressure control group, systolic blood pressure was less which is similar to systolic blood pressure in our study but the difference was not statistically significant. Weber et al.[10] Gupta et al.[18] recorded haemodynamic parameters and observed that there was difference when patients were subjected to modes of ventilation and the pressure controlled ventilation has less systolic & diastolic blood pressure compared to volume controlled ventilation group but the difference was not statistically significant. In above mentioned studies, the difference in observation may be due to small sample size and both modes of ventilation was applied on same patient at different time intervals.

MEAN ARTERIAL PRESSURE: In our study the mean arterial pressure was less in the pressure controlled group (Table 8) than the volume controlled group at all time intervals. Table 8 illustrates that there was difference in Mean arterial pressure of the pressure control group and the p values are statistical significant at all time intervals. (Table 9). The studies done by Dion et al.[17], Weber et al.[10], Gupta et al.[18] all showed that there was difference of Mean arterial pressure in pressure controlled

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group but the difference was not statistically significant. In above mentioned studies, the difference in observation may be due to small sample size and both modes of ventilation was applied on same patient at different time intervals.

VENTILATORY PARAMETERS:

END TIDAL CO_2: In our study, the End tidal Co_2 was observed low in pressure controlled group than volume controlled group (Table 10). The p values at various time intervals was found significant (Table 11). In the study performed by Leyva et al.[16] the Etco2 values which were recorded at pneumoperitoneum was 30.18+1.36 & 29.70+1.18 in pressure controlled and volume controlled group respectively. the difference was statistically insignificant (p=.224) whereas in our study the Etco2 at pneumoperitoneum was 34.21±2.42 and 28.69±2.6 in pressure & volume controlled group respectively which was statistically significant (Table 10 & 11). It did not coincide with our study probably because Levya et al.[16] adjusted ventilatory parameters so that Etco2 values remained around 30.

PEAK PRESSURE: In our study, the baseline peak pressure was 13.21±1.13 & 18.3±1.74 in pressure controlled & volume controlled group respectively. The peak pressure at pneumoperitoneum was 17.586±1.070 and 21.586±3.215 in pressure controlled and volume controlled group respectively. The peak pressure at post pneumoperitoneum was 15±1.474 and 19.214±1.999 in pressure controlled & volume controlled group respectively. So, the peak pressure was less in the pressure controlled group at all three time intervals i.e. at Baseline, pneumo-peritoneum & post pneumoperitoneum. (Table 12, 14, 16). The difference at all 3 time intervals viz. Baseline, pneumoperitoneum & post pneumoperitoneum was statistically significant. (p values in Table 13,15 & 17). The study conducted by Levya et al.[16] observed that at baseline peak pressure was 14.15±2.79 and 16.40±4.62 in presssure controlled & volume controlled group and the difference was statistically significant (p=.043) which coincides with our study. The peak pressure at the pneumoperitoneum was 18.58±3.32 in pressure controlled group and 22.03±5.03 in volume controlled group in study performed by Levya et al.[16]

The difference was statistically significant (p=.004) which coincides with our study. The peak pressure in post pneumoperitoneum was 15.55±3.23 in pressure controlled group and 17.90±4.65 in volume controlled group in study performed by Levya et al. The difference was not statistically significant (p=.059) which do not coincide with our study. The study performed by Tyagi et al.[19] involving 42 patients having BMI of more than 30kg/m^2, demonstrated that the peak pressure was reduced in pressure controlled group when compared to volume controlled group. The results of study was pressure-controlled ventilation resulted in a significant decrease in (mean ±SD) peak airway pressure at 10 min was 20.4±2.7 vs 24.0±4.7 cmH2O, (p=0.004) and 30 min 20.7±3.0 vs 23.9 ±4.9 cmH2O, (p=0.015).

The difference was statistically significant. In another study performed by Weber et al.[10] involving 21 patients demonstrated that, during laparoscopy Pressure controlled ventilation decreased peak airway pressure and increased mean airway pressure when compared with volume controlled ventilation. In this study, the peak airway pressures were significantly lower in pressure controlled group as it can be explained by the decelerating flow pattern and the earlier dissipation of flow resistance in pressure controlled ventilation.[10]

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Thus, in pressure controlled ventilation, the peak pressure is limited, reducing the chance of barotraumas. Conversely, the higher tidal volumes and increased peak airway pressures in volume controlled ventilation causes alveolar over distension, leading to lung injury.[20]

PLATEAU PRESSURE: In our study, the plateau pressure was observed at three time intervals i.e. baseline, pneumoperitoneum and post pneumoperitoneum. The study performed by Levya et al.[16] in 2007 observed that the baseline plateau pressure was 13.85±2.68 in pressure controlled group and 15.80±4.47 in volume controlled group and the difference in its study was not statistically significant (p=.093). In our study, the baseline plateau pressure was 12.971±1.006 in pressure controlled group and 15.543 ± 2.198 in volume controlled group (Table 12). The difference was statistically significant (Table 13) which do not coincide with study of Levya et al.[16] which may be due to small sample size.

In our study, the plateau pressure increased up to 18.457±1.674 and 21.857±2.286 in pressure controlled and volume controlled group respectively (Table 14).The difference was statistically significant (Table 15). In study performed by Levya et al.[16] during pneumoperitoneum, the plateau pressure was increased up to 18.09±3.27 and 21.19±4.85 for pressure controlled ventilation and volume controlled ventilation. The values showed difference with the pressure controlled ventilation which was statistically significant (p=.017) which coincides with our study.

In our study, the plateau pressure at post pneumoperitoneum period was 14.2±1.790 & 15.829±2.713 in pressure controlled and volume controlled group respectively (Table 16). The difference was statistically significant. (Table 17). In the study performed by Levya et al.[16] the plateau pressure at post pneumoperitoneum was 14.90±3.00 & 17.40±4.85 in Pressure and volume controlled group respectively. The difference was not statistically significant. (p=063) which do not match with our study. This may be due to small sample size.

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LIMITATIONS OF STUDY:

1. Various types of surgeries were included requiring different positions thereby influencing the various parameters observed.
2. Invasive hemodynamic monitoring would have been used in our study.

CONCLUSION: It is concluded that pressure controlled ventilation is a better than the volume controlled ventilation in laparoscopic surgery regarding hemodynamic & ventilatory parameter.

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AUTHORS:

1. Abhishek Kumar
2. Major General H. S. Nanda

PARTICULARS OF CONTRIBUTORS:

1. 3rd Year Post Graduate Student, Department of Anaesthesiology, SRMS-IMS, Bareilly, U. P. India.
2. Professor & HOD (Retd.), Department of Anaesthesiology, SRMS-IMS, Bareilly, U. P. India.

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NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Abhishek Kumar,
Room No. 121,
'F' Block, SRMS-IMS Campus,
Bareilly, U. P, India.
E-mail: abhishekdoctor@hotmail.com

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