Original Research Article

Comparative evaluation of intraabdominal pressure on hemodynamic parameters during laparoscopic procedures

Sumanth[1], P Rajeswar[2*]

[1]Senior Resident, [2]Associate Professor, Department of Anesthesia, Kamineni Academy of Medical Sciences and Research Centre,Hyderabad.
Email: dr.rajeswar.kimsrchyd@gmail.com

Abstract

Background: The present prospective non randomized study, Evaluation of intraabdominal pressure on hemodynamic parameters during laparoscopic procedures was observed in 90 ASA1/ASA2 patients undergoing elective surgeries. Patients were divided into 3 groups based on IAP (10/15/20 mmHg), 30 in each group. One basal reading of Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP), Mean arterial blood pressure (MAP) and Central venous pressure (CVP) was taken in patient after induction of anaesthesia but before peritoneal insufflation. After insufflation these parameters were measured at 5-min intervals for the first 15 minutes. Results showed that there was significant increase in HR within the 10 mm Hg and 15 mm Hg IAP groups, but in 20 mm Hg IAP group heart rate rose till 10 min after insufflation then it fell significantly. Over all there was no significant difference between groups. SBP, DBP and MAP increased significantly within the 15 mm Hg IAP group. In 10 mm Hg IAP group increase in these parameters was seen till 10 min after insufflation and at 15 min after insufflation there was no significant difference. In 20 mm Hg IAP group increase in these parameters was seen till 10 min after insufflation and at 15 min after insufflation there was a significant drop. Over all there was significant difference in SBP and MAP between groups, no statistically significant difference was observed in DBP between groups. CVP showed significant increase within the 10 mm Hg and 15 mm Hg IAP groups, but in 20 mm Hg IAP group increase was seen till 10 min after insufflation and significant fall was seen at 15 min after insufflation. Significant difference between groups was seen. This study concludes that intraabdominal pressure of upto 15 mm Hg could be used for laparoscopic procedures without adverse hemodynamic changes.

Key Words: Hemodynamics, intraabdominal pressure, Laparoscopy, Pneumoperitoneum

[*]**Address for Correspondence:**
Dr P Rajeswar, Associate Professor, Department of Anesthesia, Kamineni Academy of Medical Sciences and Research centre, Hyderabad.
Email: dr.rajeswar.kimsrchyd@gmail.com

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INTRODUCTION

Laparoscopy has become a widely accepted surgical approach since its inception in the early 1980s. Improved cosmesis, decreased pain and an earlier return to preoperative activities are the clinical benefits of laparoscopy.[1] "Laparoscopic" is a Greek word meaning to look into the flanks through the abdominal wall after creation of pneumoperitoneum.[2] The majority of studies concur that laparoscopy causes a decrease in cardiac index and that this effect appears to be dependent on the level of intraabdominal pressure. Since the introduction of laparoscopic surgery, efforts have been made to reduce the adverse hemodynamic and cardiopulmonary effects of pneumoperitoneum without compromising the efficacy, feasibility, and safety of the operation.[3,4] Pneumoperitoneum during laparoscopy produces significant haemodynamic changes, which can be detrimental especially in elderly and haemodynamically compromised patients[5]. Evaluating the effects of different IAPs during laparoscopic procedures on hemodynamic

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parameters and comparing them may help in determining the optimal recommended pneumoperitoneal pressure that can be employed with no deleterious outcomes. The purpose of the study is to know about the effects of intraabdominal pressure on hemodynamic parameters during laparoscopic procedures, which helps to evaluate the safe limit of intraabdominal pressure.

MATERIALS AND METHODS

This study is conducted at Kamineni Hospitals, L.B. Nagar, Hyderabad. It is a Prospective, non randomized study conducted during Jan 2012 – Dec 2014. Inclusion criteria were ASA 1 and ASA 2 grade patients of either sex, aged between 20 to 50 years, non obese patients (BMI < 30 kg/meter2). Patients with ASA 3 - 5 grades, more than 50 years of age, hemodynamically unstable, Pregnancy, Patient's with BMI > 30 Kg/meter2 were excluded from the study. After taking approval from the ethics committee, informed consent for the study was obtained from 90 patients scheduled for laparoscopic surgeries. General anaesthesia with endotracheal intubation and controlled ventilation was the anaesthetic technique applied. A standard balanced anesthesia protocol comprised of propofol (2 mg/kg), fentanyl (2 mg/kg), isoflurane, and vecuronium (0.1 mg/kg) was used for all patients. Ventilatory settings were volume controlled ventilation, FiO2: 0.5, Tidal volume: 6 ml/Kg, respiratory rate: 14 – 18 breaths/min , inspiratory to expiratory time ratio – 1:2, Positive end expiratory pressure : 0 cm H2O. The minute ventilation was adjusted to maintain the end tidal CO2 between 30 and 40 mm Hg. This is achieved by increasing the respiratory rate rather than the tidal volume since lung compliance is reduced. ASA standard monitoring by Oxygen saturation by Pulse oximetry, HR by ECG, Blood pressure via arm cuff (Non-invasive blood pressure monitoring), end tidal CO2 by Capnography, Temperature by temperature probe, CVP was measured by cannulating right Internal Jugular vein using single lumen 7F catheter and by using hydromanometer. Supine position of the patient was maintained till 15 min after insufflation, there by nullifying the effects of different patient positions. Insufflation of the abdomen with CO2 was maintained at a desired pressure (10/15/20 mmHg). One basal reading of HR, Systolic , Diastolic and Mean arterial blood pressure(SBP,DBP and MAP) and Central venous pressure(CVP) was taken in patient after induction of anaesthesia but before peritoneal insufflation. After insufflation these parameters were measured at 5-min intervals for the first 15 minutes. Respiratory parameters 14 (Minute ventilation, ETCO2) were also recorded pre insufflation and after insufflation for 15 minutes. An intraabdominal pressure of 10/15/20 mm Hg was decided on the operation theater table by the anaesthesiologist without compromising with the abdominal view. These patients were then assigned into 3 different groups, 30 in each group. Group 1: 10 mmHg of intraabdominal pressure - Group 2 : 15 mmHg of intraabdominal pressure - Group 3 : 20 mmHg of intraabdominal pressure Standard statistical procedure of analysis of variance and t –test were used in this study and level of significance was considered at $p<0.001$

RESULTS

This study is conducted at Kamineni Hospitals, L.B. Nagar, Hyderabad includes a total of 90 patients undergoing laparoscopic surgeries assigned into 3 different groups, 30 in each group. Group 1, 2 and 3 were maintained at 10/20/30 mmHg of intraabdominal pressure respectively. There is no significant difference with regards to ASA grade, sex, age of patients in 3 groups.

Heart rate (HR)

The HR in different groups before peritoneal insufflations (HR0) and after insufflation were measured at 5-min intervals for the first 15 minutes(HR5,10,15) were shown in table1 and compared in fig.1.There was no statistically significant difference in HR measurements between the groups (p value = 0.306), but there was significant difference in HR measured within each group at different times (p <0.001).At 10 mm Hg IAP – Pairwise comparisons show that there was statistically significant difference. At 15 mm Hg IAP – Pairwise comparisons show that there was statistically significant difference. At 20 mm Hg IAP - Pairwise comparisons show that there was no statistically significant difference between HR5 and HR15 (p = 0.202).

Table 1: Heart rate in different intraabdominal pressure groups

	AT 10 mm Hg IAP	AT 15 mm Hg IAP	AT 20 mm Hg IAP
HR0	74.26±1.29	74.36 ± 1.31	71.16 ± 0.75
HR5	79.36±1.25	82.06 ± 1.33	86.16 ± 0.72
HR10	84.8±1.25	86.93 ± 1.37	89.66 ± 0.83
HR15	86.43±1.34	88.83 ± 1.42	87.53 ± 0.97

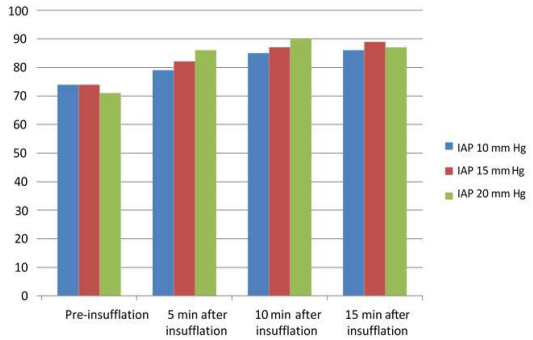

Figure 1: Comparison of heart rate in different intraabdominal pressure groups

Systolic blood pressure (SBP)

The SBP in different groups before peritoneal insufflations (SBP0) and after insufflation were measured at 5-min intervals for the first 15 minutes (SBP 5,10,15) were shown in table 2 and compared in fig.2. Statistically significant difference was seen in SBP measurements between the groups ($p < 0.001$), within each group at different times ($p < 0.001$) At 10 mm Hg IAP – Pairwise comparisons show that there was no statistically significant difference between SBP10 and SBP15 ($p = 0.3375$) At 15 mm Hg IAP – Pairwise comparisons show that there was statistically significant difference. At 20 mm Hg IAP - Pairwise comparisons show that there was no statistically significant difference between SBP5 and SBP15 ($p = 1$).

Table 2: Systolic blood pressure in different intraabdominal pressure groups

	AT 10 mm Hg IAP	AT 15 mm Hg IAP	AT 20 mm Hg IAP
SBP0	114.06±1.09	116.3± 1.05	113.3± 0.78
SBP5	124.86±1.16	129.86± 1.14	136.16± 0.86
SBP10	128.56±1.08	133.93± 1.08	140.43± 0.89
SBP15	128.96±1.05	134.86± 1.33	136.2± 0.92

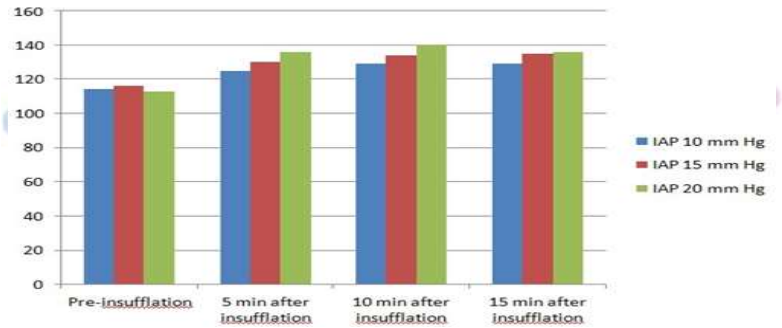

Figure 2: Comparison Systolic blood pressure in different intraabdominal pressure groups

Diastolic blood pressure (DBP)

The DBP in different groups before peritoneal insufflations (DBP0) and after insufflation were measured at 5-min intervals for the first 15 minutes (DBP 5,10,15) were shown in table 3 and compared in fig.3. There was no statistically significant difference in DBP measurements between the groups (p value = 0.199), but there is significant difference in DBP measured within each group at different times ($p < 0.001$) At 10 mm Hg IAP – Pairwise comparisons show that there was no statistically significant difference between DBP10 and DBP15 ($p = 1$) At 15 mm Hg IAP – Pairwise comparisons show that there was statistically significant difference. At 20 mm Hg IAP - Pairwise comparisons show that there was no statistically significant difference between DBP5 and DBP15 ($p = 0.1673$).

Table 3: Diastolic blood pressure in different intraabdominal pressure groups

	AT 10 mm Hg IAP	AT 15 mm Hg IAP	AT 20 mm Hg IAP
DBP0	72.46±0.95	73.4± 1.06	70.2± 0.93
DBP5	81.43±0.92	85.6± 1.13	85.3± 0.99
DBP10	86.33±1.01	87.6± 1.10	88.93± 0.96
DBP15	86.36±0.99	89.63± 1.14	84.0± 0.99

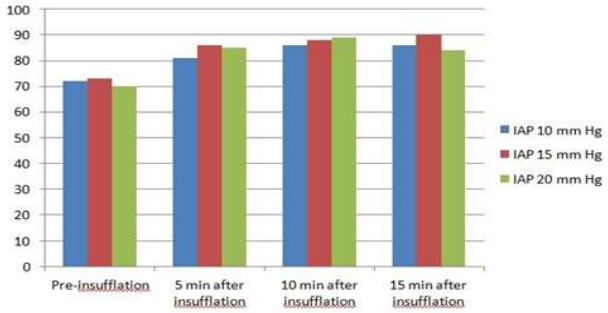

Figure 3: Comparison Diastolic blood pressure in different intraabdominal pressure groups

Mean arterial pressure (MAP)

The MAP in different groups before peritoneal insufflations (MAP0) and after insufflation were measured at 5-min intervals for the first 15 minutes (MAP 5,10,15) were shown in table 4 and compared in fig.4. Statistically significant difference was seen in MAP measurements between the groups ($p < 0.001$), within each group at different times ($p< 0.001$). At 10 mm Hg IAP – Pairwise comparisons showed that there was no statistically significant difference between MAP10 and MAP15 ($p = 1$). At 15 mm Hg IAP – Pairwise comparisons showed that there was statistically significant difference. At 20 mm Hg IAP - Pairwise comparisons showed that there was no statistically significant difference between MAP5 and MAP15 ($p = 0.3078$).

Table 4: Mean arterial pressure in different intraabdominal pressure groups

	AT 10 mm Hg IAP	AT 15 mm Hg IAP	AT 20 mm Hg IAP
MAP0	86.36±0.93	87.66± 0.99	84.46± 0.83
MAP5	95.93±0.92	100.4± 1.04	102.06± 0.90
MAP10	100.5±0.90	102.96± 1.03	106.06± 0.90
MAP15	100.5±0.87	104.66± 1.02	100.96± 1.03

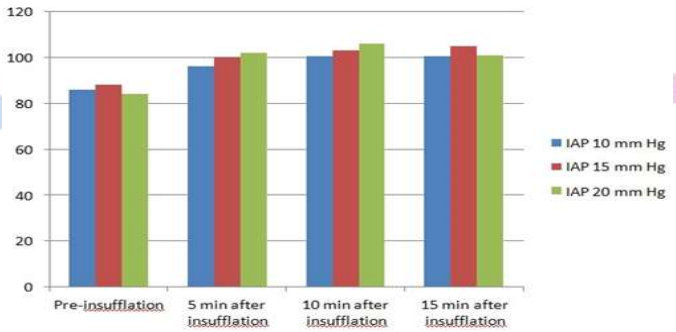

Figure 4: Comparision Distolic blood pressure in different intraabdominal pressure groups

Central venous pressure (CVP)

The CVP in different groups before peritoneal insufflations (CVP0) and after insufflation were measured at 5-min intervals for the first 15 minutes (CVP 5,10,15) were shown in table 5 and compared in fig.5. Statistically significant difference was seen in CVP measurements between the groups ($p < 0.001$), within each group at different times ($p< 0.001$). At 10 mm Hg IAP – Pairwise comparisons show that there was statistically significant difference. At 15 mm Hg IAP – Pairwise comparisons showed that there was statistically significant difference. At 20 mm Hg IAP - Pairwise comparisons showed that there was no statistically significant difference between CVP5 and CVP15 ($p = 0.2604$).

Table 5: Central venous pressure in different intraabdominal pressure groups

	AT 10 mm Hg IAP	AT 15 mm Hg IAP	AT 20 mm Hg IAP
CVP0	8.06±0.21	8.00± 0.20	8.06± 0.19
CVP5	9.83±0.17	11.06± 0.20	10.23± 0.14
CVP10	10.86±0.14	12.8± 0.15	10.96± 0.15
CVP15	11.76±0.17	13.9± 0.18	9.83± 0.14

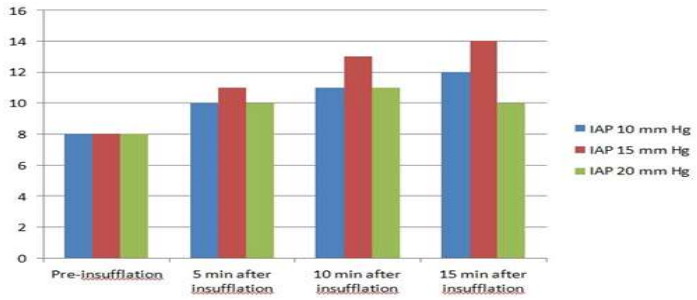

Figure 5: Comparison Central venous pressure in different intraabdominal pressure groups

DISCUSSION

In our study we investigated 90 patients under different IAPs (10/15/20 mm Hg), measured their effects on hemodynamic parameters (HR/SBP/DBP/MAP/CVP). From results it can be said that there was a significant rise in HR within groups of 10 mm Hg and 15 mm Hg IAP. Significant difference was seen in group 20 mm Hg, HR increased till 10 min after insufflation but there was a significant fall in HR at 15 min after insufflations. Between groups, no significant difference was seen in the present study. These results were in comparison with Dexter *et al.*[1] study which also showed increase in HR. Excess CO2 results in an increase in sympathoadrenal activity, and absorption of CO2 from the peritoneum probably accounts for the elevation in heart rate. The absorption of CO2 through the peritoneum and the resultant End tidal CO2 elevation are related to the intraperitoneal CO2 pressures; however, this is not a direct relation. At lower pneumoperitoneal pressures, peritoneal capillaries enable CO2 absorption; conversely, in higher pressures, the capillaries are compressed, thereby reducing CO2 peritoneal diffusion. The peritoneal CO2 absorption rate starts to decline at intraabdominal pressures ranging between 14 to 20 mmHg[6]. This could explain the results in the present study. In 10 mm Hg IAP group SBP/DBP/MAP rose significantly till 10 min after insufflation and there was no significant difference ($p > 0.05$) thereafter with the reading at 15 min after insufflation. In 20 mm Hg IAP group SBP/DBP/MAP increased till 10 min after insufflation and then there was a significant fall at 15 min after insufflations. Between groups, significant difference was seen with SBP and MAP, but no significant difference was observed with DBP in the present study. The difference between the measurements depends on the IAP (p-value < 0.001). The elevation of the mean arterial blood pressure (MAP) is caused, according to many authors[1,7], by an increase of systemic peripheral vascular resistance (PVR). IAP ~15 mmHg, the usual maximal desired intra-operative pressure, raises systemic vascular resistance (resulting from an increase in venous resistance, abdominal aortic compression and increase after load due to humoral factors), mean arterial pressure, heart rate and caval pressures[8]. Results in the present study are in accordance with previous studies, SBP/DBP/MAP showed increase with IAP (10/15 mm Hg) but with IAP 20 mm Hg there is a fall at 15 min after insufflation probably because of decreased venous return due to inferior vena cava compression Venous return is increased after the insufflation of the peritoneum to the lower IAPs, probably due to mobilization of blood pooled in the splanchnic region[9] When using pressures of 20 mm Hg and more, insufflation leads to a significant reduction of the venous return[10] Giebler *et al.*[11] stated that the body's low-pressure circulation could be described by the concept of "abdominal vascular zone conditions" in humans. Significant increase was seen in CVP within groups of 10 mm Hg and 15 mm Hg IAP, same result was also seen in previous studies[2,9]. In 20 mm Hg IAP group CVP increased till 10 min after insufflation and then it decreased significantly at 15 min after insufflations. The difference between the measurements depends on the IAP (p-value < 0.001). Between groups, significant difference was seen in the present study. Recent studies demonstrated CVP elevation following increase in intra-abdominal pressure during pneumoperitoneum[12]. The increase in CVP in humans is directly related to the intra-abdominal pressure only to a certain level. In very high pressures the CVP starts to decrease due to vena cava compression and decrease in its blood flow to the thorax[13]. This explains the results of our study where CVP decreased at 15 min after insufflations in 20 mm Hg IAP group. In some studies, stated that operating under reduced IAP may be beneficial to the patients with decreased cardiopulmonary reserve, especially while undergoing long surgical procedures[14,15].

CONCLUSION

From our study we conclude that intraabdominal pressure of upto 15 mm Hg could be used for laparoscopic procedures without adverse hemodynamic changes. It raises systemic vascular resistance resulting from an increase in venous resistance, abdominal aortic compression and increase after load due to humoral factors, mean arterial pressure, heart rate and caval pressures.

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