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Estimation of Serum Potassium in Patients Undergoing Laparoscopic Cholecystectomy.

Jai Singh[1], Dheeraj Singha[2], Ravinder K Verma[1], Surinder Singh Sodhi[3], Shyam Bhandari[2], Aman Thakur[4]

[1]Professor Department of Anaesthesia, Dr Rajendra Prasad Govt. Medical College Kangra at Tanda.
[2]Assistant Professor, Department of Anaesthesia, Prof. Dr Rajendra Prasad Govt. Medical College Kangra at Tanda.
[3]Professor and Head, Department of Anaesthesia, IGMC Shimla.
[4]Senior resident, Department of Anaesthesia, Dr Rajendra Prasad Govt. Medical College Kangra at Tanda.

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ABSTRACT

Background: The cardiovascular implications due to CO2 insufflation during laparoscopic surgeries have been a subject of research. Animal studies have reported life threatening increase in serum potassium levels during rise in intra-abdominal pressure. **Methods:** Induction of 30 patients undergoing laproscopic cholecystectomy was done by giving Thiopentone sodium 5 mg/kg and orotracheal intubation was facilitated by 0.1 mg/kg of vecuronium bromide. Blood samples for potassium were taken at pre-induction, pre insufflation, every 20 minutes during insufflations, immediate post exsufflation and immediately after extubation. **Results:** Serum potassium increased significantly ($p<0.01$) after insufflation of carbon dioxide (pre-induction 3.9 ± 0.3 vs. 4.5 ± 0.3 at 40 minutes of insufflation). The haemodynamics i.e blood pressure and pulse rate remained fairly ($p>0.05$) throughout the study period. **Conclusion:** Based on the findings of this study, we recommend that monitoring of serum potassium should be done in patients undergoing laparoscopic procedures of prolonged duration.

Keywords: Carbon dioxide, Cholecystectomy, Laparoscopy, Serum potassium.

INTRODUCTION

The modern surgical endoscopic procedures in the present era are becoming minimally invasive with the special aim of reducing trauma, morbidity, mortality and cost.[1] In early 1970s laparoscopy was predominantly confined to gynaecological procedures both for diagnosis and treatment. Over the time, laparoscopic surgery has been developed to avoid conventional open laparotomy for a large number of abdominal operations and it has come to stay as the new therapeutic standard in uncomplicated cholelithiasis in a large number of centres.[2] Like all other laparoscopic procedures insufflations of carbon dioxide is required in laparoscopic cholecystectomy which results in increased intra-abdominal pressure and affects various organ systems of the body pressure.

Name & Address of Corresponding Author
Dr. Jai Singh,
Professor, Dept of Anaesthesia,
Dr Rajendra Prasad Govt. Medical College Kangra at Tanda, India
E-mail: drjaisingh62@gmail.com

The cardiovascular implication of different levels of intra- abdominal pressure have been a subject of great scrutiny.[3] Animal studies have reported life threatening increase in serum potassium levels during prolonged carbon dioxide insufflations. This rise of potassium has been attributed to trauma, ischemia of the abdominal muscles and intracellular acidosis in abdominal organs due to carbon dioxide diffusion. Therefore, this study was planned to study the serum potassium level in laparoscopic cholecystectomy in our set up.

MATERIALS AND METHODS

Anaesthetic Technique

After securing intravenous line with 18G cannula and starting Normal Saline, patients were connected to monitor NIBP, SPO2, ECG. Preinduction values of these were recorded. A blood sample for knowing basal potassium level was drawn before induction. Induction of all patients was done by giving Thiopentone sodium 5 mg/kg and orotracheal intubation was facilitated by 0.1 mg/kg of vecuronium bromide. ETCO2 monitor and temperature probe was attached. Anaesthesia was maintained with 66% nitrous oxide in oxygen with 0.5%-1% Isoflurane. Muscle relaxation was continued with vecuronium bromide in pharmacological doses. Analgesia was

supplemented by Fentanyl 2 microgram/kg. During intra-operative period, normocarbia was maintained by adjusting minute ventilation in response to ETCO2. Intra-abdominal pressure was maintained at 13 mm of Hg by carbon dioxide insufflation to facilitate laparoscopic cholecystectomy in all patients. Blood samples were taken at pre-induction, pre insufflation, every 20 minutes during insufflations, immediate post exsufflation and immediately after extubation. Continuous monitoring of pulse, ECG, ETCO2 and temperatures was done, NIBP monitoring was done 3 minutes apart. These parameters were documented at same intervals for the blood sampling. Any untoward incidence that occurred at any point of time was also documented and appropriately managed. The results were analysed by Students "t" test. Probability P- values >0.05, <0.05, <0.01 were considered not significant, significant and highly significant respectively.

RESULTS

The study was carried out in 30 ASA patients aged 20 -50 years and weighing 45 – 60 kg. Pre-induction values of various parameters were recorded and taken as baseline values for the purpose of comparison with subsequent values of the same parameters. Serum electrolytes, blood urea, serum creatinine, blood sugar, serum bilirubin and haemoglobin were within normal ranges in all the patients.

Serum Potassium [Table 1, Figure 1]

The mean serum potassium level was found to be 3.9 + 0.3 mEq/l at preinduction period . It did not differ significantly from baseline value and potassium was 3.9 + 0.3 mEq/l during pre insufflation period (p>0.05), However, the serum potassium increased from 3.9 + 0.3 mEq/l to 4.2+0.4 mEq/l (p<0.01) after 20 minutes and to 4.5 +0.3 mEq/l at 40 minutes of carbon dioxide insufflation. Both these values were highly significant (p<0.01). In the immediate post exsufflation period , the serum potassium was found to be 4 +0.4 mEq/l(p<0.01)still significantly higher than pre-induction values. Post extubation (16 +2 minutes after exsufflation) value of serum potassium was however , found to be 4.0 + 0.4 mEq/l not significantly different from the basal value (p>0.05). In comparison the preinduction values, serum potassium level increased significantly after the insufflation of carbon dioxide and subsequently continued to rise throughout the insufflation period as signified by the respective values and returned to baseline values after extubation (16+0.2 minutes after exsufflation). None of the patients at any point of time showed abnormal values of serum potassium.

Systolic blood Pressure [Table 2, Figure 2]

The mean systolic blood pressure at pre-induction period was 127±13 mm of Hg and this mean systolic blood pressure decreased to 121±13 mm of Hg which is not statistically significant (p>0.05) at pre-insufflation period. Blood pressure increased to 127±16 mm of Hg after 20 minutes and 131±15 mm of Hg after 40 minutes of insufflation. Both these values were statistically insignificant from basal values (p>0.05).

The mean systolic blood pressure when compared with pre-induction period, did not show any significant increase or decrease throughout the procedure. No patient showed abnormal deviation from the mean values during the study period.

Diastolic Blood Pressure [Table 3, Figure 3]

The mean diastolic blood pressure at pre-induction period was 60±8 mm of Hg. Diastolic Blood Pressure was 58±7 mm of Hg before insufflation, not significantly different from its base line values (p>0.05). Following 20 minutes of insufflation this diastolic blood pressure increased only slightly i.e to 60± 9 mm of Hg as compared to preinduction level. Blood pressure decreased by 2 mm of Hg i.e 60±9 mm of Hg which has no statistical significance (p>0.05). No statistically significant change in mean blood pressure was found during insufflation of carbon dioxide and throughout the procedure(p>0.05)at all intervals. No individual abnormal variation in diastolic blood pressure was recorded.

Pulse Rate [Table 4, Figure 4]

The mean pulse rate at pre-induction period was 83±7 per minute. The mean pulse rate was 84±7 beats per minute at pre-insufflation period(p>0.05). After 20 minutes of insufflations of carbon dioxide the pulse rate was 80±6 (p>0.05), and at 40 minutes after insufflation the pulse rate was recorded as 80±7 per minute (p>0.05)and at post ex-sufflation 80±7 per minute. This mean pulse rate increased to 86±3 per minute at extubation. These changes in pulse rate during insufflation period when compared with the baseline values, which were statistically insignificant (p>0.05). Continuous ECG monitoring (Lead II) was done throughout the procedure. No rhythm disturbance except transient sinus tachycardia at the time of intubation and extubation was observed.

End Tidal Carbon dioxide

The value of ETCO2 was kept between 35-45 mm of Hg in all the patients throughout the study period by adjusting minute ventilation. None of the patients had hypercapnic or hypocapnic values during study period.

Percentage oxygen saturation of Haemoglobin

Continuous monitoring of percentage oxygen saturation of haemoglobin in all the patients was done throughout the procedure. Spo2 remained normal (>95%) throughout the study period.

Temperature

Body temperature of all the patients throughout the study period was between 35.5-37 degree C. None of the patient developed hyperthermia or hypothermia during the study.

Untoward incidents

No untoward incidents were witnessed during the study period in any of the patients.

Table 1: Changes In Serum Potassium (meq/l.) During laparoscopic cholecystectomy.

Stage	Mean	Standard Deviation	t-value in Students t-test	P value in Students t-test
Pre Induction	3.924	0.291	-	-
Pre insuflation	3.892	0.275	0.3996	≥ 0.05
After 20 minutes of insufflation	4.216	0.381	3.0454	<0.01**
After 40 minutes of insufflation	4.492	0.341	6.3352	<0.01**
Post- exsufflation	4.352	0.409	4.2633	<0.01**
Post extubation	3.984	0.448	N.S	≥ 0.05

*Significant, **Highly Significant

Table 2: Changes In Systolic Blood Pressure (mm of Hg) During Laparoscopic Cholecystectomy.

Stage	Mean	Standard Deviation	T value in Students t-test	P- value in students t – test
Pre Induction	127.28	13.284	-	-
Pre Insufflation	121.16	14.616	N.S	≥ 0.05
After 20 minutes of Insufflation	126.88	15.717	N.S	≥ 0.05
After 40 minutes of Insufflation	130.72	14.676	N.S	≥ 0.05
Post Exsufflation	127.04	15.643	N.S	≥ 0.05
Post Extubation	131.04	16.154	N.S	≥ 0.05

Table 3: Changes in Diastolic Blood Pressure (mm of Hg) During Laparoscopic Cholecystectomy.

Stage	Mean	Standard deviation	T value in Students t-test	P-value in Sudents t-test
Pre Induction	60.00	7.867	-	-
Pre Insufflation	58.00	6.504	N.S	≥ 0.05
After 20 minutes of Insufflation	60.00	8.888	N.S	≥ 0.05
After 40 minutes of Insufflation	58.00	9.397	N.S	≥ 0.05
Post - Exsufflation	58.00	8.435	N.S	≥ 0.05
Post - Extubation	60.00	8.740	N.S	≥ 0.05

Table 4: Changes In Pulse Rate Per Minute During Laparoscopic Cholecystectomy

Stage	Mean	Standard deviation	T value in Students t-test	P value in Students t – test
Pre induction	83.28	7.027	-	-
Pre Insufflation	84.32	7.532	N.S	≥ 0.05
After 20 minutes of insufflation	79.92	6.298	N.S	≥ 0.05
After 40 minutes of insufflation	79.56	6.696	N.S	≥ 0.05
Post exsufflation	79.80	6.285	N.S	≥ 0.05
Post extubation	86.36	7.767	N.S	≥ 0.05

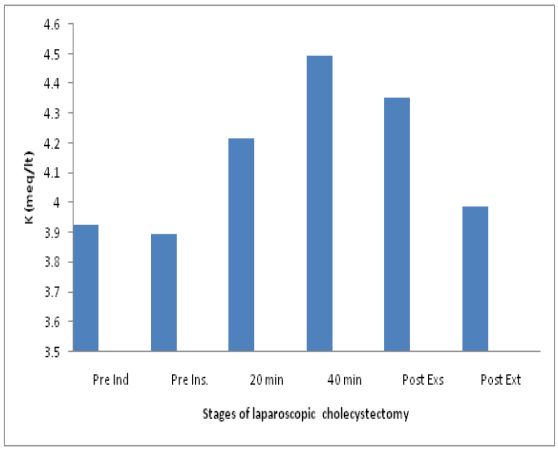

Figure 1: Changes In Serum Potassium (mEq/l.) During Laparoscopic Cholecystectomy.
Pre Ind = Pre Induction; Pre Ins. = Pre Insufflation; Post Exs. = Post Exsufflation; Post Ext. = Post extubation

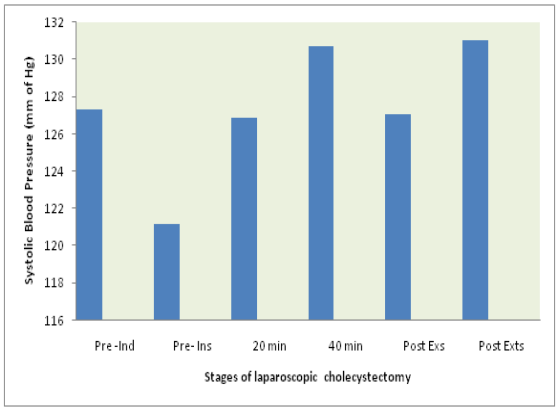

Figure 2: Changes in Systolic Blood Pressure (mm of Hg) During Laparoscopic Cholecystectomy.
Pre Ind = Pre Induction; Pre Ins. = Pre Insufflation; Post Exs. = Post Exsufflation; Post Ext. = Post extubation.

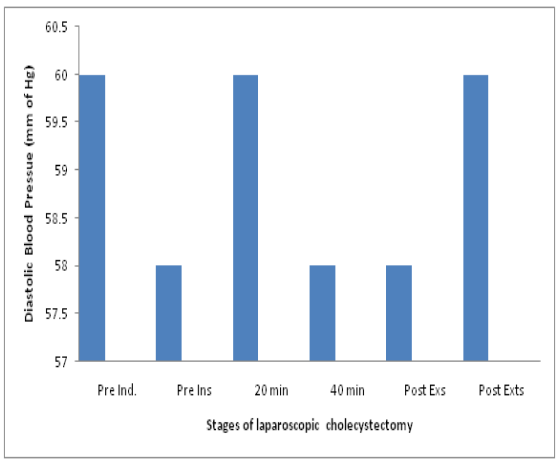

Figure 3: Changes In Diastolic Blood Pressure (mm of Hg) During Laparoscopic Cholecystectomy.
Pre Ind = Pre Induction; Pre Ins. = Pre Insufflation; Post Exs. = Post Exsufflation; Post Ext. = Post extubation

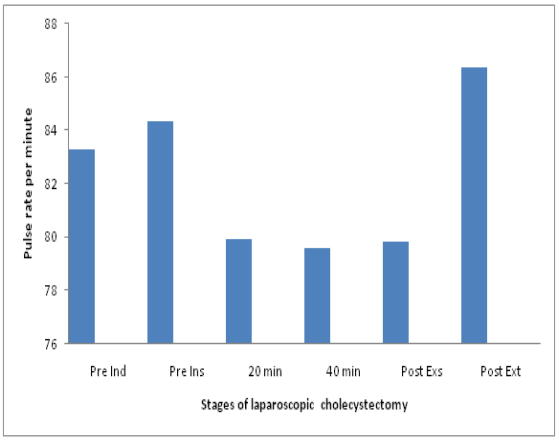

Figure 4: Changes in Pulse Rate (mm of Hg) During Laparoscopic Cholecystectomy.
Pre Ind = Pre Induction; Pre Ins. = Pre Insufflation; Post Exs. = Post Exsufflation; Post Ext. = Post extubation

DISCUSSION

Laparoscopic cholecystectomy has become the new gold standard for the treatment of uncomplicated symptomatic cholelithiasis, ever since French surgeon Philip Mouret performed the first laparoscopic cholecystectomy in 1987[6]. The advantages of this technique include less pain, invisible scar, earlier return to work, a satisfied patient, less financial burden etc.

In our study, patients underwent laparoscopic cholecystectomy and an attempt was made to evaluate any change in potassium levels during carbon dioxide insufflation, a step towards recognizing the possibility of such eventuality in explaining the cause of occurrence of unexplained dysrhythmias during the procedure. The mean duration of the procedure was just above 1 hour, of which carbon dioxide insufflation period was approximately 40 minutes.

In present study, the serum potassium level increased significantly in the 40 minutes of carbon dioxide insufflation as compared to the pre-induction level. The progressive hyperkalemia response observed in the present study was despite of the fact, that none of these patients were administered suxamethonium hydrochloride and potassium containing fluids. In an animal study, MBR Pearson and ML Sander (1994)[5], pigs were subjected to 3.5 hours of carbon dioxide pneumoperitoneum, the mean rise of potassium was 5.63 (SD 0.44) which was statistically significant and clinically life threatening. This finding, though not quantitatively of same magnitude, yet correlated to the present study. The probable reason could be lesser time of carbon dioxide pneumoperitoneum in our study. The various mechanisms to cause rise in serum potassium could be tissue damage, ischemia,

decreased perfusion of abdominal muscles due to stretching, renal hypoperfusion, alteration in hydrogen ion concentration and possibly intracellular acidosis due to carbon dioxide diffusion into the cells.

During carbon dioxide insufflation, there is reduction of blood flow to the abdominal muscles as a result of increased intra-abdominal pressure and this may contribute to hyperkalemic response. Renal blood flow is decreased due to increased intra-abdominal pressure and it might have reduced glomerular filtration rate and thus decreased potassium excretion. Another possible cause is the diffusion of carbon dioxide from the peritoneal cavity, producing local intracellular acidosis, sufficient enough to cause shift of intracellular potassium into the blood. The rise may even be more alarming in high risk patients e.g. pre-existing renal failure and in those on potassium sparing diuretics. The rate of increase in in serum potassium in our study and that of animal study[5] clearly demonstrates serum potassium must be monitored if the laparoscopy has to be continued for prolonged period.

In summary, the present study demonstrates a significant rise in serum potassium though not sufficient enough to cause dysrhythmias, this increase was limited to short duration of carbon dioxide pneumoperitoneum. Monitoring of serum potassium during procedures, requiring prolonged period of pneumoperitoneum, is highly desirable.

Various study on haemodynamic changes during laparoscopic cholecystectomy with intra-abdominal pressure between 13- 15 mm of Hg have shown a cardiac output either unchanged or modestly increased.[7-10] When arterial carbon dioxide tension and intra-abdominal pressure are kept within physiological acceptable limits, haemodynamic parameters i.e. pulse rate and blood pressure do not change significantly. Like most modern sets, intra-abdominal pressure was maintained at 13 mm of Hg and no haemodynamic alteration of clinical importance was observed in any of the patients, except for the usual intubation and extubation responses.

Slight fall in blood pressure (6 mm of Hg) was probably due to induction with thiopentone. Therefore, the blood pressure and pulse rate remained nearly unaffected and no iv fluids in addition to normal fasting and maintenance requirements of the patients, were required to maintain haemodynamic homeostasis. The fact testifies the existing observations that haemodynamics are not adversely affected by intra-abdominal pressure of 10-15 mm of Hg.[7-10] The fall in the blood pressure is often accompanied by slight tachycardia and has been attributed to vasodilation, peripheral pooling of the blood and consequent decrease in venous return[11].

Continuous electrocardiographic monitoring (lead II) did not reveal any rhythm disturbances in any of the patients before, during and after the pneumoperitoneum. Only sinus tachycardia was noticed in most of the patients, which coincided with intubation, and extubation, No alterations in the characteristics of individual waveform were noticed. These negative findings can be attributed to the patients at risk for such events were excluded from the study, absence of major haemodynamic alteration, the potassium levels despite significant increase, remained well within normal limits and the relatively short duration(40 minutes) of carbon dioxide insufflation.

CONCLUSION

Based on the findings of this study, we recommend that monitoring of serum potassium should be done in patients undergoing laparoscopic procedures of prolonged duration. It is further advisable to be extra cautious in high risk patients where hyperkalemia can be detrimental and can potentiate life threatening arrhythmias. Patients with cardiac comorbidity such as dilated cardiomyopathies, on digoxin treatment, acute or chronic kidney diseases will be more vulnerable for side effects of hyperkalemia. Extra precaution must be taken and preferably prolonged laparascopic surgeries should be avoided in these high risk patients.

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