

Estimation of Perioperative Serum Potassium Levels and Cardiovascular Changes during Laparoscopic Surgery: An Observational Study

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Abstract

Background: Laparoscopic surgeries are preferred and are becoming a standard therapeutic procedure. CO₂ insufflation in these surgeries results in hemodynamic changes and fluctuations in the potassium level.

Materials and Methods: The observational study was conducted in Department of Anaesthesia in Teerthanker Mahaveer Medical College and Research Centre on 100 patients undergoing laparoscopic surgery. Blood potassium level and hemodynamic parameters (pulse rate, systolic, and diastolic blood pressure) were measured at four stages of surgery (preinduction, pre-insufflation, immediate postextubation, and immediately after extubation) were recorded. The results were analyzed by Student's "t" test and $P < 0.01$ was considered as significant.

Results: The changes in potassium level showed a significant difference in postextubation stage in which potassium level changed significantly (<0.01). The hemodynamic parameters (pulse rate, systolic, and diastolic blood pressure) showed no significant difference in four stages of surgeries.

Conclusion: This study endorses that checking of serum potassium should be conducted in patients enduring laparoscopic procedures of extended duration.

Key words: Hemodynamic, Laparoscopy, Potassium, Surgery

INTRODUCTION

The laparoscopic procedures which are minimally invasive causes less trauma and are cheaper is the requirement of modern era. Previously, the laparoscopic surgeries were done mainly in cholelithiasis and in gynecological procedures. But now, these surgeries are preferred and are becoming a standard therapeutic procedure.^{1,2}

There are a number of advantages to the patient with laparoscopic surgery as compared with the open procedure.

Small sized incisions result in the decrease in incidence of pain and hemorrhage. Furthermore, the hospital stay and recovery time are reduced.³

The key element in laparoscopic surgery is the use of a laparoscope, a long fiber optic cable system which allows viewing of the affected area by snaking the cable from a more distant, but more easily accessible location.⁴

Although, these surgeries have various benefits but some limitations are present which require thorough research. The biggest disadvantage of such type of surgeries is that CO₂ insufflation in the peritoneal cavity is the essential step which causes increase in intra-abdominal pressure. This results in hemodynamic changes and fluctuations in the potassium level.^{5,6}

Literature regarding the effect of CO₂ insufflation is lacking. Various animal studies^{1,6,7} have informed life-threatening

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increase in serum potassium levels or hyperkalemia during CO₂ procedures.

Hyperkalemia is defined as an elevated level of potassium in the blood serum. Normal potassium levels are between 3.5 and 5.0 mmol/L. When the rise is severe it results in palpitations, muscle pain, muscle weakness, or numbness. An abnormal heart rate can occur which can result in cardiac arrest and death. Abnormal rise in potassium level can lead to ischemia of the abdominal muscles and intracellular acidosis in abdominal organs due to carbon dioxide diffusion.⁸

With the increasing trend of laparoscopic surgeries, it is now essential for the researchers to study its various aspects. Thus, we conducted this study in our medical college to study the effect of laparoscopic surgeries on potassium level and hemodynamic parameters.

MATERIALS AND METHODS

The observational study was conducted in the Department of Anaesthesia in Teerthanker Mahaveer Medical College and Research Centre on 100 patients undergoing laparoscopic surgery. Detailed history was taken, and complete clinical examination was done. Basic investigations were done.

The intravenous line was secured and connected to monitor NIBP, SPO₂, and electrocardiogram. Hemodynamic parameters before induction were recorded. Furthermore, blood potassium level was measured. The patients were induced by giving thiopentone sodium 5 mg/kg, and orotracheal intubation was facilitated by 0.1 mg/kg of vecuronium bromide. 66% nitrous oxide in oxygen with 0.5-1% isoflurane was used for maintenance of anesthesia. Fentanyl 2 µg/kg was added as analgesic drug. CO₂ insufflation was done, and intra-abdominal pressure of 13 mm of Hg was maintained. Four blood potassium levels were measured (preinduction, pre-insufflation, immediate postexsufflation, and immediately after extubation). The hemodynamic parameters (pulse rate, systolic, and diastolic blood pressure) were recorded. The results were analyzed by Students “t” test and *P* < 0.01 was considered as significant.

RESULTS

The study was conducted in patients aged 25-60 years with a male:female ratio of 2:1. All the basic investigations such as serum electrolytes, blood urea, serum creatinine, blood sugar, serum bilirubin, and hemoglobin were in

normal range. Preinduction values of various parameters were noted and taken as baseline values for the purpose of evaluation with consequent values of the identical parameters.

The pre-induction value of serum potassium level was 4.125 ± 0.31 meq/L. The changes in potassium level in different phases of surgery showed no significant difference except postexsufflation stage in which potassium level changed significantly (<0.01) to 4.854 ± 0.51 (Table 1 and Figure 1).

The mean systolic blood pressure in different stages of surgery when compared with preinduction 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 (Table 2 and Figure 2).

No statistically significant change in mean blood pressure was found during insufflation of carbon dioxide and throughout the procedure (*P* > 0.01) at all intervals. No individual abnormal variation in diastolic blood pressure was noted (Table 3 and Figure 3).

The changes in pulse rate during different periods when compared with the baseline values were statistically insignificant (*P* > 0.01). No rhythm disturbance except transient sinus tachycardia at the time of intubation and extubation were observed (Table 4 and Figure 4).

Table 1: Variations in serum potassium (meq/L) during laparoscopic surgery

Phase	Mean±standard deviation	t value	P value
Preinduction	4.125±0.31	-	-
Pre-insufflation	3.912±0.293	0.49	≥0.01
Postexsufflation	4.854±0.51	4.133	0.006
Postextubation	3.64±0.358	2.49	≥0.01

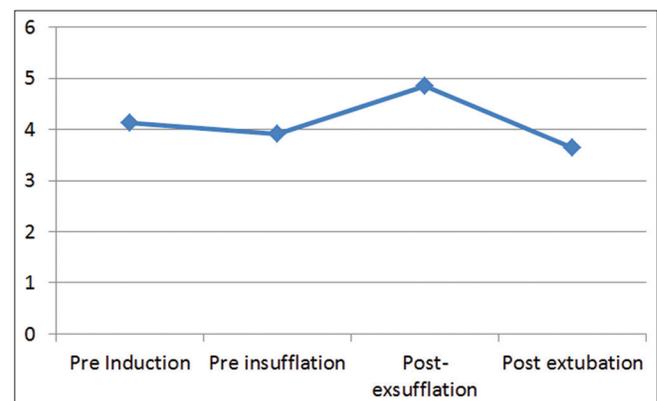


Figure 1: The changes in serum potassium level in different phases of surgery

Table 2: Variation in systolic blood pressure (mm of Hg) during laparoscopic surgery

Phase	Mean±standard deviation	t value	P value
Preinduction	124.20±11.26	-	-
Pre-insufflation	120.32±15.22	1.68	≥0.01
Postexsufflation	128.2±17.6	0.85	≥0.01
Postextubation	135.04±15.4	1.28	≥0.01

Table 3: Variation in diastolic blood pressure (mm of Hg) during laparoscopic surgery

Phase	Mean±standard deviation	t value	P value
Preinduction	62.00±8.48	-	-
Pre-insufflation	56.00±6.8	1.86	≥0.01
Postexsufflation	54.00±7.4	0.95	≥0.01
Postextubation	59.00±8.5	1.49	≥0.05

Table 4: Variation in pulse rate per minute during laparoscopic surgery

Phase	Mean±standard deviation	t value	P value
Preinduction	80.1±7.11	-	-
Pre-insufflation	83.41±7.58	1.82	≥0.01
Postexsufflation	78.50±6.44	0.74	≥0.01
Postextubation	84.22±7.81	0.88	≥0.01

DISCUSSION

Laparoscopic surgery has become the new gold standard for the treatment of various diseases in the modern era. First laparoscopic surgery was performed by French surgeon Philippe Mouret in 1987. Laparoscopic surgery is preferred technique because it includes less pain, invisible scar, earlier return to work, a satisfied patient, less financial burden, etc.⁹

In this study, an attempt was made to evaluate any change in potassium levels and hemodynamic changes in patients undergoing laparoscopic surgery especially during carbon dioxide insufflation, a step toward identifying the possibility of such contingency in explaining the cause of manifestation of unexplained dysrhythmias during the process.

The literature regarding the variations in serum potassium level in laparoscopic surgeries is lacking. Various studies on animals have been done. In an animal study, Diamant *et al.*,¹⁰ pigs were subjected to 3.5 h of carbon dioxide pneumoperitoneum, the mean rise of potassium was 5.63 (standard deviation 0.44) which was statistically significant and clinically life threatening. This verdict, though not quantitatively of equal scale, yet allied to this study. The feasible reason could be a minor time of carbon dioxide pneumoperitoneum in our study. The various mechanisms to elevate serum potassium could be tissue damage,

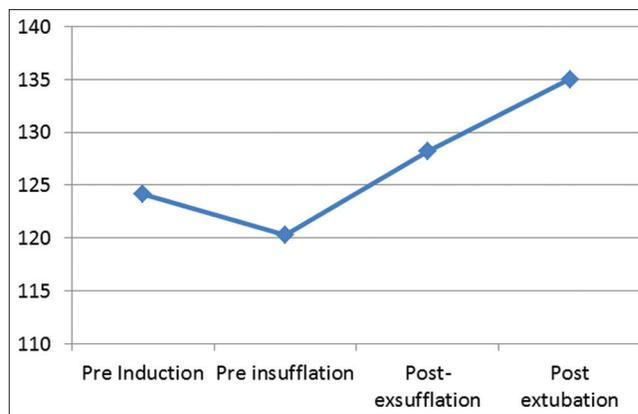


Figure 2: The changes in systolic blood pressure in different phases of surgery

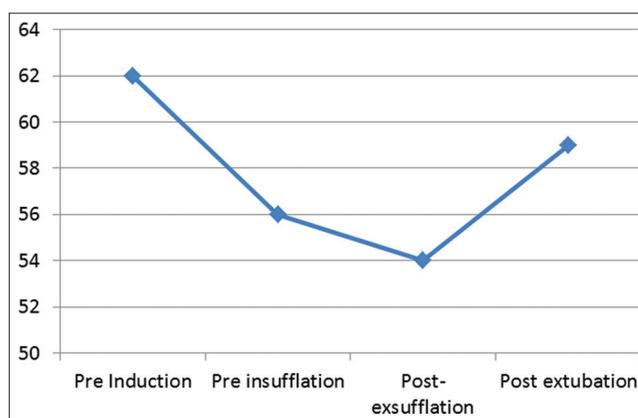


Figure 3: The changes in diastolic blood pressure in different phases of surgery

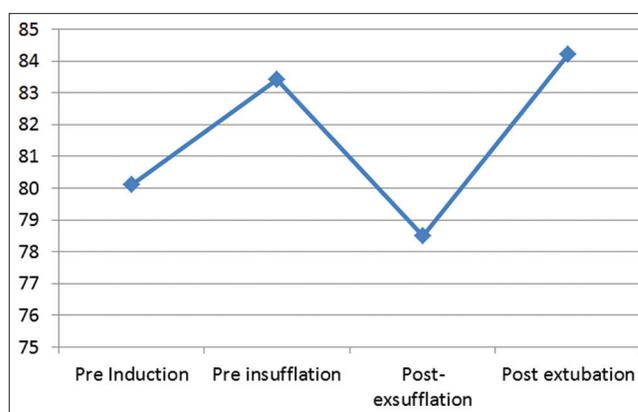


Figure 4: The changes in pulse rate in different phases of surgery

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.

Various study^{4,8,11} on hemodynamic changes during laparoscopic cholecystectomy with intra-abdominal

pressure between 13 and 15 mm of Hg have shown a cardiac output either unchanged or modestly increased. When arterial carbon dioxide tension and intra-abdominal pressure are kept within physiological acceptable limits, hemodynamic 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 hemodynamic alteration of clinical importance was observed in any of the patients, except for the usual intubation and extubation responses.

Slight fall in blood pressure was probably due to induction with thiopentone. 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.⁴ The negative findings of hemodynamic changes can be attributed to the patients at risk for such events were excluded from the study, absence of major hemodynamic alteration, the potassium levels despite significant increase, remained well within normal limits, and the relatively short duration (40 min) of carbon dioxide insufflation.⁹

CONCLUSION

This study endorses that checking of serum potassium should be conducted in patients enduring laparoscopic procedures of extended duration. It is recommended that

potassium level estimation is essential in patients with high risk of hyperkalemia as it can lead to development of arrhythmia.

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