Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Effect of CO_2 Insufflation on Corrected QT Interval Prolongation during Laparoscopic Surgeries: A Prospective Observational Study

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Abstract

Introduction: Laparoscopic surgeries in various surgical specialties are most routinely performed with general anesthesia. The physiological effects of intra-abdominal CO_2 insufflation combined with the variations in patient positioning can have a major impact on cardiorespiratory function. Prolongation of corrected QT interval (QTc) has been known to predispose torsades de pointes, a potentially fatal ventricular arrhythmia may occur during CO_2 insufflation. Our aim is to evaluate the effect of insufflation of CO_2 on QT interval and QTc during prolonged laparoscopic surgeries.

Methodology: Fifty patients of American Society of Anesthesiologists physical status 1 and 2, of either sex, between the ages of 25 and 65 years posted for laparoscopic surgeries included in the study. After general anesthesia, we measured mean arterial pressure, heart rate, SpO_2 and $ETCO_2$ before anesthesia induction, before CO_2 insufflation, 30, 60, 120, and 150 min after CO_2 insufflation, 5 min after CO_2 deflation, and at the end of surgery. We observed statistically significant increase of QTc interval around 120 min after CO_2 insufflation.

Conclusion: The cause of this QTc interval prolongation is multifactorial and clinical significance of producing life-threatening cardiac arrhythmias has to be determined.

Key words: Cardiac arrhythmias, CO_2 insufflation, Laparoscopic surgeries, Corrected QT interval

INTRODUCTION

Laparoscopic surgery is a principle technique for minimally invasive surgery of the abdomen, and it has been employed in procedures ranging across multiple surgical disciplines.[1] Laparoscopic surgeries in various surgical specialties are most routinely performed with general anesthesia. It is, furthermore, facilitated by proper decompression of the gastrointestinal tract and by the establishment of adequate muscle relaxation, pneumoperitoneum, and various patient positions. The physiological effects of intra-abdominal CO_2 insufflation combined with the variations in patient positioning can have a major impact on cardiorespiratory function. A complete understanding of these hemodynamic changes is essential for optimal anesthetic care. One indicator of these changes is corrected QT interval (QTc), an index of myocardial function. Prolongation of QTc has been known to predispose torsades de pointes, a potentially fatal ventricular arrhythmia may occur during CO_2 insufflation.[2] The purpose of this study is to evaluate the effect of insufflation of CO_2 on QT interval and QTc during prolonged laparoscopic surgeries.

Access this article online

www.ijss-sn.com

Month of Submission : 12-2019
Month of Peer Review : 01-2020
Month of Acceptance : 02-2020
Month of Publishing : 02-2020

METHODOLOGY

This prospective observational study conducted in our tertiary care hospital. After obtaining the Institutional Ethical Committee approval and informed consent, 50 patients of American Society of Anesthesiologists physical status 1 and 2, of either sex, between the ages of 25 and 65 years posted for laparoscopic surgeries included in the study. Patients with cardiovascular, respiratory, or cerebrovascular diseases were excluded from the study.

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All patients received injection glycopyrrolate 0.2 mg intramuscular as premedication. At operation theater, all anesthesia equipment and anesthesia drugs were checked and kept ready as per institutional protocol. On arrival of the patient at operation theater standard, 12-lead electrocardiogram (ECG), non-invasive blood pressure, and pulse oximetry were attached to all patients. After preoxygenation, anesthesia induced with injection propofol 2 mg/kg and injection fentanyl 150 μg. Tracheal intubation done with appropriate size endotracheal tube and injection vecuronium 0.1 mg/kg. Once airway secured $ETCO_2$ monitoring device attached to endotracheal tube. Anesthesia was maintained with nitrous oxide and oxygen 2:1 supplemented with 1–2% of sevoflurane and titrated dose of injection vecuronium. The anesthesia ventilator setting adjusted to tidal volume of 9 ml/kg of patient weight and respiratory rate of 10–12/min. The $PETCO_2$ was maintained between 35 and 45 mmHg by adjusting the respiratory rate during intraperitoneal CO_2 insufflation. All patients received continuous infusion of crystalloid solution 5 ml/kg intraoperatively.

Intraoperatively, pneumoperitoneum was created by insufflation CO_2 through Veress needle and CO_2 insufflator. Intra-abdominal pressure was maintained between 10 and 12 mmHg throughout the procedure. The patient was positioned according to the type of laparoscopic surgery.

We measured mean arterial pressure, heart rate, SpO_2 and $ETCO_2$ before anesthesia induction, before CO_2 insufflation, 30, 60, 120, and 150 min after CO_2 insufflation, 5 min after CO_2 deflation, and at the end of surgery. Intraoperatively, measurement of the RR interval, QT interval, and QTc interval according to the Bazett's formula was performed before anesthesia induction, before CO_2 insufflation, 30, 60, 120, and 150 min after CO_2 insufflation, 5 min after CO_2 deflation, and at the end of surgery. Statistical analysis for continuous variables such as mean arterial pressure, heart rate, and SpO_2, QT interval, and QTc interval is presented as mean ± standard deviation (SD). *P* value was determined and $P < 0.05$ was taken as statistically significant.

RESULTS

A total of 50 cases were enrolled in this study. The demographic details of the patients such as age, gender, duration of surgery, and duration of anesthesia were recorded [Table 1]. The pre-operative and intraoperative mean arterial pressure, heart rate, SpO_2, $ETCO_2$, QT interval, QTc interval before CO_2 insufflation, 30, 60, 120, and 150 min after CO_2 insufflation, and 5 min after CO_2 deflation were recorded. We observed that the mean arterial pressure was increased from 86.36 ± 5.76 mmHg before insufflation of CO_2 to 88.04 ± 5.92 mmHg at 120 min after insufflation [Figure 1]. The rise in mean arterial pressure was not statistically significant ($P > 0.15$). We noticed that the heart rate was increased from 84.18 ± 5.36 per minute before insufflation of CO_2 to 82.34 ± 5.72 per minute at 120 min after insufflation [Figure 1] and it was statistically insignificant ($P > 0.15$) [Figure 1].

Table 1: Demographic details

Parameters	Mean±SD
Age (years)	40.94±16.0
Duration of surgery (minutes)	140.98±12.97
Duration of anesthesia (minutes)	154.12±11.59
Gender (M/F)	27/23

SD: Standard deviation

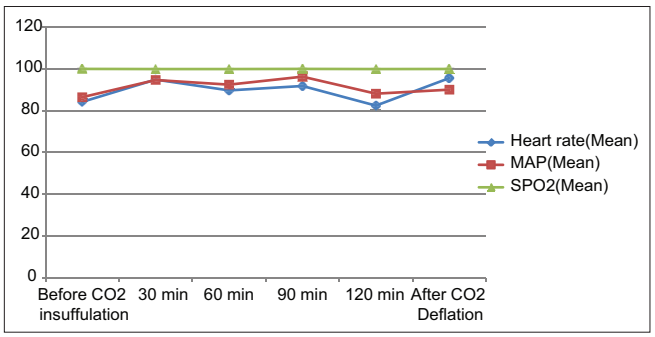

Figure 1: Changes in heart rate, mean arterial pressure, and SpO_2

We observed statistically significant increase ($P < 0.0001$) of QTc interval from 361.7 ± 11.76 ms before insufflation of CO_2 to 461.10 ± 17.2 ms at 120 min after insufflation [Table 2] [Figure 2]. We also observed statistically significant increase ($P < 0.008$) in $ETCO_2$ from 34.78 ± 3.14 mmHg before insufflation of CO_2 to 42.10 ± 3.54 mmHg at 120 min after insufflation [Figure 3].

DISCUSSION

The QT interval recorded on the surface ECG reflects the time required for ventricular depolarization and repolarization. The normal range of heart rate QTc varies with age and sex. Typically, QTc interval <440 ms is considered to be normal. Abnormal cardiac repolarization which can be identified by prolongation of QT interval and QTc interval on ECG is a well-known cause for developing life-threatening tachyarrhythmias like torsade des pointes, characterized by "twisting" of QRS axis around the isoelectric line.

The QTc interval prolongation may be due to either inherited like long QT syndrome or acquired causes. Large numbers of medications have potential to prolong QTc interval. Some of the drug classes that are implicated in QTc prolongation are antiarrhythmic agents, antihistaminic

Table 2: Mean and SD of all measured variables

Parameters	Before CO_2 insufflation Mean±SD	120 min after CO_2 insufflation Mean±SD	*P* value*
Heart rate (per minute)	84.18±5.36	82.34±5.72	>0.10
Mean arterial pressure (mmHg)	86.36±5.76	88.04±5.92	>0.15
$ETCO_2$ (mmHg)	34.78±3.14	42.10±3.54	<0.008
Corrected QT interval (ms)	361.7±11.76	461.10±17	<0.0001

**P*<0.05 is significant SD: Standard deviation

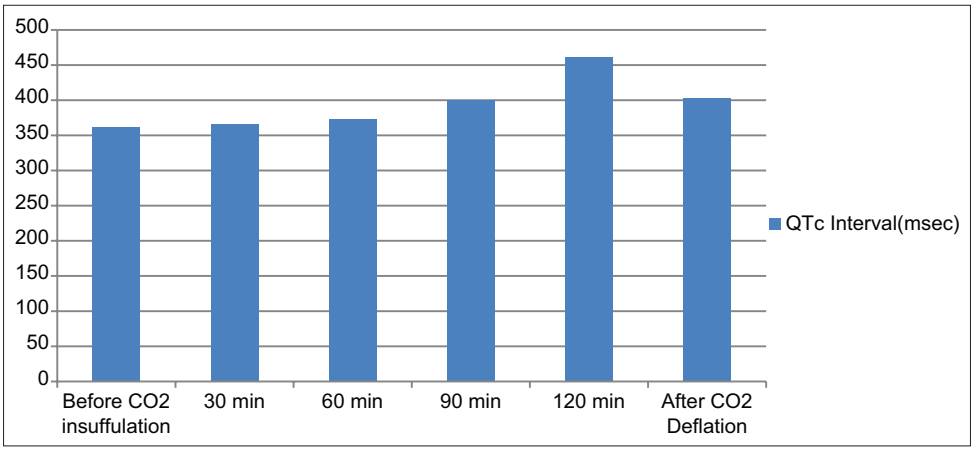

Figure 2: Corrected QT interval in ms

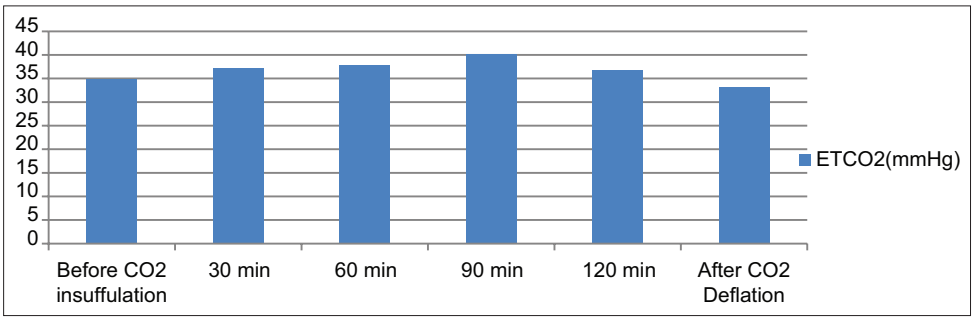

Figure 3: $ETCO_2$ in mmHg

agents, antimicrobials, promotility drugs, and antineoplastic agents. Non-pharmacologic factors which cause QTc prolongation include electrolyte disturbances such as hypokalemia, hypomagnesemia, and hypocalcemia.

In the present study, QTc interval of all the patients before start of laparoscopy was within normal limits. After about 120 min from the start of insufflation of CO_2, we noted QTc prolongation in all patients with mean ± SD of 461.10 ± 17.2 ms. The cause of this prolongation cannot identify but hypothesized to the following reasons such as intraoperative electrolyte disturbance, hypercapnia due to CO_2 insufflation during laparoscopy, and anesthetic drugs such as sevoflurane and surgical stress.

Hypercapnia which may be a result of insufflation of CO_2 during laparoscopic surgeries has been incriminated to produce QTc interval prolongation, which was confirmed by Ciftci *et al.*[3] in their study. In our study, $ETCO_2$ monitored during laparoscopic surgeries and there was no hypercapnia noted during the procedure.

Surgical stress may cause QTc interval prolongation but as mentioned in Egawa *et al.*[4] The laparoscopic procedures are minimally invasive procedures and surgical invasion may have had minimal effect on changes in QT interval and QTc interval.

The effects of commonly used general anesthetic drugs and inhalational agents on QTc interval have been studied in healthy adults and children. A recent study found that the mean QTc interval prolongation of 46 ms in patients anesthetized with inhalational agents.[2] The effect of sevoflurane on QTc interval is controversial. Some studies have shown a prolongation of QTc interval, but others failed to show the QTc interval prolongation.[5]

QTc interval prolongation has been shown to predispose to ventricular arrhythmias. It is exhibited in patients with myocardial infarction, subarachnoid hemorrhage, and diabetes mellitus.[6] In the present study, however, no arrhythmic events were observed during laparoscopic cholecystectomy in both elderly and younger patients. This may be due to the fact that patients with cardiac diseases were not included in this study.

CONCLUSION

CO_2 insufflation in laparoscopic surgeries is associated with prolongation of QTc interval. The cause of this QTc interval prolongation is multifactorial and clinical significance of producing life-threatening cardiac arrhythmias has to be determined.

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How to cite this article: Balamurugan M, Vijayaragavan S, Sivakumar PR. Effect of CO_2 Insufflation on Corrected QT Interval Prolongation during Laparoscopic Surgeries: A Prospective Observational Study. Int J Sci Stud 2020;8(2):8-11.

Source of Support: Nil, **Conflicts of Interest:** None declared.