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High Pressure Peritoneum Induces Electrocardiographic P-Wave Changes

KEYWORDS: ECG changes, Laparoscopy, Intra-abdominal pressure

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ABSTRACT *Creation of pneumoperitoneum induces hemodynamic and cardiac changes.*

We compared the P wave changes in the electrocardiograms of patients with low-pressure (Group I: 7 mmHg) and high-pressure (Group II:15 mmHg) carbon dioxide pneumoperitoneum.

Group I, contained 32 and Group II; contained 30 consecutive patients. A 12-lead electrocardiogram was obtained to measure P wave changes. Patient's electrocardiograms recorded before anesthesia and serially after creation of pneumoperitoneum and after desufflation. Two observers made measurements of P wave parameters and calculated P wave dispersion.

The minimum P wave duration did not change significantly between the groups. The maximum P wave and P wave dispersion in the Group II increased significantly during pneuomoperitoneum, and were significantly higher than those of the Group I.

Creation of pneumoperitoneum made significant changes on the P wave in electrocardiograms between groups which have been shown to be associated with an increased risk of arrhythmias

Introduction

Laparoscopic cholecystectomy (LC) would appear to be the current gold standard for surgical management of benign gallbladder disease[1-3]. Previous clinical studies established that pneumoperitoneum have some adverse cardiac effects including electrophysiologic changes[4-7]. Low-pressure pneumoperitoneum (P<10mmHg) have been used to prevent the adverse cardiopulmonary effects associated with the conventional-pressure (12-15 mmHg) of pneumoperitoneum[8, 9].

Atrial arrhythmias are the most frequent observed rhythm disorders in clinical practice[10]. They are rarely mortal but associated with increased morbidity including stroke and deterioration of underlying cardiac disease. [11, 12] Autonomic nervous system activated by changes in left atrial size and the velocity of impulse propagation effects the P wave dispersion[13]. The prolongation of atrial conduction time and heterogeneous propagation of sinus impulses in atria cause the atrium to fibrillate. [14-17] P-wave dispersion can reflect this abnormal conduction or propagation[16, 17]. It is defined as the difference between maximum and minimum P-wave duration (P maximum and P minimum) on the 12 lead surface electrocardiograms (ECG). It is also practical and useful test to predict the patients at high risk of atrial arrhythmias[16, 17].

To our knowledge, none has studied the P-wave duration and dispersion with high and low pressure pneumoperitoneum. The goal of this study was to evaluate the changes in the P-wave duration and dispersion of patients undergoing LC in low (7mmHg) and high (15 mm Hg) pressure pneumoperitoneum.

Material and Methods

Sixtytwo patients (American Society of Anesthesiologists grade 1 and 2) were enroled the study roviding written informed consent. This prospective, randomized, controlled study was approved by the research and the ethics committee of Baskent University. Patient's operation indication was uncomplicated symptomatic cholelithiasis disease.

Patients having cardiac diseases, metabolic problems, previous history of atrial fibrillation, or those taking antiarrhythmic medications were excluded from the study.

Between October 2010 and February 2013, 62 patients were allocated to 2 groups: the low-pressure (group I; 7 mm Hg; n=32), and high-pressure (group II; 15 mm Hg; n=30) pneumoperitoneum. Randomization of groups was done before the operation, and the surgeon was informed of the randomization before the operation. Demographic data and body mass index was gathered form the patients undergoing LC. The ECG, noninvasive blood pressure, heart rate, peripheral oxygen saturation, and end-tidal carbon dioxide values of perioperative period were colected prospectively.

During anesthesia, intravenous propofol (2mg/kg), fentanyl (1 mcg/kg), vecuronium bromide (1mg/kg), and 1 minimum alveolar concentration sevoflurane in a 50% O_2/air were used. Three experienced surgeons performed the operations. Laparoscopic procedures were performed as described before[18].

In both groups after anesthesia induction and tracheal intubation, pneumoperitoneum was created with CO_2 via a Veress needle at the infraumblical incision site. Intra-abdominal pressure was gradually increased and stabilized on 7 mm Hg for low pressure group and 15 mm Hg for high pressure group, as determined by an electronic carbon dioxide insufflator. LC was performed with 4 ports using the American technique. Two 10-mm and two 5-mm trocars were inserted through the infraumbilical, subxiphoid, subcostal midclavicular, and subcostal anterior axillary incisions respectively.

Patient's blood pressure and heart beat were monitoized

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and recorded during perioperative time. Operatin position was supine for all patients. Conventional 12-lead ECG evaluation was used to follow and record the cradiographic changes. We obtained data before anesthetic induction (baseline), immediately after the pneumoperitoneum had been created, every 15 minutes during pneumoperitoneum, and 5 minutes after deflation. Two investigators, were measure P-wave duration manually with calipers and a magnifying lens who were blind about the groups. The junction between the isoelectric line and the beginning of the P-wave deflection was defined as the onset of the P wave. The return of the wave to baseline was considered to be the end of the P wave. PD was defined as the difference between the maximum and the minimum P wave durations.

All data are presented as means ± standard deviation. An analyses of variance test was used for repeated measurements. Significant differences between groups determined with analysis of variance were assessed by "posthoc Scheffe" test for differences among groups. A *P* value of less than .05 was accepted as statistically significant.

Results
The body mass index and demografics of patients were similar in both groups (Table 1).

Table 1. General characteristics of the patients

	Group 1(n=32)	Group2 (n=30)
Sex M/F	4/28	1/29
Age (years)	43.2±9	45.3±12.64
Body Mass Index	29.5±4.76	28.4±5.13
Duration of operation (min)	53.05±20.19	50.02±17.23

Operation times of the groups were similar respectively (Table 1). After induction of pneumoperitoneum the mean arterial blood pressure increased significantly in both groups (group I, P<.05; group II, P<.05) and there was no statistically significant difference between the groups (Figure 1).

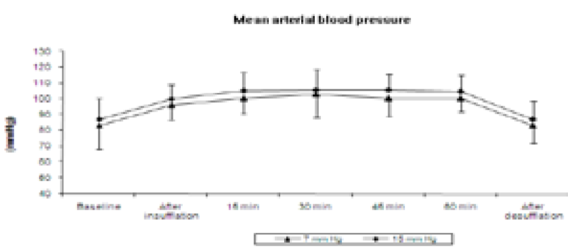
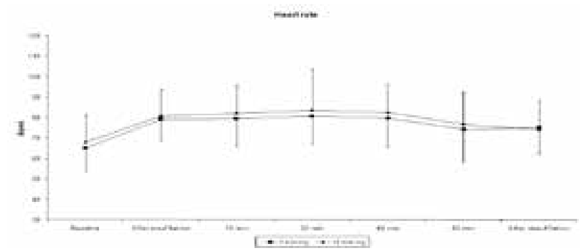


Figure1. Changes in mean arterial blood pressure

Statistically insignificant moderate increase was recorded in heart rate in both groups (Figure 2).

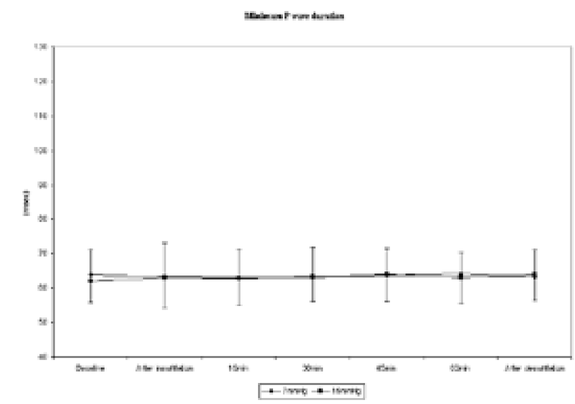
Figure 2. . Changes in heart rate.



The heart rate and arterial blood pressure returned to normal after desufflation.

In group I average p minimum values 64±8.1 msec and 62±9.1 msec in group II respectively. The P minimum wave duration did not show statistically significant change during pneumoperitoneum in the two groups (Figure 3).

Figure 3. Changes in minimum P-wave duration.



However there was no intergroup significance about P minimum.

During pneumoperitoneum, P maximum and PWD measurements significantly increased in groups from immediately after insufflation until desufflation (figure 4, 5).

Figure 4. Changes in maximum P-wave duration.

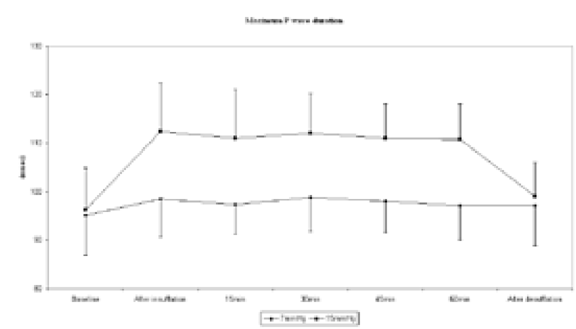
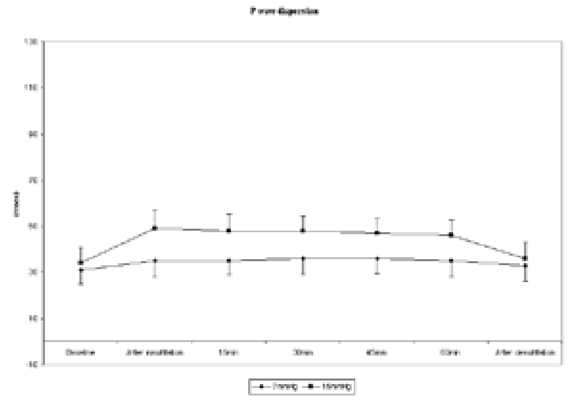


Figure 5. Changes in P dispersion.



In group I, average of the P maximum values at baseline was 94.4±7.8 msec, which increased to a peak value of 98.7±9 msec after the insufflation (*P*>.05). In group II, average of the P maximum values at baseline was 96±8 msec that increased significantly after the insufflation to 112.5±10.2 msec (*P*<.05).

P maximum, determined after desufflation, still remained lengthened than the baseline values in the two groups (97.5±9 msec, in group I, 99.6±8 msec, in group II) and there was no statistically significant difference between the groups. The average value of P maximum in group II was significantly higher than that in group I during insufflation period.

Similarly PWD increased significantly through the insufflation period in the two groups. In group I, the average of the PWDs at baseline was 30.3±6.1 msec, which increased to a peak value of 35.7±10 msec after the insufflation (*p*>.05). In group II, the average of the PWDs at baseline was 34.4±7.8 msec, which increased to a peak value of 49.8±10.3 msec after the insufflation (*P*<.05). After the desufflation PWD still remained higher than the baseline values and there was no significant difference between groups. The PWD was significantly higher in the high pressure group compared to low-pressure group during insufflation period. No atrial arrhythmias occurred during the session.

Discussion

Atrial arrhythmias are the most common arrhythmia disorder but, it doesn't always cause symptoms. It is generally associated with heart disease but with older age and metabolic disorders as well. Asymptomatic genetical tendency was reported. Preoperative characteristics of the patients were similar in both groups. There was no detected atrial fibrillation in both groups.

In patients without known atrial arrhythmia risk factors minimum P wave duration did not changed through the operation. Shorter minimum P wave duration was associated with paroxysmal lone atrial fibrillation but we did not find the mean values as reported in both groups.

In group II, maximum P wave duration and PWD were significantly increased after creating the pneumoperitoneum and decreased to baseline after desuflation process during LC. In group I, maximum P wave duration and PWD were insignificantly prolonged. İntergroup differences were significant according to maximum P wave duration and PWD. The maximum values were collected after creation of pneumoperitoneum and remain higher than through the pneumoperitoneum period. According to these values no atrial rythm disorder, no associated mortality, and morbidity was determined.

The demograpgic data of patients were similar in the groups. The position of the patients due to perioperative period was supine. Hypercapnia has been thought to produce an increase in the duration of P wave by affecting effective refractory period and changing cardiac conduction time. [19] Although no such effect was reported associated to hypoxia[19]. However, in this study, carbon dioxide and oxygen values were monitored, no hypercapnia and no hypoxemia was observed during the perioperative period. Creating a high pressure peritoneum for the operation affects intrathoracic pressure more than a low pressure peritoneum. Intrathoracic pressure changes affect venous return, cardiac output, arterial pressure, and heart rate. Initially after creating high presure pneumoperitoneum P wave duration and PWD values increased through the pneumoperitoneum period. However no clinical and electrical atrial disorder was detected perioperatively.

Propofol and sevoflurane were used for anaesthesia induction and maintanence in both groups. Maximum P wave and PWD did not change in low-pressure group. Thus, P wave changes associted to pneumoperitoneum did not related to this type of anaesthesia procedure.

Recently, it has been suggested that most cases of atrial arrhythmia were induced or provoked by inflammation[20-22]. Its cellular basis is not yet fully established, but P wave variations in surface electrocardiography in humans have been correlated with acute or chronic hemodynamic, metabolic, or inflammatory stressors may change atrial conduction changes. It is thought that surgical stress also affects the initiation of atrial arrhythmias. The duration and type of surgical procedure were similar in all patients. At the same time increases in the P wave duration and PWD in our series were seemed to be independent from the duration of pneumoperitoneum and surgical procedure.

During pneumoperitoneum an increase in left atrial pressure was associated with elevated left ventricular afterload and left ventricular end diastolic volume[18]. P wave alteration was significantly meaningful only in group II.

Conclusions

According to the study, low pressure peritoneum did not affect P wave duration significantly during LC. However compared to group I, group II caused significant increase on PWD, which reflects a higher risk for atrial arrhytmias. Electrocardiograpic changes were returned to near baseline after desufflation. These effects well tolerated and did not result with a cardiac or related morbidity on these otherwise healthy patients. Reported cardiovascular effects of pneumoperitoneum and alteration P wave are not induced atrial disorders during elective laparoscopic operations.

Choosing low-pressure pneumoperitoneum during LC may prevent patients from cardiac risks. Lower pressure pneumoperitoneum may be suitable to older, more complex or longer duration laparoscopic procedures and those with cardiopulmonary problems.

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