Original Article

Gas or Gas-Less Laparoscopic Cholecystectomy?

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ABSTRACT

Background: With the advent of minimally invasive surgery, laparoscopic cholecystectomy has become the standard treatment of symptomatic gall bladder disease. Gas-less laparoscopy has been developed to reduce the few but well documented complications induced by carbon dioxide insuflation.

In this study we have attempted to compare the intra-operative physiologic changes, technical limitations and postoperative outcome in the standard laparoscopic cholecystectomy and the laparoscopic gas-less method.

Materials and Methods: This prospective study was carried out at King Fahd Hospital of the University, in the eastern province of Saudi Arabia. 100 patients with symptomatic gall bladder disease were included. 50 patients underwent standard laparoscopic cholecystectomy with gas insufflation, and the other 50 patients gas-less laparoscopic cholecystectomy. Intra-operative monitoring of the heart rate, blood pressure, oxygen saturation, end tidal carbon dioxide, end expiratory volume, procedure technicalities, operative time and post-operative care were documented.

Results: The procedure time and most of the intra-operative physiologic changes were similar in both groups except for the heart rate, blood pressure, oxygen saturation and end-tidal carbon dioxide which showed more stability with the gas-less group. However, more technical difficulties were encountered in the gas-less group due to the limited exposure. Postoperative pain was also similar in both groups.

Conclusion: Gas-less laparoscopic cholecystectomy has been developed to reduce the well-documented physiologic changes and the potential limitations imposed by the airtight system. However, due to its documented technical limitations, it is best reserved for patients with compromised cardiovascular and respiratory functions.

KEY WORDS: gall bladder disease, gas-less laparoscopic cholecystectomy

INTRODUCTION

A rapid increase in the rate of cholecystectomy was reported in the eastern province of Saudi Arabia between 1977-1986[1]. Numerous reports have documented the benefits of laparoscopic cholecystectomy compared with conventional open surgery in terms of reduced hospital stay and earlier return to full activity. This procedure is usually performed using the standard technique of carbon dioxide peritoneal insufflation, a procedure that inevitably limits the free use of conventional surgical techniques and instruments. It is accompanied by few but well documented complications.

Carbon dioxide has been the favored gas used to create pneumoperitonium because of its high solubility in the blood and the fact that its does not support combustion. Although the physiologic problems resulting from carbon dioxide are well documented, they are becoming of more concern in long and extensive laparoscopic procedures in elderly debilitated patients.

Gas-less laparoscopy was developed to reduce the potential risks and the technical limitation imposed by the airtight system. It can provide an added margin of safety in patients with compromised cardiovascular and respiratory systems.

MATERIALS AND METHODS

This prospective study was carried out at King Fahd Hospital of the University, Eastern Province of Saudi Arabia. One hundred selected patients with symptomatic gallstones, medium-built and with no underlying cardiac or pulmonary disease, graded according to the American Society of Anesthesiologists ASA I and ASA II, were included in this study. Patients were divided randomly on alternate basis into two groups, odd numbers underwent the standard carbon dioxide insufflation laparoscopic cholecystectomy (group I), and even numbers gas-less laparoscopic cholecystectomy (group II).

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Table 1
Demographic data

Groups	Age (mean)	Sex (M:F ratio)	Weight (mean)
Gas insufflation group	39.04 (SD ± 8.64)	13:37	77.81 (SD ± 17.32)
Gas-less group	35.50 (SD ± 9.21)	7:43	66.01(SD ± 7.7)

The Laparo-lift was used for gas-less laparascopic chloecystectomy. Laparolift equipment using laparolift Tm, Medsystem Inc. California was employed to elevate the abdominal wall 15-20 cm through a supra-umbilical incision allowing visualization of the abdominal cavity. In group I patients, carbon dioxide was insufflated thorough a sub-umbilical incision at a rate of .9 liter per minute keeping the intra-abdominal pressure constant at 14 mm Hg. A total amount of 3-6 liters of carbon dioxide was used. The other three ports were used in the standard methods for both groups.

Demographic data, pre-operative preparation, intra-operative monitoring of heart rate, blood pressure, oxygen saturation (O_2 Sat.), end-tidal carbon dioxide ($ETCO_2$), expiratory tidal volume (TV exp.), technical feasibility, procedure time, post-operative care, hospital stay and outpatient follow up at six weeks were documented.

RESULTS

No significant difference was noticed at a calculated P value of >0.05 on demographic data (Table I).

Patients were used as their own control in monitoring the heart rate before initiation of insufflation and laparolift. Heart rate was monitored at 15, 30, 45, 60 minutes and at the end of surgery. There was a significant difference in the heart rate noticed in the laparolift group starting after 30 minutes when the rate dropped from pre-procedure levels and continued till the end of the procedure, while in the gas group, the heart rate increased at the initiation of the insufflation and remained elevated throughout.

Significant differences were also noticed in the mean blood pressure as shown in (Table II). On monitoring the respiratory functions it was noticed that there were significant changes in both the oxygen saturation and end-tidal carbon dioxide, while the end expiratory tidal volume did not show any changes (Table II).

There was technical limitation in the surgical procedure using the gas-less method. With the elevation of the abdominal wall there was abdominal wall tenting that led to narrowing of the surgical field and limited, to some degree, diagnostic laparoscopy as compared to the standard method. There was no difficulty encountered in the actual procedure of cholecystectomy. The operation time for both groups was similar.

Post operatively it was noticed that the site of pain differed in the two groups, the standard group (group I) patients complained of shoulder tip pain while in the gas-less group (group II) the pain was centered at the site of the retractor. The demand for analgesia and the one-day hospital stay and outpatient six weeks follow up were similar in both groups.

DISCUSSION

Upper abdominal surgery causes major changes in postoperative lung volumes and breathing patterns[2]. Continuous modifications of surgical techniques have played a major role in the reduction of postoperative respiratory complications. Laparoscopic cholecystectomy has been shown to reduce the incidence of postoperative pneumonia in the large patient registries of Meyers and Litwin as compared to historical controls of open cholecystectomy[3]. This is mainly attributed to the reduction in the

Table 2
Comparing the peri-operative changes between the two groups.

Gas/ gas-less	Heart rate	Mean blood pressure	Oxygen saturation	End-exp-volume
Control	79.85 ± 11.55 / 75 ± 13.46	74.58 ± 8.99 / 76.55 ± 7.46	98.08+0.56 / 98.71+ 0.76	32.12 ± 3.36 / 29.13 ± 2.17
15 mins	78.88 ± 10.77 / 75.13 ± 8.59*	102.20 ± 13.85* / 84.00 ± 14.07*	97.96 ± 0.95 / 98.38 ± 0.55	38.48 ± 4.41* / 31.38 ± 2.45*
30 mins	81.53 ± 11.9* / 72.30 ± 9.62*	98.78 ± 14.49* / 81.00 ± 12.65*	97.83 ± 0.94 / 98.88 ± 22.9	41.87 ± 4.77* / 31.30 ± 3.16*
45 mins	84.53 ± 11.97* / 67.71 ± 11.24*	102.60 ± 15.43* / 78.29 ± 9.68*	97.93 ± 1.10 / 99.00 ± 0.82*	42.67 ± 5.08* / 32.57 ± 2.70*
60 mins	83.25 ± 14.31* / 70.67 ± 13.37*	104.60 ± 9.61* / 74.00 ± 15.57*	97.50 ± 0.76 / 99.50 ± 0.84	45.38 ± 5.88* / 32.17 ± 3.06*
End of surgery	81.04 ± 13.23* / 74.75 ± 8.48*	100.50 ± 11.96* / 76.75 ± 12.46*	98.00 ± 0.94 / 98.88 ± 0.83*	45.38 ± 5.88* / 32.17 ± 3.06*
15 mins post operative	85.23 ± 13.93* / 73.75 ± 8.84*	89.55 ± 11.96* / 76.75 ± 12.46*	90.55 ± 1.06 / 98.86 ± 1.07	42.25 ± 4.62* / 32.50 ± 3.42*
P Value	< 0.05	< 0.05	< 0.05	<0.05

* significant difference between the two groups.

operative time and the reduced postoperative pain, leading to a lesser degree of suppression of immunological and antibacterial function following minimally invasive procedures.

Laparoscopic cholecystectomy with pneumoperitoneum is the standard procedure for the treatment of symptomatic gall bladder disease. It has a significant effect on both cardiovascular and respiratory functions[4]. Carbon dioxide is the favored gas because its high solubility in the blood reduces the risk of gas embolism and because it does not support combustion[5]. It has been suggested that carbon dioxide is converted to carbonic acid on the moist peritoneal surfaces, irritating the diaphragm and leading to referred shoulder and neck pain. Recent reports showed that there is a statistical but not clinically significant rise in the end tidal carbon dioxide during laparoscopy with carbon dioxide insufflation which reliably reflects the arterial carbon dioxide tension[6]. Yet this statement should be handled with caution, in elderly patients or patients with an underlying lung disease, rapid absorption of insufflated carbon dioxide may lead to acidosis and hypotension requiring aggressive intra-operative treatment to stabilize the patient[7]. Transient reduction of lung volumes and loss of vital capacity in the first 24 hours after laparoscopic cholecystectomy have also been reported, yet the number of patients with postoperative pulmonary complications is quite small[8]. Measured ultrasonic velocity profiles in the femoral veins has demonstrated that venous stasis occurred promptly with the introduction of pneumoperitoneum, these changes are similar to those occurring in conditions such as ascites and pregnancy[9]. The high intra-abdominal pressure on the other hand reduces the renal cortical perfusion by about 60%, and peripheral venous stasis as a result of the increased venous pressure and resistance. The effects of increased intra-abdominal pressure are well documented in the literature and requires extra vigilance by anesthesiologists[5]. Clinical studies have shown that there is increased after-load, decreased cardiac index, increased venous pressure and decreased venous return from the lower limbs and in addition, there is increased arterial pulmonary wedge pressure due to reduction in lung compliance[10].

Although peripheral venous stasis is an inevitable consequence of pneumoperitoneum, there is no significant evidence to date of an increased incidence of venous thrombosis[11]. Myocardial infarction, pulmonary edema, lung collapse and pulmonary embolism may also contribute to the morbidity and mortality[12].

Sudden onset of transient bradycardia and hypotension in elderly patients, immediately after insufflation, had been experienced by the authors. These responded to rapid deflation and treatment with atropine. This complication is thought to be due to vagal stimulation from the over stretched peritoneum. The symptoms did not reoccur in any of the patients after resuming the procedure.

This study confirms that gas-less laparoscopy has definite advantages over the pneumoperitoneum by allowing the use of the conventional instruments. Yet it has its technical limitations. The laparo-lift handle placed in the way of the assistant hinders the free manipulations of the graspers. In addition tenting of the abdominal wall leads to the formation of a narrow field and poor visualization, thereby hindering complete diagnostic laparoscopy. It is worth mentioning that only medium built patients were included in this study, however, if stouter patients were included more technical limitations could be anticipated.

It is true that gas-less laparoscopic cholecystectomy may help avoid all the complications mentioned above, yet because of the technical limitations it is best reserved for elderly patients and those with cardiopulmonary compromise.

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