THE FEASIBILITY OF SPINAL ANESTHESIA WITH SEDATION FOR LAPAROSCOPIC GENERAL ABDOMINAL PROCEDURES IN MODERATE RISK PATIENTS

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Abstract

Background: One of the major advantages of laparoscopic surgery is minimizing postoperative morbidity. The previous limitations to the use of spinal anesthesia in laparoscopic surgery were the limited work space, high failure rate, more intra-operative morbidity and significant arterial blood gas alterations. However, the addition of a small-dose Ketamine infusion to propofol might provide a suitable sedative combination to be used with high spinal anesthesia, producing titerable sedation, increased hemodynamic stability, and minimal respiratory depression.

Patients and Methods: At KFSH & RC Hospital, after Ethical Committee approval and informed written consent, 18 ASA III patients scheduled for various laparoscopic abdominal procedures were enrolled. Exclusion criteria consisted of ejection fraction below 45% and or peak expiratory flow rate and forced vital capacity of less than 65% of predicted values. Following oral premedication with midazolam 7.5-10 mg 30 min preoperatively, spinal anesthesia was conducted by bupivicaine 0.75% 3-3.5 ml at L3-4, in the lateral position to reach a sensory level at T4.

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Sedation was started by intravenous injection of 0.4 mg/kg propofol and 0.1 mg/kg ketamine prior to spinal anesthesia. This was followed by infusion of 1.0-1.5 mg/kg/h and 0.3-1.0 mg/kg/h. of the same drugs respectively. The sedation requirements were adjusted to keep the patient sleepy with conservation of airway reflexes at level 3 on a 5 point sedation score. Heart rate, respiratory rate and SpO_2 were monitored, together with direct arterial blood pressure monitoring and arterial blood gas analysis through arterial cannulation. Postoperative first time call for analgesia, total morphine consumption during the first hour and incidence of complications were recorded. Twenty Four hours later, surgeons' and patients' satisfaction were obtained and recorded.

Results: Heart rate and mean arterial blood pressure were significantly decreased after spinal anesthesia and intra-peritoneal insufflations of CO_2, with significant increase in arterial carbon dioxide tension accompanied by increase in the respiratory rate. The increase in respiratory rate led to gradual decrease of CO_2 level down to near the pre-operative $PaCO_2$ values. However, there was insignificant decrease in oxygen saturation throughout the intra-operative time. Postoperatively there were excellent surgeon and patient's satisfaction. Only one patient regained sensation before completion of surgery and sedation was deepened to level 5 sedation score. The mean surgical time was 98.5 ± 21.4 min while the mean anesthesia time was117.7 ± 20.1 min**.** First mean time call for analgesia was 50 ± 8 min. 7/18 patients required single dose of morphine of 4 mg during the 1st hour postoperatively.

Conclusions: The addition of a sedative combination of ketamine and propofol to spinal anesthesia was found to be safe and efficient from both the anesthetic and surgical point of view, especially for sick patients with intermediate clinical predictors.

Key words: Spinal anesthesia, Laparoscopic surgery.

Introduction

One of the major advantages of laparoscopic surgery is minimizing postoperative morbidity. Other advantages include reduction of postoperative pain, better cosmetic result and quicker return to normal activities. Hospital stay is shortened resulting in a reduction in overall medical cost.

Significant physiological changes and complications may result from laparoscopic surgery. The laparoscopic surgeries performed on geriatric patients and those for abdominal indications carry more complications than gynecological procedures. The major problems during laparoscopic procedures are related to the cardiopulmonary effects of pneumo-peritoneum, systemic carbon dioxide absorption, venous gas embolism, extra-peritoneal gas insufflation and unintentional injuries to intra-abdominal structures[1].

Some limitations to regional anesthesia in laparoscopic surgery were described by Chui et al., and included the limited work space, high failure rate, more intra-operative morbidity and significant arterial blood gas alterations[2].

Spinal anesthesia and sedation is a recognized technique for many surgical procedures. However, during laparoscopic surgery, sedation should not deteriorate the hemo-dynamics and respiratory drive of the patient. Appropriate sedation technique can be obtained by combining ketamine and propofol. The effect of ketamine on the respiratory system is unique among the anesthetic sedative drugs. While ketamine may cause transient apnea at anesthetic induction doses, it does largely preserve the integrity of laryngeal and pharyngeal reflexes and it is a recognized bronchodilator. Again, its effect on central respiratory drive is minimal, preserving the response to carbon dioxide. So the addition of ketamine as a part of the sedation technique in the present study is expected to have little effect on the respiratory variables monitored; respiratory rate, and SpO_2. Ketamine also has other advantages as it increases the heart rate and arterial blood pressure by activating the sympathetic nervous system and reduces the incidence of spinal anesthesia-induced hypotension. However, the occurrence of hallucinations, confusion, and other emergence phenomena has tended to limit its widespread use. Frizelle et al reported fewer emergence phenomena when ketamine was combined with propofol for general anesthesia[3].

The aim of the present study was to assess the feasibility of high spinal anesthesia for laparoscopic surgery in patients with moderate risk stratification. Also, we hypothesized that the addition of a small-dose ketamine infusion to propofol might provide a suitable sedative combination to be used with high spinal anesthesia, producing titrable sedation, increased hemodynamic stability, and minimal respiratory depression, without psycho-mimetic effects.

Patients & Methods

Institutional Ethical Committee approval and patient informed concent were procured. 18 patients, ASA III, 10 males 8 females, aged 52.3 ± 12.2 years scheduled for laparoscopic abdominal surgery procedures under spinal anesthesia were studied. An intra-abdominal pressure of 12 mm-Hg, and low-flow insufflation (1.5 l/min) were used for pnuemoperitoneum. Patients with a history of allergic reaction to propofol or ketamine, significant central nervous system disease, ejection fraction below 45% and or peak expiratory flow rate and forced vital capacity of less than 65% of predicted values, were excluded from participating in the study.

All patients received oral Midazolam 7.5-10 mg as premedication 30 minutes prior to surgery. On arrival to the anesthesia induction room, standard monitoring was applied to the patient. 20 G arterial cannula was inserted under local analgesia. Baseline measurements, including hemodynamic parameters (heart rate (HR) and mean arterial blood pressure (MAP)), respiratory rate (RR), and arterial blood gases were recorded prior to the administration of spinal anesthesia, pre-insufflation (after stabilization of spinal anesthesia), post-insufflation (before the start of surgical manipulation), after complete desufflation, and 10 minutes after arrival to the recovery room.

Patients were positioned in the lateral position for spinal anesthesia, and a bolus of propofol 0.4 mg/kg and ketamine 0.1 mg/kg followed by continuous infusion of 1-1.5 $mg.kg^{-1}.h^{-1}$, and 0.3-1 $mg.kg^{-1}.h^{-1}$ of both drugs was started. A 25 G pencil point (Pencan) spinal needle was used to administer (3-3.5 ml) bupivicaine 0.75% to provide a satisfactory sensory block for the intended procedure (T4).

The level of sedation was recorded every 5 min, and subsequent infusion rates were titrated to achieve a predetermined level of 3 on a 5-point sedation score (arousal to command). Oxygen was administered by face mask at a flow of 4-6 L/min to keep oxygen saturation above 95%. Fluid and vasopressor were given to minimize the mean blood pressure fluctuation to less than 20% of the base line. Sedative infusion was stopped if the respiratory rate was ≤10 bpm, and finally discontinued at the end of the surgical procedure.

Monitoring of heart rate, blood pressure, and SaO_2 were continued and recorded in recovery room. All patients were closely observed for evidence of hallucinations or other emergence phenomena. Patients remained in the recovery room until motor function had returned to the lower limbs, the autonomic effects of spinal anesthesia had resolved, and standard discharge criteria had been met (stable vital signs, awake and oriented, controlled pain, and absent nausea and vomiting). Any requirements for fluids, vasopressor, antiemetic, or other medications in the recovery room were recorded.

24 hours after the anesthetic all patients and surgeons, were questioned about their impressions of and satisfaction with the anesthetic technique used, and whether there was any other side effects experienced. Patients were specifically asked about hallucinations, nightmares, visual problems, nausea, vomiting, and headache.

Statistical Analysis

Results were expressed as mean ± SD, analyzed using tests of significance, Paired t -test, student t- test. Statistical significance was considered at the level of $p<0.05$

Results

Table 1 shows patients' characteristic and operative data. The mean age of the studied population was 52.3 ± 12.3 years, mean body weight was 80.3 ± 13.7 Kg and mean body surface area of 1.89 ± 0.17 m^2. The mean surgical time was 98.5 ± 21.4 min, while the mean anesthesia time was 117.7 ± 20.1

min. Fifteen patients were scheduled for laparoscopic ventral hernia repair while 3 patients were scheduled for diagnostic laparoscopy and biopsy.

13/18 (72.2%) patients had bronchial asthma on steroids, 3/18 (16.6%) patients had systemic lupus, 2/18 (11.1%) patients had nephrotic syndrome, 1/18 (5.1%) patient had renal artery stenosis, 8/18 (44.4%) patients had controlled hypertension and 5/18 (27.7%) patients had diabetes mellitus.

Table1
Patients Characteristics and Operative Data

Age (Yr)	52.3 ± 12.3
Sex	8 F/10M
Weight (kg)	80.3 ± 13.7
BSA (m^2)	1.89 ± 0.17
Surgical Procedure:	
● Laparoscopic hernia repair	15 / 18 (83.3%)
● Diagnostic laparoscopy & biopsy	3 / 18 (16.6%)
Patients Co morbidity:	
● Bronchial asthma (n)	13/18 (72.3%)
● Systemic lupus erythromatosis (n)	3/18 (16.6%)
● Nephrotic syndrome(n)	2/18 (11.1%)
● Renal artery stenosis(n)	1/18 (5.5%)
● Controlled hypertension(n)	8/18 (44.4%)
● Diabetes mellitus(n)	5/18 (27.7%)
Mean Duration of surgery(min)	98.5 ± 21.4
Mean Duration of anesthesia (min)	117.7 ± 20.1

Data are presented as mean ± SD or number of cases as appropriate.

The dermatome level of analgesia achieved was satisfactory in all patients.

The base line MBP was 83.2 ± 9.7 mmHg which decreased significantly after spinal anesthesia to 69.7 ± 5.8 mmHg (p = 0.002) and persisted after CO_2 insufflation at a level of 73.05 ± 4.1 mmHg (p = 0.002).

The changes in MBP were accompanied by significant decrease in HR after spinal anesthesia and CO_2 insufflation which increased again after desufflation and in PACU (Table 2, Fig. 1) starting with a mean baseline of 78.2 ± 11.5, and progressing to 70.1 ± 8.4, 71.4 ± 8.0, 74.3 ± 8.7 and 73.2 ± 7.5 beat/min respectively.

Fig. 1

Peri-operative changes in Mean Blood Pressure (MBP) and Heart rate (HR)

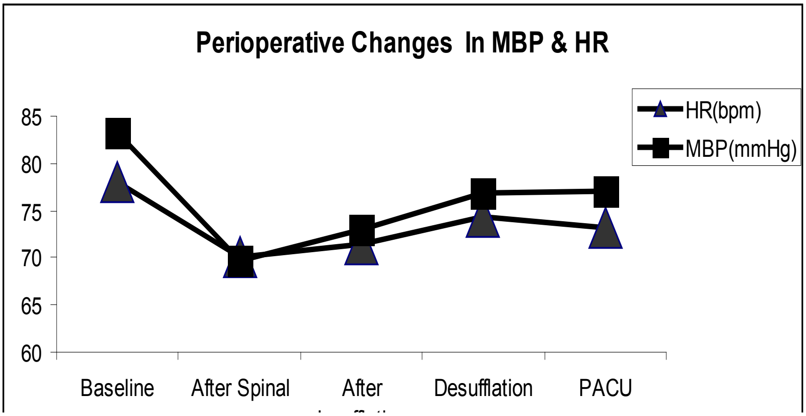
Variables / Time	Base Line	After Spinal	After CO_2 Insufflation	After Desufflation	PACU Admission
Mean Blood Pressure (MBP) (mmHg)	83.2 ± 9.7	69.7± 5.8* *P* = 0.002	73.05 ± 4.1* *P* = 0.002	76.8 ± 9.7 *P* = 0.05	77.2 ± 9.2 *P* = 0.06
Heart Rate (HR) (bpm)	78.2 ± 11.5	70.1 ± 8.4* *P* = 0.02	71.4 ± 8.0* *P* = 0.04	74.3 ± 8.7 *P* = 0.26	73.2 ± 7.5 *P* = 0.13
Respiratory Rate (RR) (bpm)	13.4 ± 1.29	13.8 ± 1.11 *P* = 0.41	20.1 ± 2.08* *P* = 0.003	14.3 ± 1.1 *P* = 0.13	13.8 ± 1.15 *P* = 0.3
Arterial Carbon Dioxide Tension ($PaCo_2$) (KPa)	5.51 ± 0.25	5.55 ± 0.24 *P* = 0.69	5.97 ± 0.39* *P* = 0.001	5.63 ± 0.2 *P* = 0.2	5.5 ± 0.18 *P* = 0.9
Oxygen Saturation (SaO_2) (%)	98.05 ± 1.11	97.3 ± 1.13 *P* = 0.06	96.7 ± 0.9* *P* =.0007	97.9 ± 1.16 *P* = 0.7	97.7 ± 1.3 *P* = 0.5

Data are presented as mean ± SD.

* Significantly (P <0.05) different from the baseline.

Table 2

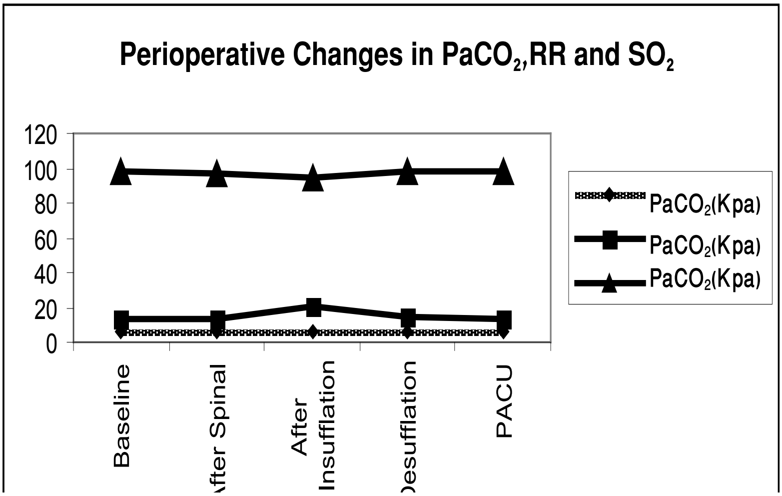
Perioperative Hemodynamic and Respiratory Changes



After CO_2 insufflation, there were significant increase in $PaCO_2$ from a mean value of 5.51 ± 0.25 to 5.97 ± 0.39 Kpa (p = 0.001) accompanied by significant increase in respiratory rate from a mean value of 13.4 ± 1.49 to 20.1 ± 2.08 bpm (p = 0.003) and significant decrease in SaO_2 96.7 ± 0.9 (p = 0.007) compared to the baseline.

The changes in $PaCO_2$ and respiratory rate disappeared after desufflation (5.63 ± 0.2, 14.3 ± 1.13 respectively) and in PACU (5.5 ± 0.18, 13.8 ± 1.15 respectively) as shown in Table 2 and Fig. 2.

Fig. 2
Perioperative Changes in arterial Carbon Dioxide Tension ($PaCo_2$), Respiratory Rate (RR) and Oxygen Saturation (SO_2)



Postoperatively, none of the patients suffered vomiting, and there was excellent surgeons' and patients' satisfaction. The post-operative pain was minimal, and 7 out of 18 patients (38.8%) required single dose of morphine of 4 mg during the first hour postoperatively, with a mean first time call for analgesia of 50 ± 8 min.

Three patients reported headache the following day (first post-operative day), one of which was migraine like in nature. No headache was typically postdural puncture in character. Two patients described either short-lived auditory hallucinations or vivid dreams. No other emergence phenomena were reported.

Discussion

Many researchers have observed that performing laparoscopic surgery under regional analgesia carries many advantages. The reduction of surgical stress response is considered one of its major advantages. This is accomplished through two aspects; the laparoscopic technique, itself which reduces the degree of tissue trauma and consequently the injury response (minimal invasive surgery concept), and the spinal analgesia itself which provides pain relief by blocking afferent neural block, together with block of various humoral mediator cascade systems[6,7,8]. Avoidance of airway instrumentation and lower incidence of deep vein thrombosis are other important advantages of this technique. These advantages, however, were counteracted by some reported disadvantage like, limited, work space, high failure rate, more intra-operative morbidity and significant arterial blood gas alterations.

In order to avoid these disadvantages, we modified the surgical technique, and a more effective sedation technique was used through out the whole procedure. The intra-abdominal insufflation pressure was limited to 12 mmHg with a low insufflation flow technique (1.5 L/min) thus contributing to reduction of the intra-operative hemodynamic alterations.

The alterations in hemodynamic parameters in patients undergoing laparoscopic surgery under general anesthesia are well presented in the work of Critchley et al.[4], who used insufflation pressure of 15 mmHg. They reported that after induction of anesthesia and gas insufflation there was 29% increase in the mean arterial blood pressure, associated with variable changes in cardiac index from a decrease of 17% to an increase of 22% of its baseline value. They also observed a decrease in arterial pH and base excess after one hour of insufflation.

In contradistinction, the present study under spinal anesthesia showed a significant decrease in both heart rate and the mean arterial blood pressure. Those changes were attributed to the sympathetic block and decreased after load, which was corrected by using fluids and vasopressor drugs after starting spinal anesthesia. This led ultimately to patient's hemodynamic stabilization secondary to the increase in ejection fraction and cardiac index, as confirmed in the results of Lau et al who reported stable peri-operative hemo-dynamics in patients undergoing laparoscopic hernia repair and attributed to the same factors[19].

The MBP increased after insufflation from 69.7 ± 5.8 to 73.05 ± 4.1 mmHg (p<0.005), possibly because of changes in peripheral vascular resistance and relative increase in cardiac index, effects that were maintained thereafter.

In addition, ketamine infusion used in the present study played a role in supporting blood pressure as explained in Frizelle et al.[3] who showed that the group of patients who received a bolus dose of ketamine (0.7 mg/kg) prior to spinal anesthesia had a higher mean arterial pressure when compared with another group given fentanyl (1.5 µg/kg). Ketamine produces dose-related increases in the rate-pressure product and a transient increase in cardiac index. Both peripheral vascular resistance and heart rate are augmented. However, there is no increase in stroke index, and ketamine is a mild direct cardiac depressant. The stimulant effects are dependent on an intact sympathetic nervous system. When used with propofol for induction of general anesthesia, the cardio-stimulant effects of ketamine, even in sub-anesthetic doses, balances the cardio-depressant effects of propofol.

Ciofolo et al.[5], evaluated the respiratory changes during laparoscopic surgery under epidural anesthesia in seven female patients scheduled for a gamete intrafallopian transfer procedure. They stated that there were no significant changes in the ventilatory variables, and $PaCO_2$ was kept constant throughout the study. In our present study there was significant increase in $PaCO_2$ after insufflation but it came down gradually to the preoperative value secondary to the compensatory increase in respiratory rate which reached 20.1 ± 2.08 bpm. Respiratory depression is unlikely with the sedation technique we use, although supporting data from other works concerning sedation infusion regimens are limited[12,13]. Again Hirschber et al., found that respiratory compensation gas insufflation is not decreased by regional anesthesia.

Postoperative pain was minimal in most of our patients. Only 7 patients out of 18, received single dose of 4 mg of morphine, and the mean time for first call for analgesia was 50 ± 8 min. The rest of patients did not require analgesics in the recovery room. These results are in-agreement with Tzovaras G et al.[16], who found that there was minimal post operative pain in patients undergoing laparoscopic cholecystectomy under spinal anesthesia and concluded that spinal anesthesia is well tolerated when low flow and low insufflation pressure technique are used, with excellent patient satisfaction. A high incidence of shoulder pain has been reported by Minai H. et al.[17], attributed to the physical and chemical stimulation of the diaphragm by pneumoperitoneum. In contrast to our study, Hirschber et al stated that most of the patients in their study experienced severe agitation often accompanied with chest pain. They related these findings to the lack of efficient sedation or a low level of the block.

Patients and surgeons satisfaction were excellent when asked 24 hrs post-operatively. Similar results observed by Liem and his colleagues[9] though the patients in the laparoscopic-surgery group were discharged sooner and had less early and late postoperative pain than the patients in the open-surgery group. Lennox confirms our study by concluding that a small-dose spinal anesthesia is an effective alternative to a desflurane general anesthesia in terms of cost and recovery profiles in ambulatory gynecological laparoscopy"[10].

The incidence of complications in the present study was low. Three patients (16.6%) reported headache the following day, one of which was migraine like in nature. No headache was typically post-dural puncture in character. Only two patients described either short-lived auditory hallucinations or vivid dreams. No other emergence phenomena were reported. Vaghadia et.al.[11], observed that postoperative headache occurred in 38% of all patients and oral analgesia was the only treatment required.

With regard to patients' satisfaction, follow-up revealed that 96% of patients said that spinal needle insertion was acceptable, 93% found surgery comfortable, and 90% said they would request spinal anesthesia for laparoscopy in future. No urinary retention was observed.

In agreement with our work, Bejarano *etal*., used spinal analgesia associated with midazolam sedation for patients undergoing laparoscopic ventral hernia repair. The dermatomal block reached up to T2 and they used an insufflation technique similar to ours. They reported a successful technique in 19 patients out of 23, while 4 patients required conversion to general anesthesia. They conclude that spinal anesthesia is feasible and well tolerated in laparoscopic hernia repair[14]. Similar conclusion was reached by Van Zundert et al., who stated that segmental spinal anesthesia is feasible for patients with impaired organ function[15]. Same successful technique was also reported by Lau et al in patients undergoing laparoscopic hernia repair under spinal anesthesia[19].

Conclusions

The addition of a sedative combination of ketamine and propofol to spinal anesthesia was found to be safe and efficient from either the anesthetic and surgical point of view especially for sick patients with intermediate clinical predictors.

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