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RESEARCH ARTICLE

EVALUATION OF LAPAROSCOPIC SURGERY UNDER LOW-PRESSURE PNEUMOPERITONEUM AND REGIONAL ANESTHESIA

[1,*]Mostafa Abd Allateef, [1]Omar Abdel-Raheem, [1]AsemElsani M.A. Hassan and [2]Ahmed Abd-El Maboud

[1]Department of General Surgery, Faculty of Medicine, Sohag University
[2]Department of Anaesthesia, Faculty of Medicine, Sohag University

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ABSTRACT

Objectives: assessment of the feasibility and safety of laparoscopic procedures under low-pressure CO2 pneumoperitoneum and regional anaesthesia. **Patients and methods**: 30 adult ASA I or II patients admitted for different laparoscopic procedures were enrolled in the study. Pre-anaesthetic values of HR, RR, body temperature, BP and pulse oximetry were recorded. Spinal an aesthesia was given in sitting position with a 25 G needle into the L1 - L2 subarachnoid space. Different laparoscopic procedures were performed with the pneumoperitoneum was maintained with low CO2 pressure at 8-12 mm Hg. Anaesthesia time, Surgery time, Intraoperative complications and Conversion from regional to general anesthesia or from laparoscopic to open technique were recorded and the technical difficulty was ranked by the surgeon. **Results**: 28 of the patients (93.3%) completed the procedure under spinal anaesthesia and 2 (7.7%) were converted to general anaesthesia. Rank of technical difficulty ranged from 2/5 in 24 cases (80%) to 4/5 in one case (3.3%). Overall operative and anaesthesia times ranged from 30 to 65 minutes (Mean 37.33 $\pm$ 10.15 min.) and 45 to 90 minutes (Mean 53$\pm$ 12.12 min.) respectively. No intraoperative complications and none of the patients was converted to open surgery. The vitals were maintained at a normal range. Mean arterial pressure ranged from 86.6 to 101.67 (Mean 93.6$\pm$5). The maximum respiratory rate during pneumoperitoneum ranged from 16 to 26 per minute (Mean 19 $\pm$ 3.8). **Conclusion**: Laparoscopic procedures under regional anesthesia with low-pressure pneumoperitoneum seems to be safe and feasible.

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INTRODUCTION

Laparoscopic procedures became the gold standard option for several surgeries. Their advantages include a significantly shorter hospital stay and a quicker convalescence compared with the classical open procedures. There's also significantly lower blood loss in the laparoscopic approach. Postoperative pain is much lower and analgesia requirement is decreased after the laparoscopic surgery (Shimoda, 2018; Keus, 2006; Sangrasi, 2010). Until about 20 years ago, the authors suggested general anaesthesia as the only anaesthetic option for abdominal laparoscopic surgery. Recently, authors' reports of laparoscopic surgery being carried out under regional anaesthesia in select patients have started to exist (Sinha, 2008). Traditionally, regional anaesthesia had been reserved for the patients who were unfit for general anaesthesia, particularly, patients with chronic cardiopulmonary disease.

Corresponding author: **Mostafa Abd Allateef,**
Department of General Surgery, Faculty of Medicine, Sohag University.

It has not been routinely used as a standalone technique of anaesthesia in laparoscopic surgery due to the traditional assumption that the induction of CO2 pneumoperitoneum may lead to respiratory embarrassment and may cause shoulder pain due to stretching of the diaphragm in awake patients during the operation (Zuckerman, 2002; van Zundert, 2006). Lower pressures cause less distension of the abdomen and diaphragm, resulting in less stretching of pain fibers resulting in less pain. In patients who required reduction in their insufflation pressures (10–12 mmHg), exposure of the surgical site was slightly more challenging but visualization remained adequate. Others recommend using pressures of 8–10 mmHg, which were commonly reported for laparoscopic surgeries under regional anaesthesia (Sangeeta Tiwari, 2013; Zhang, 2012). Recently, however, the medical literature supports the use of regional anaesthesia in healthy patients. It has been successfully used in several laparoscopic procedures, such as laparoscopic cholecystectomy (LC), laparoscopic ventral hernia repair, laparoscopic total extraperitoneal inguinal hernia

repair, laparoscopic ligation of bilateral spermatic varices; laparoscopic varicocelectomy (LV) and laparoscopic appendectomy (LA) (Tzovaras et al., 2008; Chiu, 1996; Lal et al., 2007; Tzovaras et al., 2006). The main reason for selecting regional anaesthesia for laparoscopic procedures was its advantages over general anaesthesia which include reduced postoperative pain, nausea, vomiting, uniform total muscle relaxation, a conscious patient, economical, relatively uneventful recovery, and the protection from potential complications of general anaesthesia. Regional anaesthesia is a commonly used anaesthetic technique that has a very good safety profile (Sangeeta, 2013; Lal et al., 2007; Kalaivani, 2013).

Patients and methods: This prospective study was conducted at surgery department, Sohag university hospital, from December 2014 to March 2016. After approval of ethical committee of our institute, a written informed consent was obtained from each patient with full explanation of the details of the procedure and its possible complications.

Patient selection: Adult fit patients admitted to the surgery department who were candidate for different laparoscopic procedures and who met the following criteria were enrolled in the study:

- American Society of Anesthesiologists' (ASA) I or II physical status.
- Adult between 18 and 75 years of age.

Exclusion criteria were as follows:

- ASA physical status III or more.
- Pediatric age group and elderly patients above 75 years.
- Anxiety prone patient/diagnosed psychological morbidity.
- Bleeding diathesis.
- Local spinal deformity which precluded safe regional anaesthesia.
- Patients who were at time of the study suffering from chronic pain requiring narcotic.
- Patient refusal.

Anaesthetic management: Pre-anaesthetic medication was standardized for all patients. Ranitidine 150mg orally was given the night before. The patients were instructed to void before the operation. Preoperatively, I.V. cannulation with 18G line was done and preloading with Ringer lactate 10ml/kg over 30 min was done. Other premedication included Midazolam 2mg, Metoclopramide 10 mg and prophylactic antibiotic.Pre-anaesthetic values of heart rate, respiratory rate, body temperature, blood pressure, mean arterial pressure and pulse oximetry were recorded. Spinal anaesthesia was given in a sitting position with a spinal needle 25 G into the L1 - L2 subarachnoid space. 3ml of hyperbaric bupivacaine (0.5%) was used. The patient was kept in Supine position with slight head down tilt for 5 minutes until sensory block up to (T4) sensory level was achieved which was tested with pinprick.

Surgical technique: Different laparoscopic procedures were performed according to their standard techniques. Pneumoperitoneum was induced through Veress needle. Insufflation flow rate was initially slow 1-2 L/min and maintained at 2-5L/min. The pneumoperitoneum was maintained with low CO2 pressure at 8-12 mm Hg.

Harmonic scalpel (R) was used as it's an advanced ultrasonic cutting and coagulating surgical device with important clinical advantages, such as: reduced ligature demand; greater precision due to minimal lateral thermal tissue damage; minimal smoke production; absence of electric currents running through the patient. Technical difficulty was ranked by the surgeon by giving a number from 1 to 5 over 5. To avoid postoperative shoulder pain, near complete evacuation of pneumoperitoneum was done.

Intraoperative monitoring: Continuous monitoring of hemodynamic parameters was maintained with noninvasive multiparameter monitor. Vital signs were recorded at 5minute interval.

Intraoperative shoulder pain was controlled by:

- Diaphragmatic irrigation with anaesthetic solution.
- Injectable narcotic fentanyl 25ug iv bolus which was repeated at 5 minutes if needed (maximum 100ug).
- Lowering CO2 pressure.

During the procedure, anxiety was treated by injectable midazolam 1mg bolus and pain treated by injection of fentanyl 25ug bolus which was repeated on need. Nausea and vomiting were treated by Metoclopramide 10mg.Intraoperative hypotension was treated by ephedrine as needed if mean arterial pressure (MAP) was < 20% baseline. Ringer lactate was maintained at rate of 4ml/kg/h. Oxygen inhalation by ventimask at rate of 4-6 L/min was routinely used to maintain oxygen saturation above 96%. The following criteria were established for conversion of the anaesthesia from regional to general:

- Patient anxiety not controlled by sedative.
- Pain which was not relieved by addition of narcotic.
- Bleeding which could not be controlled by routine maneuvers.

The following parameters were also noted in all cases:

- **Anaesthesia time:** It is defined as time taken from spinal puncture to final dressing of patient.
- **Surgery time:** This is defined as time from first incision to final suture.
- Intraoperative complications.
- Conversion from laparoscopic to open technique.

Post-operative management: Patient was shifted to general ward after surgery and maintained on IV fluids for 4 hours post-surgery. Thereafter, operating surgeon along with anaesthesiologist evaluated the patient for pain, nausea, and vomiting, consciousness level and vital parameters. Post-operative pain was evaluated by the Visual Analogue Scale (VAS) (Hawker, 2011) at 6, 12 and 24 hours after the end of the surgery, and by quantity of analgesia administered to alleviate patient's pain. Other post-operative events related to the surgery or anaesthesia, such as discomfort, nausea, vomiting, shoulder pain, urinary retention, headache, or any other neurologic sequelae or pruritus were also recorded. Patients were routinely discharged to home the next day,

unless some complication warranted further stay Post-operative hospital stay was also recorded. All subjects had follow-up visit at outpatient clinic 1 week after the operation. The follow-up visits included assessment of patient satisfaction.

RESULTS

A total of 30 patients were included in our study. Age varied between 18 years and 46 years (Mean 30 ± 8.61). No morbidly obese patients were included in the study and none of the patients had previous surgery. Fourteen patients (46.67%) underwent laparoscopic cholecystectomy (LC),8 patients (26.67%) underwent laparoscopic varicocelectomy (LV) and the other 8 patients (26.67%) underwent laparoscopic appendectomy (LA). Twenty-eight patients (93.3%) completed the surgical procedure under spinal anaesthesia and two female patients (6.7%) were converted to general anaesthesia due to a severe right shoulder pain not responding to shoulder rubbing, injection of fentanyl and diaphragmatic irrigation along with injection of midazolam. Patient characteristics are shown in table 1.1.

Table 1.1. Characteristics of patients

Total No. of patients	30 (100%)
Age range	18 to 46 years
Age mean	30 years
Sex	13 Males 17 Females
LC under spinal anesthesia	14 (46.67%)
LV under spinal anesthesia	8 (26.67%)
LA under spinal anesthesia	8 (26.67%)
Conversion from spinal to general anesthesia	2 (6.7%)

Table 1.2. Dosage of fentanyl

Total dosage of fentanyl	No. of patients
25 ug	19 (63.3%)
50 ug	4 (13.3%)
100 ug	4 (13.3%)
Total number of patients	30 (100%)

Table1.3. Dosage of midazolam

Total dosage of midazolam	No. of patients
0 mg	13 (43.3%)
2 mg	11 (36.7%)
3 mg	3 (10%)
4mg	3 (10%)
Total number of patients.	30 (100%)

Table1.5. Rank of technical difficulty

Rank of technical difficulty	No. of patients
2/5	24 (80%)
3/5	5 (16.7%)
4/5	1 (3.3%)
Total number of patients	30 (100%)

Table 1.6. Values of mean operative and anesthesia times

Operation	No. of patients	Mean Operative Time	Mean Anesthesia Time
LC	14	40.36 min	56.79 min
LV	8	34.38 min	49.38 min
LA	8	35 min	50min

Out of the thirty patients, 11 (36.7%) complained of right shoulder tip pain, whom two of them required conversion to general anaesthesia, three of them responded to reassurance and diversion of attention through gentle continuous massaging over their right shoulder area and the

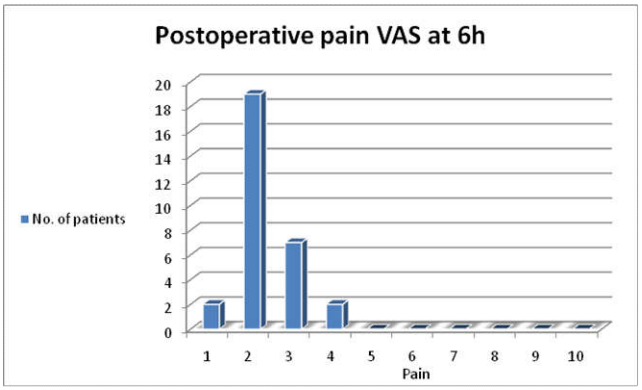

Figure 1.1. Scale of postoperative pain after 6 hours

Remaining patients required an extra injection of fentanyl for pain relief. The total dosage of fentanyl given was recorded and shown in table 1.2. Seventeen (56.7%) patients complained of anxiety and were managed with injection of midazolam. Total dosage of midazolam was calculated and shown in Table1.3. The maximum respiratory rate during pneumoperitoneum ranged from 16 to 26 per minute (Mean 20±4). The respiratory rate was more in patients with shoulder pain. In cases of laparoscopic cholecystectomy patients were counseled to take quiet breaths during dissection of Calot's triangle for better visualization. In all patients, blood pressure was maintained at a normal range. Mean arterial pressure ranged from 86.6 to 101.67 (Mean 93.6±5). The pneumoperitoneum pressure was kept low in the range of 8 to 12 mmHg as shown in table 1.4. Rank of technical difficulty was determined by the surgeon by giving number over five and it ranged from 2/5 in 24 cases (80%) to 4/5 in one case (3.3%) as seen in table 1.5.

Overall operative and anaesthesia times ranged from 30 to 65 minutes (Mean 37.33±10.15 min.) and 45 to 90 minutes (Mean 53±12.12 min.) respectively, but it differed according to the type of surgical procedure as shown in table1.6. No intraoperative complications occurred and none of the patients was converted to open surgery. The two patients who was converted to general anaesthesia completed their laparoscopic procedures successfully as planned. Only two patients (6.7%) needed opioid injection for postoperative pain management after 6 hours with score ≥ 4 according to the VAS pain score as shown in Figure 1.1. Postoperative pain was controlled efficiently by paracetamol infusion every 12 hours until discharge. After discharge, simple NSAID was prescribed orally at home. Five patients (16.7%) complained of a transient post-spinal headache 6 hours after surgery, and were managed by repeated paracetamol infusions. Injections of Metoclopramide were used to manage nausea and vomiting in 4 patients (13.3%) in the postoperative period. All patients were discharged to home the next day as there were no complications warranted further stay. 76.7% (N=23) of the patients were satisfied during the follow up visit in the outpatient clinic after 1 week. No early postoperative complications were encountered.

DISCUSSION

Recently, the laparoscopic intervention is performed as a standard option in many situations under general or regional anaesthesia. Regional anesthesia is cheaper than general anesthesia and there is also no incidence of a postoperative sore throat, aspiration, and no chances of failure of intubation. Patient monitoring is easier under regional anesthesia, as patients are awake during surgery. The incidence of postoperative nausea and vomiting is also less with regional anesthesia. In regional anesthesia, there is no airway instrumentation and there is low incidence of deep vein thrombosis (Tzovaras, 2006; Yuksek, 2008). In our study we used oxygen supplementation as a routine for all patients to maintain SpO2 above 96% because regional anesthesia carries the possibility of inadequate ventilation due to extensive thoracic nerve block. The main inspiratory muscle, diaphragm, will be unaffected because it is innervated from cervical level, and expiration is normally a passive phenomenon. However, forceful expiration and coughing will be affected because they are generated primarily by the muscles of the anterior abdominal wall which are innervated by the thoracic nerves as explained by Gray's anatomy (Gray et al., 2005). By preloading with fluids, the incidence of perioperative hypotension decreased. To prevent the fall of blood pressure, lowering of the head end of the table for 5-6 minutes immediately after regional anesthesia, a neutral position of the patient after Calot's triangle dissection in cases of laparoscopic cholecystectomy, elevation of the foot end of the table during repair of the ports as well as during the postoperative period were done. This is in agreement with Barczyński et al. (2003). Regional anesthesia for laparoscopic cholecystectomy reduces the surgical stress response. The incidence of hypercarbia producing hypertensive episodes was negligible, as all the patients were operated under low-pressure pneumoperitoneum. The same was reported by Sinha et al. (2008).

Because pneumoperitoneum by CO2 insufflation can stimulate vagal nerve and cause bradycardia, CO2 was insufflated slowly, and the maximum intra-abdominal pressure was 12 mmHg. This is more challenging than the maximum pressure determined by Gebhardt which was 14mmHg. The negative effects of the pneumoperitoneum with CO2 on the respiratory function have been widely investigated. Usually, CO2 is used for safety due to its high water solubility and its high capacity of exchange in the lungs. The concentration of CO2 can be easily monitored by capnography (Gebhardt, 1997). Kar et al reported that perioperative shoulder pain can be managed by reassurance and by diverting the attention of the patient, diminution of elevation of the head end of the table after Calot's dissection, using low-pressure pneumoperitoneum and a clearing out of smoke due to diathermy at the earliest. In our study we did the same and better by using the Harmonic scalpel which is superior to monopolar diathermy. Catena et al proved that the Harmonic scalpel has important clinical advantages, such as: reduced ligature demand; greater precision due to minimal lateral thermal tissue damage; minimal smoke production and absence of electric currents running through the patient (Fausto, 2014; Kar, 2011).

In our study we used a lower inflow rate of carbon dioxide (1-2 L) during the initial phase of inflation to lessen the incidence of shoulder pain, the same was stated by Gautam. Postoperative shoulder pain was avoided by near complete evacuation of pneumoperitoneum and by elevation of the foot end of the table which is in agreement with Kar et al. (Kar, 2011; Gautam, 2009). Agrawal et al reported that no significant difference was noticed in operating time under spinal or general anaesthesia. Instead, the time from application of total anaesthesia to wheeling the patient out of the operating room actually decreases appreciably when the patient is being operated under SA, because the intubation and extubation time of GA is saved. Preoperative shoulder pain never persisted in the postoperative period. In the postoperative period after SA, there was no restlessness as is commonly seen after GA, and the patient is always receptive and more compliant to suggestions. A specific advantage of SA seems to be the decrease in the requirement of postoperative analgesia. Injectable diclofenac was required by 36.56% of SA patients for their abdominal pain as compared to 96% of GA group. The injectable analgesic was required between 2 to 6 hours after surgery in SA while within 2 hours after extubation in GA patients. In our study only two patients (6.7%) required opioid injection after 6 hours (Agrawal, 2012).

Conclusion

Laparoscopic procedures under regional anesthesia with low-pressure pneumoperitoneum are safe and feasible. Low-pressure pneumoperitoneum appears to be effective in decreasing shoulder pain during and after laparoscopic intervention and minimal postoperative pain.

Recommendation

We recommend expanding this study to include more patients and include a comparative group of patients undergoing laparoscopic procedures under GA.

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