A SIMPLE PULMONARY RECRUITMENT MANOEUVRE TO REDUCE SHOULDER TIP PAIN AND POSTOPERATIVE NAUSEA AND VOMITING AFTER GYNAECOLOGICAL LAPAROSCOPIC SURGERY- A RANDOMIZED CONTROLLED STUDY

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ABSTRACT

BACKGROUND

To study the efficacy of pulmonary recruitment manoeuvre for removal of residual abdominal carbon dioxide after laparoscopic surgery to reduce shoulder pain and postoperative nausea and vomiting (PONV).

METHODS

A total of 70 patients undergoing gynaecological laparoscopic surgery were randomly allocated to control and intervention group. In control group, CO_2 was removed by passive deflation of the abdominal cavity through the port site by applying gentle abdominal pressure. In intervention group, patients were placed in Trendelenburg position and CO_2 was removed by means of a pulmonary recruitment manoeuvre consisting of five manual inflations of the lungs with a pressure of 40 cm of water, with the 5th inflation sustained for 5 seconds, with the trocar sleeve fully open. Postoperative shoulder pain (Visual Analogue Scale of 0–10) and PONV (0-3 scale) were observed as primary outcome, requirement of rescue analgesic and antiemetic (up to 48 hours), haemodynamic stability and respiratory function (up to 24 hours) were noted as secondary outcome.

RESULTS

Pain scores (at 0, 8, 12, 24 and 48 hours) and PONV grade (at 0, 4, 8, 12 and 24 hours) significantly reduced in intervention group. Requirement of rescue analgesic and antiemetic also reduced significantly in intervention group. No haemodynamic or respiratory function alteration was noted.

CONCLUSIONS

Application of five manual inflations of the lungs with a pressure of 40 cm of water, with the 5th inflation sustained for 5 seconds, with the trocar sleeve fully open, reduced shoulder pain as well as PONV after gynaecological laparoscopic surgery.

KEYWORDS

Gynaecological Laparoscopic Surgery, Pulmonary Recruitment Manoeuvre, Shoulder Pain, PONV.

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BACKGROUND

Recently, laparoscopic surgeries are gaining popularity over laparotomies. However, these are associated with shoulder tip pain, which may be of moderate to severe intensity with an incidence of 35% to 80%[1] and postoperative nausea and vomiting, with an incidence of 40% to 75%.[2] This shoulder tip pain is likely to be caused because of retention of carbon dioxide which induces phrenic nerve irritation leading to referred pain in C4 dermatome.[3] Although aetiology of PONV is not fully understood, some of the risk factors are carbon dioxide insufflations and bowel manipulation.[4]

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This study has been designed to see the effect of recruitment of a simple pulmonary manoeuvre to reduce shoulder tip pain and postoperative nausea and vomiting following laparoscopic gynaecological procedures.

METHODS

After obtaining approval from the institutional ethical committee, and obtaining informed written consent, 70 patients undergoing elective laparoscopic gynaecological procedures- laparoscopic ovarian cystectomy, laparoscopic myomectomy, total laparoscopic hysterectomy, laparoscopy assisted vaginal hysterectomy, under general anaesthesia between 18-55 years, having ASA (American Society of Anaesthesia) physical status I and II and BMI (Body Mass Index) of 18-25 were included in the study. Patients with difficult airway, patients having any kind of drug allergy, patients with history of gastroesophageal reflux disease, patients with hepatic or renal function impairment, patients with cardiovascular or respiratory diseases, patients having inflammatory or neoplastic collections in the subphrenic space, patients having any kind of subphrenic pathology,

patients having diseases of pleura or diaphragm, patients having diseases of phrenic nerve, were excluded from the study.

Patients were randomly allocated through computer based random allocation (simple randomization), to control or intervention group. This was a prospective, interventional, double blinded study, where the observer as well as the patients were unaware of the group allocation. Only the anaesthetist in the operating theatre was aware of the groups. In the operation theatre, iv access was secured using an 18G intravenous (iv) cannula and iv fluid was started. All standard monitors were attached- SpO_2 (oxygen saturation) probe, NIBP (Non-Invasive Blood Pressure), ECG, capnograph. Midazolam (0.05 mg/kg, iv) was given for anxiolysis and fentanyl (2.0 microgram/kg, iv) was given for pre-emptive analgesia. After preoxygenating for 3 minutes, anaesthesia was induced using propofol (2 mg/kg, iv). Rocuronium (0.9 mg/kg, iv) was used for endotracheal intubation. All patients were put on mechanical ventilation and anaesthesia was maintained using O_2 and N_2O and isoflurane, with repeated boluses of rocuronium according to clinical needs. Vital signs were monitored according to clinical standards. Ventilator settings were set at a tidal volume of 8 ml/kg, respiratory rate of 12/min and an I:E ratio of 1:2.5. Laparoscopy was performed using CO_2 gas. After all the trocars were placed, the flow rate and intra-abdominal pressure were adjusted to sustain a pressure of 12-15 mm Hg. The pressure was monitored throughout the procedure and maintained at this level. The flow of CO_2 did not exceed 2 L/min when creating the capnoperitoneum and throughout the procedure.

At the end of surgery, in the control group CO_2 was removed by passive deflation through the port site by applying gentle abdominal pressure. In the intervention group, the patients were placed in the Trendelenburg position (30 degrees), and a pulmonary recruitment manoeuvre consisting of five manual pulmonary inflations were performed with a pressure of 40 cm H_2O, with the 5^{th} breath sustained for 5 seconds, with the trocar sleeve valve fully open to allow CO_2 gas to escape. The patients were then placed back in the level position, the trocar removed, and the abdominal incisions closed. Infiltration of incision sites was done with 0.25% bupivacaine. Reversal from muscle relaxation was done using neostigmine (0.5 mg/kg, iv) and glycopyrrolate (0.008 mg/kg, iv). After extubation, patients were shifted to recovery room.

Postoperative shoulder pain and PONV were assessed as primary outcome, whereas, requirement of rescue analgesic, rescue antiemetic, and respiratory and hemodynamic factors were observed as secondary outcome. Postoperative shoulder pain was assessed using visual analogue scale (VAS) of 0-10, where 0 indicates no pain and 10 indicates worst possible pain. PONV was assessed using a 3- point PONV grading scale where, 0= no nausea, 1= only nausea, 2= retching/ 1 episode of vomiting, 3= more than 1 episode of vomiting, at 0, 4, 8, 12, 24, 36 and 48 hours postoperatively. Haemodynamic stability (Mean arterial pressure and Pulse rate) and respiratory rate (RR) were also observed at 0, 4, 8, 12 and 24 hours.

Diclofenac (75 mg I.M.) was given as rescue analgesia, if the VAS (visual analogue scale) for shoulder pain was more than 4. Total dose of rescue analgesic required in 48 hours was noted. Rescue antiemetic in the form of ondansetron 4 mg iv was given for grade 2 and 3. Total dose of antiemetics required was noted.

Statistical Analysis

Sample size was calculated assuming p value< 0.05 to be significant and considering effect to be two sided, power of study to be 80% and confidence interval to be 95%, using the formula, $N= ((Z\alpha + Z\beta)^2 X (SD_1^2+ SD_2^2)) / d^2$ where standard deviation, SD_1 (4.8) and SD_2 (2.4) were taken from a similar previous study, and d (difference between the VAS scores) assumed to be 2.5. Statistical analysis was done using the software- IBM SPSS statistics 220.

RESULTS

There was no significant difference between the patient and surgery related parameters between the two groups. (Table-1).

Pain scores (VAS) were significantly reduced in the intervention group compared with control group at 0 (p= 0.027), 8 (p= 0.036), 12(p= 0.006), 24 (p= 0.007) and 48 (p= 0.048) hours, postoperatively. The VAS scores in both the control group, as well as the intervention group, were observed to be highest at 12 to 24 hours, and reduced gradually at 36 and 48 hours. (Table-2)

PONV grade was also significantly reduced in intervention group at 0 (p= 0.004), 4 (p= 0.028), 8 (p= 0.001), 12 (p= 0.001), and 24 (p=0.003) hours. (Table-3) In both the control and the intervention group, number of patients with higher grades of postoperative nausea and vomiting, gradually increased and was maximum at 12-24 hours.

No haemodynamic or respiratory function alteration was noted. (Table-4)

Requirement of rescue analgesic (p= 0.001) and antiemetic (p= 0.001) was also reduced significantly in intervention group. (Table-5)

	Group c	Group i	Test used	P value
Age (years)	37.24±10.75	34.75±11.55	Unpaired t test	0.356
BMI	22.95±1.59	27.94±3.39	Unpaired t test	0.389
ASAPS (1/2)	26/ 8	32/ 4	Chi square test	0.168
TOS- OC	16	22	Chi square test	0.125
LM	1	2	Chi square test	
TLH	6	4	Chi square test	
LAVH	11	8	Chi square test	
LOS(minutes)	95.65±23.65	87.08±23.11	Unpaired t test	0.156
IAP (mmHg)	13.59±1.04	13.67±1.01	Unpaired t test	0.751

Table 1. Patient and Surgery Parameters

BMI- Body Mass Index, ASAPS- American Society of Anaesthesia Physical Status, TOS- Type of surgery, OC- Ovarian Cystectomy, LM- Laparoscopic Myomectomy, TLH-

Total Laparoscopic Hysterectomy, LAVH- Laparoscopy associated vaginal hysterectomy, LOS- Length of Surgery, IAP- Intra-abdominal Pressure.

Group c= Control

Group i= Intervention

Time (hours)	Group c	Group i	Test used	P value
T0	2.62±1.90	1.69±1.50	Unpaired t test	0.027
T4	2.26±1.10	1.86±1.22	Unpaired t test	0.153
T8	3.00±0.98	2.39±1.35	Unpaired t test	0.036
T12	4.71±1.69	3.56±1.66	Unpaired t test	0.006
T24	3.82±1.42	2.92±1.31	Unpaired t test	0.007
T36	2.50±1.28	2.03±1.42	Unpaired t test	0.151
T48	1.94±0.92	1.50±0.91	Unpaired t test	0.048

Table 2. VAS Score

The VAS scores were found to be significantly higher in the control group, compared to the intervention group, at 0, 8, 12, 24, and 48 hours since the p value was < 0.05 at these hours.

The VAS scores, though higher in the control group compared to intervention group, at 4 and 36 hours, but the difference was not significant, since the p value > 0.05.

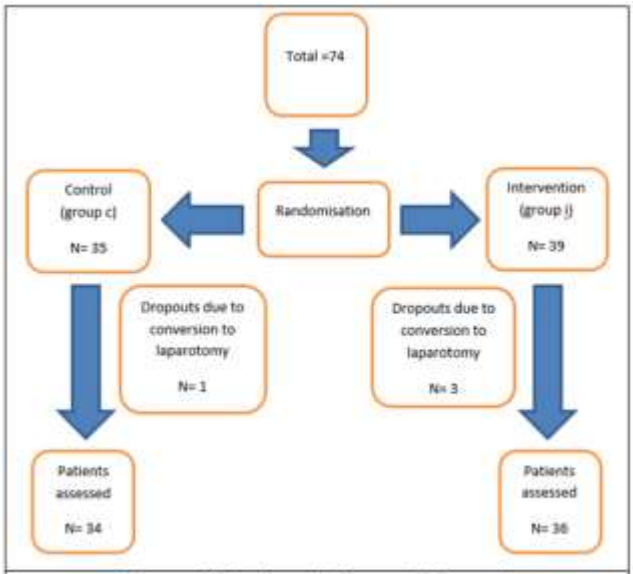

Figure 1. Randomisation and Dropouts

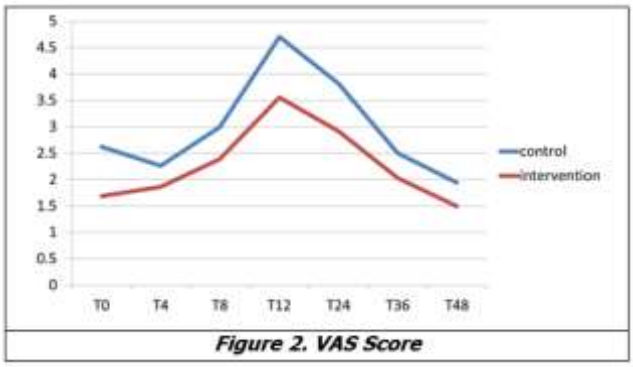

Figure 2. VAS Score

Time (hours)	Group c PONV grade (0/1/2/3)	Group i PONV grade (0/1/2/3)	Test used	P value
T0	15/16/3/0	29/7/0/0	Chi square test	0.004
T4	14/19/0/1	26/9/1/0	Chi square test	0.028
T8	5/27/1/1	24/10/1/1	Chi square test	0.001
T12	3/11/12/8	22/10/2/2	Chi square test	0.001
T24	9/12/8/5	25/7/3/1	Chi square test	0.003
T36	22/12/0/0	28/8/0/0	Chi square test	0.226
T48	29/5/0/0	33/3/0/0	Chi square test	0.402

Table 3. PONV Grade

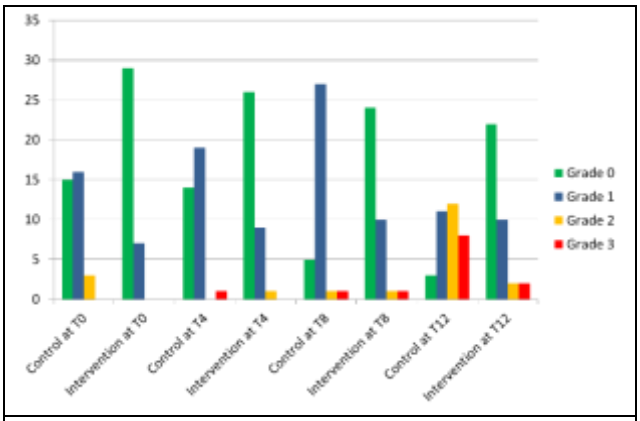

Figure 3. PONV Grade (0-12 hours)

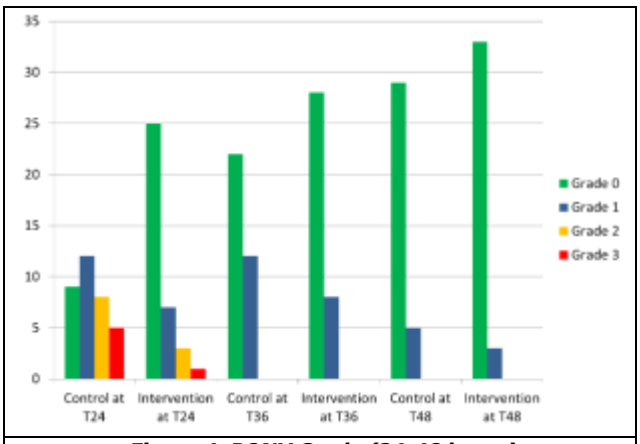

Figure 4. PONV Grade (24-48 hours)

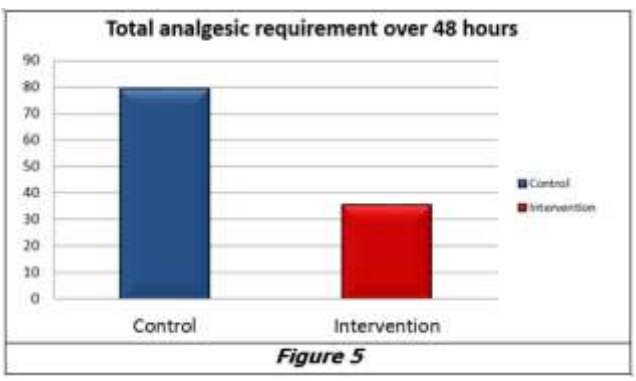

Figure 5

Time (hours)	VAS Score		p Value	PONV Grade (No. of patients 0/1/2/3 grades)		p Value
	Group c	Group i		Group c	Group i	
T0	2.62 ± 1.90	1.69 ± 1.50	0.027	15/16/3/0	29/7/0/0	0.004
T4	2.26 ± 1.10	1.86 ± 1/22	0.153	14/19/0/1	26/9/1/0	0.028
T8	3.00 ± 0.98	2.39 ± 1.35	0.036	5/27/1/1	24/10/1/1	0.001
T12	4.71 ± 1.69	3.56 ± 1.66	0.006	3/11/12/8	22/10/2/2	0.001
T24	3.82 ± 1.42	2.92 ± 1.31	0.007	9/12/8/5	25/7/3/1	0.003
T36	2.50 ± 1.28	2.03 ± 1.42	0.151	22/12/0/0	28/8/0/0	0.226
T48	1.94 ± 0.92	1.50 ± 0.91	0.048	29/5/0/0	33/3/0/0	0.402

Table 4. Mean Arterial Pressure and Respiratory Rate

There was no significant difference in the mean arterial pressure between control and intervention groups, since the p value was >0.05 at 0, 4, 8, 12 and 24 hours.

	Group c	Group i	Test used	p Value
Analgesic (mg)	79.41±58.21	35.42±45.66	Independent t- test	0.001
Antiemetic (mg)	4.47±4.26	1.33±2.53	Independent t- test	0.001

Table 5. Total Dose of Rescue Analgesic and Antiemetic Required in 48 Hours

DISCUSSION

There have been several studies indicating that residual CO_2 is responsible for the shoulder pain after laparoscopic surgeries.[3] Although aetiology of PONV is not fully understood, some of the risk factors are carbon dioxide insufflations and bowel manipulation.[4,5] A study found correlation between the size of the remaining gas bubble and the intensity of pain.[6] Also, another study found that, patients reported less pain when nitrous oxide (N_2O) was used instead of CO_2.[7]

The most important technique to reduce shoulder pain is to allow escape of the CO_2 gas from the abdominal cavity at the end of surgery. A study showed that forced aspiration of residual CO_2 gas by an aspiration cannula after minor gynaecologic laparoscopic surgery significantly reduced the intensity of shoulder pain and analgesic requirements up to 24 hours after surgery.[8] Studies have shown the use of intraperitoneal local anaesthetics like ropivacaine and bupivacaine to be effective in reducing postoperative pain as well as nausea and vomiting.[9] Coating of filshie clips[10] with lignocaine[11] or gel[12] have also shown to be effective. Gas warming[13,14] and Gas drain by catheter[15] have also shown to be effective.

Most of these studies relied on additional drugs or devices, which have not only additional costs but also risks of side-effects or need for follow up, such as removal of a CO_2 drain. The manoeuvre we propose does not need any additional resources and requires minimal time. Positive pressure ventilations performed at the end of surgery inflate the lungs and lower the diaphragm, which is known to increase intraperitoneal pressure. Increasing intraperitoneal pressure causes the elimination of CO_2 gas from the peritoneal cavity at the end of laparoscopic surgery, resulting in less intraabdominal acidosis and its consequent phrenic nerve or peritoneal irritation.

A similar study showed decrease in incidence of shoulder pain using pulmonary recruitment manoeuvre, using an airway pressure of 60 cm of H2O. However, there were more chances of barotrauma at this pressure.[16] We used a pressure of 40 cm of H2O, thereby reducing the chance of barotrauma or pneumothorax.

However, shoulder pain has been reported to last up to 7 days or even 5 weeks in a small number of patients.[17] Since our follow-up period lasted 48 hours postoperatively, we cannot comment on the lasting effects of this manoeuvre.

CONCLUSIONS

Application of five manual inflations of the lungs with a pressure of 40 cm of water, with the 5th inflation sustained for 5 seconds, with the trocar sleeve fully open, reduced shoulder pain as well as PONV after gynaecological laparoscopic surgery. It is easy enough to be implemented in daily clinical practice and might have additional benefits as well, such as reducing atelectasis induced by the laparoscopic technique.

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