SCIENTIFIC PAPER

Prevention of Postlaparoscopic Shoulder Pain by Forced Evacuation of Residual CO_2

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ABSTRACT

Background and Objectives: Shoulder pain is one of the early postlaparoscopic symptoms related to CO_2 used for pneumoperitoneum and remaining in the abdomen. The present study was conducted to validate the hypothesis that complete evacuation of the residual CO_2 would prevent postlaparoscopic shoulder pain.

Methods: Forty consecutive patients, the candidates for gynecologic laparoscopic surgery, were randomly enrolled into one of the following 2 groups. Nineteen patients entered Group I where the residual CO_2 was evacuated by abdominal oppression and served as the study control group. The remaining 21 patients entered Group II, where the residual CO_2 was evacuated by pumping warm saline into the abdomen until it spilled out of the open ports. Nurses, blind to the patient's grouping, recorded shoulder pain VAS scores twice daily.

Results: VAS scores in Group I started to increase at Day 1AM, reached a peak at Day 1PM, and decreased gradually thereafter. VAS scores in Group II stayed low throughout the investigation period. The difference was highly significant ($P<0.001$).

Conclusions: Abdominal filling with saline at the end of laparoscopic surgery effectively evacuates residual CO_2 thus preventing postlaparoscopic shoulder pain.

Key Words: Shoulder pain, Laparoscopy, Complication, Prevention, Saline instillation.

INTRODUCTION

Laparoscopic surgery provides great satisfaction to patients. High-grade visibility guarantees the completeness and safety of the surgery.[1] Limited damage to the abdominal muscular fascia minimizes postsurgical symptoms, and, therefore, increases the speed at which a patient can return to normal activity and minimizes the deterioration in patient's quality of life. Consequently, minimal invasiveness is achieved, which is one of the most important properties of laparoscopic surgery.

The minimal invasiveness of laparoscopic surgery is enjoyed by the vast majority of patients, but not all. Some experience an unpleasant postsurgical symptom, ie, shoulder pain, seemingly specific to laparoscopic surgery. Occasionally, shoulder pain is so severe that patient's quality of life is markedly damaged, though transient. The genesis of shoulder pain is not clearly understood. Although it is generally regarded as a symptom related to CO_2 pneumoperitoneum, shoulder pain may occur in gasless laparoscopy.[2] It has been suggested that shoulder pain is reducible by creating pneumoperitoneum with warm, humid CO_2, not with cold, dry CO_2.[3–7] However, the controversy remains. Several reports[8–11] question the benefits of warm, humid CO_2. What is interesting as to shoulder pain is that drainage after elective laparoscopic cholecystectomy reduces early postlaparoscopic pain, including shoulder pain, and, furthermore, that suction drainage is more effective than passive drainage in reducing pain.[12] This indicates that the residual CO_2 or air in the abdomen is the culprit of postlaparoscopic shoulder pain, and drainage can be an answer to the question of how to reduce or prevent this symptom. However, the story is not that simple. Routine use of drainage is not justifiable, because it increases wound infection rates and delays hospital discharge.[12]

We developed a working hypothesis that complete evacuation of the residual CO_2 could enhance patient satisfaction by reducing unpleasant early postlaparoscopic symptoms. The method, we thought, for forcibly evacuating residual CO_2 is to open all the ports and fill the abdomen with warm saline at the end of laparoscopic surgery. By doing so, CO_2 in the abdomen, being lighter than saline, rises and escapes through the open

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ports. This idea is the result of a literature survey, where it has been suggested that abdominal gas is removable by instillation of 2 to 3 liters of Ringer's lactate and placement of a 5-mm blunt probe in the umbilical incision to purge the abdomen of gas.[13] This is a very attractive idea, but no scientific relevance is provided in the literature. We, therefore, decided to conduct a prospective, randomized, comparative study to validate this working hypothesis.

MATERIALS AND METHODS

Our routine laparoscopic surgery procedures consist of the following:

1. a subumbilical transverse incision (ca. 15-mm) and the first trocar placement (Visiport Plus, Tyco US Surgical, Norwalk, CT);
2. pneumoperitoneum with warm CO_2 at the pressure of 8mm Hg;
3. Trendelenburg position;
4. placement of the second and third 5-mm trocars in the bilateral suprainguinal region;
5. surgical performance;
6. cessation of CO_2 insufflation;
7. opening all the trocars;
8. abdominal pressure by the surgeons' hands to evacuate the residual CO_2;
9. horizontal position;
10. removal of the trocars;
11. closure of the wounds.

A total of 40 consecutive patients, being the candidates for gynecologic laparoscopic surgery at Takanohara Central Hospital, provided informed consent and were randomly enrolled in either one of the following 2 groups. They were not informed of their grouping. Of the 40, 19 patients entered Group I where our routine procedures were adopted as shown above and served as the control group. The remaining 21 patients entered Group II, where step 8 of our routine procedures was replaced by instillation of warm saline into the abdomen through one of the 2 suprainguinal ports until it spilled out of the remaining open trocars. The amount of saline pumped in ranged from 1000 mL to 1500 mL.

After the surgery, shoulder pain was evaluated with the visual analog scale (VAS) twice daily (AM and PM) until Day 3 of the surgery. VAS scores were obtained through patient interviews by nurses who were blinded to the patient's grouping. Blood cell counts and serum CRP levels were measured on Day 1.

The Student *t* test, chi-square test, and discriminant analysis were used for statistical analysis. $P<0.05$ was considered statistically significant.

The Institutional Ethics Committee approved the study.

RESULTS

Table 1 denotes the basic characteristics of the 2 groups. None of the parameters incorporated here was able to differentiate the groups.

Figure 1 demonstrates the time course of mean VAS scores in the 2 groups. Mean VAS scores in Group I increased to 1.05±0.37 (mean±SEM) points on Day 1 AM and reached the highest value of 1.79±0.46 at Day 1 PM. The elevated VAS scores decreased gradually thereafter. In contrast, VAS scores in Group II stayed low throughout the period of investigation. Differences between groups were highly statistically significant ($P<0.001$).

As seen in **Table 2**, the between-group difference became highlighted when the patients were categorized according to the individual VAS scores at Day 1PM. A cut-off value of 3-points was used for categorization. Eight of the 19 Group I patients had documented VAS scores above the cut-off value. One patient had the highest VAS score, 6 points. In addition, there were 5 and 2 patients with VAS scores of 4 and 3 points, respectively. Shoulder pain became worse when the patients were in an upright posi-

Table 1.
Basic Characteristics* of the 2 Groups

	Group I	Group II	P
	(n = 19)	(n = 21)	
Age (years)†	39.0 ± 6.8	39.0 ± 7.3	0.8205
Height (cm)†	159.0 ± 4.6	157.9 ± 6.0	0.4393
Weight (kg)†	54.0 ± 9.0	52.5 ± 8.1	0.5499
Surgery‡			0.8594
Endometriosis	2	2	
Hysterectomy	5	6	
Myomectomy	7	9	
Ovarian cystectomy	5	4	
Operation time (min)†	118.7 ± 44.8	114.3 ± 57.1	0.7870
CRP (Day 1)†	1.25 ± 1.16	1.81 ± 2.78	0.4079

*None of the parameters listed here were able to differentiate the groups. This implies that randomization worked effectively.

†Student *t* test (Welch).

‡Chi-square test.

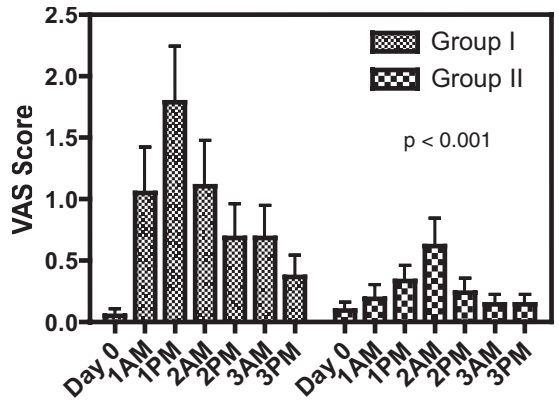

Figure 1. Time courses of mean VAS scores in the 2 groups. VAS scores in Group I started to increase at Day 1AM, reached a peak at Day 1PM, and decreased gradually thereafter. Those in Group II stayed low throughout the investigation period. The means and standard errors of the mean (SEM) are shown. The between-group difference was highly significant by the discriminant analysis ($P<0.001$).

Table 2.
Distribution of the Patients Categorized According to Individual VAS Scores at Day 1 PM*

Group	VAS ≤2 Points	VAS ≥3 Points
I	11	8
II	21	0

*$P = 0.00196$. Eight of the 19 Group I patients documented the VAS scores above the cut-off value. One patient recorded the highest VAS score, 6 points. In addition, 5 and 2 patients had VAS scores of 4 and 3 points, respectively. None of the Group II patients reported VAS scores above the cut-off value.

tion, and, therefore, the majority of those with high VAS scores tended to lie in bed throughout the day. None of the Group II patients reported VAS scores above the cut-off value.

DISCUSSION

Laparoscopic surgery is now widely accepted as a form of minimally invasive surgery and has gradually been replacing conventional laparotomy. However, this does not imply that the surgery is free of unpleasant symptoms. One of the unpleasant postsurgical symptoms is shoulder pain. A considerable number of patients undergoing laparoscopic surgery experiences shoulder pain. Occasionally, shoulder pain is so strong that the patient needs analgesics and is forced to lie in bed for some time, albeit transiently. It is desirable to prevent or diminish this symptom.

The Cochran Database[12] shows that postlaparoscopic shoulder pain is preventable by evacuating the residual CO_2, but the way to prevent it, ie, through drainage, is not justifiable. It has been suggested that the residual CO_2 could be evacuated by instillation of 2 to 3 liters of Ringer's lactate into the abdomen at the end of the surgery and, by doing so, postoperative pain could be markedly diminished.[13] This is a very attractive hypothesis, but its scientific relevance has not been shown. We decided to evaluate and validate this hypothesis.

As seen in **Table 1**, no between-group difference was observed as far as the basic characteristics of the patients were concerned. This implies that randomization worked properly and effectively in the present study, and, therefore, patient bias was negligible. Another important aspect as to the credibility of the study is that VAS scores were assessed and recorded by nurses blinded to the patient's grouping who interviewed the patients on the scheduled occasions. We believe that by using this system highly reliable data were collected.

What we have observed in the study is that the time course of shoulder pain after laparoscopic surgery was strikingly different between the groups ($P<0.001$). When laparoscopic surgery was ended with our previous routine procedures (Group I), shoulder pain VAS scores started to increase at Day 1AM of the surgery, formed a peak at Day 1PM, and decreased gradually thereafter. One of the patients in this group reported a VAS score as high as 6 points at Day 1PM. Because the pain became worse when she was in an upright position, she unwillingly stayed in bed for that whole day and the following day as well. Additionally, there are 5 more patients to be mentioned in this group. They had VAS scores as high as 4 points at Day 1PM and experienced some limitations in their daily activity. In contrast to this, when laparoscopic surgery was ended with abdominal filling with saline (Group II), shoulder pain VAS scores remained low throughout the investigation period. None of the patients in this group reported VAS scores greater than 3 points.

As mentioned earlier, we hypothesized that abdominal filling with saline at the end of laparoscopic surgery might force the residual CO_2 to pass through the open ports and that the forced evacuation of the residual CO_2 might prevent postlaparoscopic shoulder pain. The hypothesis was indeed validated. Furthermore, this seems to have another good feature. Patients receiving abdominal filling voided a considerable amount of urine during the night of surgery. This implies that abdominal saline is transferred rather

quickly through the peritoneum into the general circulation. It is quite likely, if this is the case, that the amount of intravenous infusion can be reduced. Then, the patient can move more freely and easily, without the lines connected. This might enhance patient satisfaction.

We have now applied this abdominal filling to all of the laparoscopy patients as one of the new routine procedures. No patient has reported any negative effects from this procedure.

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