

Low Pneumoperitoneum Pressure Improves Recovery of Transabdominal Preperitoneal Hernioplasty

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ABSTRACT

Objective: To evaluate the recovery influence of CO₂ pneumoperitoneum pressure for transabdominal preperitoneal hernioplasty (TAPP).

Study Design: Experimental study.

Place and Duration of Study: General Department II, Zhongda Hospital, Southeast University, Nanjing, China, from August 2016 to October 2018.

Methodology: Eighty cases were enrolled prospectively and divided into three groups in chronological order. A 14 mmHg CO₂ pressure was used for negative control group while the pressure was controlled at 12 mmHg for observation group and 10 mmHg for intervention group. General information included the patients' age, gender, type of hernia, hernia defect size, dissection of inguinal area, type of patch, time of operation, and frequency of swelling of perineum. Postoperative recovery was compared among the three groups at 24 hours and 1 month after surgery, including pain scores, foreign body sensation, local complications, urinary retention, swelling of the perineum, sex life and mobility.

Results: Seventy-eight patients were included in the final analysis. There were no differences among the three groups in patients' age, gender, type of hernia, hernia defect size, dissection of inguinal area and type of patch. However, the time of operation of intervention group increased ($p=0.015$) and incidence of swelling of perineum decreased than other two groups ($p<0.05$). After 24 hours, there were no significant differences in pain, foreign body sensation, local complications and urinary retention. Perineal swelling remission rate of intervention group was better than other two groups ($p<0.05$). After one month, three groups had no differences in the all terms of pain, foreign body sensation, sexual life and perineal swelling residual rate.

Conclusion: Low pneumoperitoneum pressure can relieve swelling of perineum perioperatively and improve recovery of TAPP.

Key Words: *Pneumoperitoneum, Enhanced recovery after surgery (ERAS), Transabdominal preperitoneal hernioplasty (TAPP).*

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INTRODUCTION

Enhanced recovery after surgery (ERAS) proposed in 2002 has undergone great developments.¹ By innovative perioperative management, it accelerates patient rehabilitation, reduces postoperative complications, shortens hospital stay, and improves patient outcomes.² At present, ERAS researches in colorectal surgery are more mature; and a number of expert consensus and guidelines have been published.³ However, the clinical applications of ERAS in hernia and abdominal wall surgery are limited. It is necessary to reevaluate the traditional treatment measures in transabdominal preperitoneal (TAPP) procedure, such as CO₂ pneumoperitoneum pressure.

Compared to the traditional anterior approach inguinal hernia repair, TAPP only dissects the parietal peritoneum,

and the previous layers of organisational structure of inguinal area stay intact. CO₂ pneumoperitoneum gets into the scrotum and labium majus pudendi through the dissecting hernial sac and causes swelling of the inguinal and perineal areas after surgery. Decreasing pneumoperitoneum pressure can theoretically reduce its swelling or other related complications.⁴

Pneumoperitoneum is an attempt to optimise the perioperative management of TAPP and has important implications for ERAS in hernia and abdominal wall surgery.

The purpose of this study was to evaluate the recovery influence of CO₂ pneumoperitoneum pressure for TAPP.

METHODOLOGY

Cases of TAPP managed from August 2016 to October 2018 were prospectively enrolled in this study. To calculate sample size, 50% of the patients were assumed to benefit from low pneumoperitoneum pressure, based on some recent studies.^{5,6} With an alpha of 0.05 and one-sided deviation of 5% (Upper

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Limit), the sample size was calculated from the PASS software (version 08.0.16). These patients were divided into three groups in chronological order. Considering that one patient may have bilateral inguinal hernias, the number of patients were counted as individual units to avoid the disadvantages of different interventions in the same patient. This study was conducted with the approval of the Ethics Committee of Zhongda Hospital Affiliated to Southeast University, Nanjing, China.

Inclusion criteria were age 14 years or older; no obvious cardiopulmonary complications, able to tolerate general anesthesia; no obvious contraindications to laparoscopic surgery; willingness for TAPP surgery; no surgical history of ipsilateral inguinal region; and willingness to join the study. Exclusion criteria were recurrence; incarceration; other types of hernia, needing to be dealt with at the same time; giant inguinoscrotal or inguinolabial hernia; and coexistent communicating hydrocele or inguinal cysts.

Weight or light 3D polypropylene patch (BARD, Murray Hill, New Jersey, USA) was preoperatively selected by the patients. The negative control group used conventional pneumoperitoneum pressure of 14 mmHg, observation group reduced pneumoperitoneum pressure to 12 mmHg and intervention group finished the operation with the pneumoperitoneum pressure of 10 mmHg. The patients were encouraged to get out of bed as early as possible and standardly no analgesics were used. If the patient's pain was unbearable, oxycodone and acetaminophen tablet was allowed. Dezocine was used for more severe pain.

General information included the patients' age, gender, type of hernia, hernia defect size (represented by the

maximum radius of the inner ring), dissection of inguinal area ($S=0.5ab$, where 'a' stood for the long diameter of dissection; and 'b' for the short diameter of dissection), type of patch, time of operation (calculated from the beginning of dissection to closure of the peritoneum) and the incidence of swelling of perineum (scrotum or labia majora). Intervention outcomes at 24 hours included pain scores, foreign body sensation, local complications (hematoma and seroma), remission rate of perineum (scrotum or labia majora) and urinary retention. Interventions for the first month after surgery included pain scores, foreign body sensation, residual swelling of the perineum (scrotum or labia majora), sex life, and mobility. Pain scores were scored by visual analogue scale (VAS), with 0 being no pain and 10 being the most unbearable. The cumulative use 10 mg of oxycodone and acetaminophen tablets resulted in 3 points increase of pain scores and 10 mg dezocine increased pain scores of 5 points. Mild foreign body sensation represented patients could feel the patch during movement, and severe sensations meant patients could also feel the patch while resting.

Categorical variables were presented as frequency and percentage (n, %) and Chi-square test was used. Continuous variables were presented as mean \pm standard deviation, and one-way analysis of variance/ ANOVA (LSD) was performed. SPSS statistical software (IBM, Inc., version 22.0) was used to process the data. $P<0.05$ indicates that the difference is statistically significant.

RESULTS

Eighty cases were enrolled in this study, of whom 27 patients were in negative control group and observation group, respectively; and 26 individuals were included in

Table I: General information.

General information	Negative control group (n=26) ¹	Observation group (n=27) ²	Intervention group (n=25) ³	p-value
Age	62.73 \pm 11.93	67.52 \pm 8.15	65.96 \pm 10.73	0.238
Gender (%)				0.445
Male	21 (80.8%)	20 (74.1%)	22 (88.0%)	
Female	5 (19.2%)	7 (25.9%)	3 (12.0%)	
Type of hernia ^{1,2,3} (%)				0.559
Indirect hernia	32 (84.2%)	32 (88.9%)	30 (88.2%)	
Direct hernia	6 (15.8%)	4 (11.1%)	3 (8.8%)	
Femoral hernia	0 (0.0%)	0 (0.0%)	1 (3.0%)	
Defect size (cm) ^{1,2,3}	3.09 \pm 1.35	2.89 \pm 1.03	2.87 \pm 1.44	0.710
Dissection area (cm ²) ^{1,2,3}	109.94 \pm 17.48	107.11 \pm 12.82	111.00 \pm 11.80	0.501
Type of patch ^{1,2,3} (%)				0.620
Weight	5 (13.2%)	6 (16.7%)	3 (8.8%)	
Light	33 (86.8%)	30 (83.3%)	31 (91.2%)	
Time of operation (min) ^{1,2,3}	34.82 \pm 7.98	33.58 \pm 6.52	38.71 \pm 8.09	0.015
Incidence of swelling / unswelling of the perineum (%)	19 (73.1%) / 7(26.9%)	17 (63.0%) / 10(37.0%)	10 (40%) / 15(60%)	0.049 ⁴
Scrotum	19 (73.1%)	16 (59.3%)	10 (40%)	
Labia majora	0 (0.0%)	1 (3.7%)	0 (0.0%)	

¹ 12 cases were bilateral hernias and totally 38 TAPP operations were included in the negative control group.

² 9 cases were bilateral hernias and totally 36 TAPP operations were included in the observation group.

³ 9 cases were bilateral hernias and totally 34 TAPP operations were included in the intervention group.

⁴ Intervention group vs negative control group $P=0.017$, intervention group vs observation group.

$p=0.098$, negative control group vs observation group $p=0.430$.

Table II: Intervention outcomes at 24 hours after surgery.

General information	Negative control group (n=26) ¹	Observation group (n=27) ²	Intervention group (n=25) ³	p-value
VAS scores	4.35 ±1.74	4.59 ±1.74	4.12 ±1.54	0.599
Foreign body sensation ^{1,2,3} (%)				
No	34 (89.5%)	29 (80.6%)	30 (88.2%)	0.680
Mild	3 (7.9%)	6 (16.7%)	4 (11.8%)	
Severe	1 (2.6%)	1 (2.8%)	0 (0.0%)	
Complications (%)	7 (26.9%)	5 (18.5%)	6 (23.1%)	0.762
Seroma	4 (15.4%)	3 (11.1%)	3 (11.5%)	0.982
Perineal swelling remission / unremission rate (%)	7 (36.8%) / 12 (63.1%)	6 (35.3%) / 11 (64.7%)	8 (80.0%) / 2 (20%)	0.048 ⁴
scrotum	7 (36.8%)	5 (29.4%)	8 (80.0%)	
labia majora	0 (0.0%)	1 (5.9%)	0 (0.0%)	
Urinary retention / urination well (%)	3 (11.5%) / 23 (88.5%)	2 (7.4%) / 25 (92.5%)	2 (8.0%) / 23 (92.0%)	0.852

¹12 cases were bilateral hernias and totally 38 TAPP operations were included in the negative control group.

²9 cases were bilateral hernias and totally 36 TAPP operations were included in the observation group.

³9 cases were bilateral hernias and totally 34 TAPP operations were included in the intervention group.

⁴The number of cases of perineal swelling is shown in Table 1. Intervention group vs negative control group.

p=0.027, intervention group vs observation group p=0.025, negative control group vs observation group p=0.923.

Table III: Intervention outcomes at first month after surgery.

General information	Negative control group (n=26) ¹	Observation group (n=27) ²	Intervention group (n=25) ³	p-value
VAS scores	0.88 ±0.95	0.81 ±1.04	0.92 ±0.86	0.921
Foreign body sensation ^{1,2,3} (%)				
No	37 (97.4%)	34 (94.4%)	34 (100%)	0.367
Mild	1 (2.6%)	2 (5.6%)	0 (0.0%)	
Sexual life (%)	13 (50.0%)	13 (48.1%)	9 (36.0%)	0.443
Satisfied	11 (42.3%)	12 (44.4%)	9 (36.0%)	
Unsatisfied	2 (7.7%)	1 (3.7%)	0 (0.0%)	

¹12 cases were bilateral hernias and totally 38 TAPP operations were included in the negative control group.

²9 cases were bilateral hernias and totally 36 TAPP operations were included in the observation group.

³9 cases were bilateral hernias and totally 34 TAPP operations were included in the intervention group.

intervention group. One patient was lost to follow-up in negative control group and another patient in intervention group. Twelve cases were bilateral hernias in negative control group, 9 cases were bilateral hernias in observation group, and 9 cases were bilateral hernias in intervention group. Therefore, a total of 38 TAPP operations were included in negative control group, 36 TAPP operations were included in observation group, and 34 TAPP operations were included in intervention group. There was no change in the surgical method for any patient.

There were no significant differences among the three groups in patients' age (p=0.238), gender (p=0.445), type of hernia (p=0.559), hernia defect size (p=0.710), dissection of inguinal area (p=0.501), and type of patch (p=0.620). However, the time of operation of intervention group increased (p=0.015) and incidence of swelling of perineum decreased than the other two groups (p=0.049, Table I). Inter-group analysis showed that intervention group fared better than negative control group (p=0.017). Comparison of other inter-groups did not reach statistical significance (intervention group vs. observation group p=0.098, negative control group vs. observation group p=0.430).

There were no significant differences among the three groups at 24 hours regarding pain (p=0.599), foreign

body sensation (p=0.680), local complications (p=0.762), and urinary retention (p=0.852). Perineal swelling remission rate of the intervention group was better than the other two groups (p=0.048, Table II). After one month, the three groups had no significant difference in all terms of pain (p=0.921), foreign body sensation, sexual life (p=0.443), perineal swelling residual rate and mobility (Table III).

DISCUSSION

Hernia and abdominal wall surgery have made great progress in recent years, especially in the minimally invasive surgical approach. TAPP only dissects the parietal peritoneum of the groin area from the abdominal cavity, preserving the integrity of the anterior wall of the inguinal canal, which reduces the trauma apparently.^{7,8} From the perspective of ERAS, some traditional therapies must be renovated to adapt to the new surgical method.^{9,10} We believe this study can promote the further development of ERAS in hernia and abdominal wall surgery.

In our previous study, groin constriction was conducted to evaluate its practicability.¹¹ During the course of that study, we found that the incidence of swelling in the patients' scrotum or labia majora is as high as 70%. The ultrasonography reveals that the swollen tissue is mainly composed of gas and sound-permeable liquid.

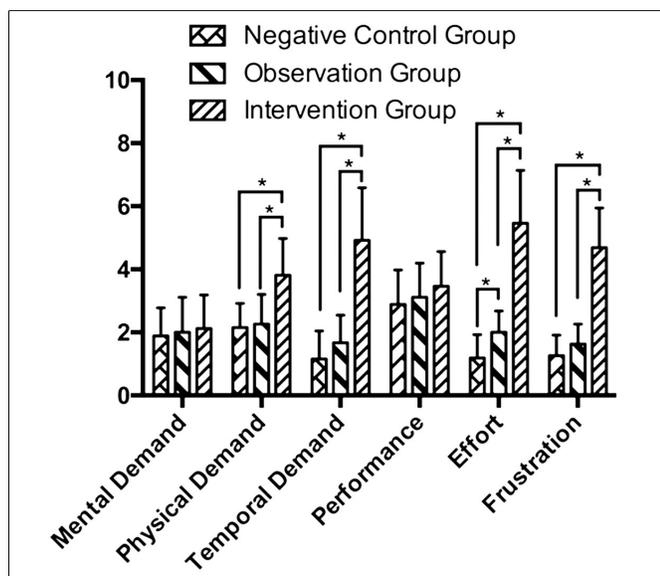


Figure 1: Workload for surgeon. *Representing $p < 0.05$.

Considering the evacuation of the perineum, it may be due to surgical trauma and CO_2 gas of the laparoscopy procedure. Therefore, the pneumoperitoneum pressure is included as an intervention measure to further explore the value of ERAS for TAPP.

The results show that different pneumoperitoneum pressure cannot relieve the pain, improve the foreign body sensation and reduce the incidence of local complications. The tissue absorbs CO_2 quickly; and CO_2 remaining in the groin area during the operation is almost completely absorbed in 24 hours. Therefore, there are no complications due to residual CO_2 in the postoperative observation.¹² For swelling of the scrotum or labia majora, 12 mmHg may be at a relatively high level as 14 mmHg, resulting in non-significant difference in almost all of the terms. However, 10 mmHg pneumoperitoneum pressure shows advantages in relieving swelling of the scrotum or labia majora. The determination of the conclusions of this study still needs to be very cautious to explain the experimental hypothesis. In the future, laparoscopic techniques can be deeply introduced into hernia and abdominoplasty, such as the pneumoperitoneum-free technique, to greatly differentiate the experimental hypothesis of the intervention measures for the further exploration of ERAS after TAPP.¹³

Increasing operating time is contrary to the hypothesis of this study. On the one hand, as the pneumoperitoneum pressure decreases, the abdominal cavity space shrinks. The presence of 10 mmHg cannot fully expand the abdominal cavity, especially in the operation of the anterior abdominal wall in the opposite direction, resulting in difficulty of TAPP.¹⁴ On the other hand, there is a learning curve at 10mmHg pneumoperitoneum pressure.^{15,16} A modified version of the validated

national aeronautics and space administration task load index (NASA-TLX) tool was completed to assess the workload of learning curve on six domains: mental demand, physical demand, temporal demand, performance, effort and frustration with a 10-point visual analogue scale.^{17,18} Larger values indicated more difficulties. The results indicated that intervention group had a heavier workload than the other two groups in the categories of physical demand, temporal demand, effort and frustration ($p < 0.05$). However, there were no differences between negative control group and observation group in all of the categories ($p > 0.05$), except effort (Figure 1). In this study, this may be a bias factor for surgeons and laparoscopic assistants.

Due to the reduction of pneumoperitoneal pressure, the abdominal cavity space is reduced, and the workload on the operator is increased. The operator needs to pay more physical strength, more patience and more effort, that corresponds to the results of increasing of the operation time. According to our experience, this can be improved by changing the positions of the operator, assistant and patients.^{19,20} For example, raising the lower body of the patient can increase the exposure of the groin area. The operator and the assistant stand on the same side to ease the fatigue of the assistant, and changing the tilt angle of the lens increases the laparoscopic field of view.

CONCLUSION

The pressure of 10 mmHg pneumoperitoneum can relieve swelling of scrotum or labia majora peri-operatively and improve recovery of TAPP with an increasing operating time.

ETHICAL APPROVAL:

This study was conducted with the approval of the Ethics Committee of Zhongda Hospital Affiliated to Southeast University, Nanjing, China.

PATIENTS' CONSENT:

Informed consents were obtained from patients to publish the data.

CONFLICT OF INTEREST:

Authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

DW: Wrote this manuscript, collected the clinical data and did the data analysis.

QST, JMW, WYZ, ZLJ: Performed the operations of TAPP. RW: Collected the clinical data.

ZLJ: Performed the operations of TAPP, designed this study, interpreted some data, and revised the manuscript critically for important intellectual content. As the corresponding author, he also gave final approval of the version to be published.

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