

## ORIGINAL RESEARCH

# The change of ventilatory function in patients with CO<sub>2</sub> inflating in peritoneal cavity for abdominal endoscopic anesthesia surgery

## *Le changement de la fonction ventilatoire chez les patients ayant le soufflement de CO<sub>2</sub> dans la cavité péritonéale pour la chirurgie abdominale endoscopique sous l'anesthésie*

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### ABSTRACT

**Objective.** This study aimed to describe the change of PetCO<sub>2</sub>, peak and Vt in patients with abdominal endoscopic anesthesia surgery when CO<sub>2</sub> inflating into peritoneal cavity at Military Central Hospital.

**Methods.** It was a perspective and descriptive study.

**Results.** PetCO<sub>2</sub> increased immediately at the time of CO<sub>2</sub> inflating, highly increased in the first 25 minutes after CO<sub>2</sub> inflating. Average PetCO<sub>2</sub> maximum was increased from 31.06±2.517 to 38.92±2.114 mmHg at T5 by 25.31%. Between 30 minutes after pumping and T120, PetCO<sub>2</sub> was slightly increased and more stable; PetCO<sub>2</sub> slightly was decreased after 5 minutes of CO<sub>2</sub> deflating and come to nearly normal at completed surgery. At the time of totally completed surgery, PetCO<sub>2</sub> was persistent higher than that at the begin; the peak was highly increased at the beginning of CO<sub>2</sub> inflating and reached the highest value during period from T10 to T25. Average peak was maximally increased from 17.24±1.762 to 25.64±3.256 cmH<sub>2</sub>O at T20 or by 48.72%. The peak was persisted highly at T120 and gradually decreased after CO<sub>2</sub> deflating and toward to the peak value before CO<sub>2</sub> inflating. Vt was slightly decreased from the beginning of CO<sub>2</sub> inflating; average Vt was minimally decreased at T30 from 466.21±54.537 to 445.67±51.621 mL or 4.41%; Vt was increased immediately after CO<sub>2</sub> deflating and gradually come to Vt value when the surgery was just completed.

**KEYWORDS:** PetCO<sub>2</sub>, respiratory system, anesthesia, tidal volume.

### RÉSUMÉ

**Introduction.** Cette étude avait pour but de décrire le changement de la PetCO<sub>2</sub>, du pic et de Vt chez les patients avec une anesthésie endoscopique abdominale lorsque le CO<sub>2</sub> est soufflé dans la cavité péritonéale à l'Hôpital Militaire Central 108.

**Méthodes.** Il s'agit d'une étude descriptive et perspective.

**Résultats.** La PetCO<sub>2</sub> a augmenté immédiatement au moment de soufflement à CO<sub>2</sub>, fortement augmenté dans les 25 premières minutes après le soufflement de CO<sub>2</sub>. Le maximum de moyen de PetCO<sub>2</sub> était passé de 31,06 ± 2,517 à 38,92 ± 2,114 mmHg à T5 de 25,31%. Entre 30 minutes après le soufflement et T120, PetCO<sub>2</sub> était légèrement augmenté et plus stable; PetCO<sub>2</sub> a été légèrement diminué après l'échappement du CO<sub>2</sub> à 5 minutes après l'intervention chirurgicale. Au moment de la chirurgie totalement terminée, la PetCO<sub>2</sub> était persistant plus haut que celui du début; le pic a été fortement augmenté au début de soufflement de CO<sub>2</sub> et au plus haut niveau pendant la période allant de T10 à T25. Le pic maximal de moyen a été est passé de 17,24±1,762 à 25,64±3,256 cmH<sub>2</sub>O à T20 et de 48,72%. Le pic a été persisté fortement à T120 et a été diminué progressivement après l'échappement de CO<sub>2</sub> et atteignait de la valeur maximale avant le soufflement de CO<sub>2</sub>. Vt a été légèrement diminué depuis le début des soufflements de CO<sub>2</sub>; Vt minimum de la valeur moyenne a été diminué à T30 de 466,21±54,537 à 445,67±51,621 mL ou à 4,41%; Vt a été augmenté immédiatement après l'échappement de CO<sub>2</sub> et a été progressivement atteignant de la valeur Vt lorsque la chirurgie vient de s'achever.

**MOTS CLÉS:** PetCO<sub>2</sub>, système respiratoire, anesthésie, volume courant.

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## INTRODUCTION

Laparoscopic surgery is considered to be a surgical revolution that has been used in diagnostics and treatment since the late 1980's and has been widely used in a variety of ways. In the field of obstetrics, gastrointestinal diseases, urology, or thoracic problems, etc.

Laparoscopic surgery has advantages over open surgery: less traumatic surgery, short hospital stay, minimally invasive surgery, less postoperative pain, significantly reduced complications of bacterial infection and adhesion after surgery, ensure aesthetics, and recovery time after surgery fastly [1].

Along with the advancement of laparoscopic surgery, anesthesia has many experimental and clinical studies related to laparoscopic surgery that have been conducted to address this issue. The use of CO<sub>2</sub> pumps into the peritoneal cavity and extra-peritoneal cavity to expand the surgical site to make the anesthetists facing to the changes in circulation and respiration due to the pumping effect. The understanding of these mechanisms is essential for application in the selection of the best anesthesia, monitoring, attitudes, and care for patients with endoscopic surgery. The circulatory, respiratory and body temperature disorders are highly dependent on inflatable pressure, inflatable area (intra-peritoneal or extraperitoneal) and pumping time [2].

For respiratory system, inflating the air into the peritoneal cavity or out of the peritoneal cavity can lead to hypercapnia, 30% reduction of lung compliance, increased airway pressure, decreased diaphragm movement, increase of respiratory workload due to increase of intra-abdominal pressure [2]. In addition, CO<sub>2</sub> that is a cold gas when injected into the body over a long period of time can lead to hypothermia. The method of laparoscopic surgery has many advantages, but it causes many disorders for patients so the anesthesia workers must always focus on monitoring, patient care, and coordination in time to ensure the safety for patients [2].

There are some studies on respiratory effects in patients with endoscopic cholecystectomy or ovarian cystoscopy. However, for other endoscopic surgeries, the level of respiratory effects is also great.

From the above situation, we conducted the study on this topic with the aim were to describe the change of PetCO<sub>2</sub> in anesthesia patients with CO<sub>2</sub> inflating into the peritoneal cavity and to describe the peak and Vt changes in laparotomies with CO<sub>2</sub> inflating into the peritoneal cavity in Military Central Hospital 108.

## METHODS

### Study subjects

Patients undergoing laparoscopic surgery with CO<sub>2</sub> inflating into the peritoneal cavity with general anesthetic methods by endotracheal anesthesia such as for endoscopic cholecystectomy, endoscopic appendectomy, endoscopic surgery colonoscopy, endoscopic surgery, cystic ovaries at the Surgery and Anesthesia Department of the Military Central Hospital 108 from April to June 2018.

### Inclusion criteria

Age  $\geq$  18 years.

Patients do not have some diseases such as heart failure, coronary disease, chronic heart valvular disease, chronic lung disease, emphysema, lung bulla, increased intracranial pressure, glaucoma.

ASA: I or II according to the classification of the American Anesthesia Association.

Inflated time  $\leq$  2h.

Patients agree to participate in the study.

### Exclusion criteria

Patients did not agree to participate in the study.

Patients do not have sufficient awareness to answer the survey such as: syncope, mental disease, deaf.

## Methods

### Study design

It was a propective and descriptive study.

### Sample size and sampling methods

All included patients underwent peritoneal laparoscopic surgery with general anesthesia with endotracheal anesthesia method at the Surgery and Anesthesia Department of Military Central Hospital 108.

### Time and place of study

Location: Department of Surgery and Anesthesia of Military Central Hospital 108.

Time: from April to June 2018.

### Information gathering techniques

Sources of information: Medical records collected information on name, age, sex, diagnosis, indications of surgery, surgeon, surgery day, anesthesia method, anesthesiologist.

Observe, asking, examining the patient, and medical history, height, weight, ...were made.

Assessment of respiratory changes (PetCO<sub>2</sub>, peak, Vt, SpO<sub>2</sub>) was based on the monitoring of the indicators on the monitoring machine, the anesthesia machine at the time of the study and recorded on the data collection form.

### Data processing and analysis

The results of present study were processed according to SPSS software 20.0 (Chicago; USA). Data are expressed as mean  $\pm$  SD, percentage (%).

RESEARCH RESULTS

General characteristics of patients and surgery

TABLE 1 General characteristics of the patient			
General features		N	Percentage (%)
Sex	Male	37	43.02
	Female	49	56.98
Age group	18 - 39	32	37.21
	40 - 59	28	32.56
	≥ 60	26	30.23
ASA	I	59	68.60
	II	27	31.40
BMI	Underweight	5	5.81
	Normal	60	69.78
	Pre-obesity	16	18.60
	Obesity Level 1	5	5.81
	Obesity Level 2	0	0
	Obesity Level 3	0	0

TABLE 2 History of the patients		
History	N	Percentage (%)
Healthy	63	73.26
High blood pressure	8	9.30
Diabetes	2	2.33
Gallstone disease	8	9.30
Gynecological infections	5	5.81

PetCO2 fluctuations of patients over time (Table 4)

TABLE 4 PetCO2 change of the patient over time					
Times	PetCO <sub>2</sub> (mmHg)	% compared to initial PetCO <sub>2</sub>	Times	PetCO <sub>2</sub> (mmHg)	% compared to initial PetCO <sub>2</sub>
PT	31.06±2.517	100%	T70	38.14±3.288	+22.79%
BH	34.60±2.503	+11.40%	T80	38.20±2.049	+22.99%
T5	37.09±2.703	+19.41%	T90	38.33±2.082	+23.41%
T10	38.31±2.667	+23.34%	T100	38.00±1.000	+22.34%
T15	38.45±2.340	+23.79%	T110	38.00±1.414	+22.34%
T20	38.92±2.114	+25.31%	T120	38.50±0.707	+23.95%
T25	38.69±2.120	+24.57%	Xa	38.19±2.374	+22.96%
T30	38.17±2.242	+22.89%	P5	36.88±2.437	+18.74%
T35	38.38±3.022	+23.57%	P10	36.00±2.012	+15.90%
T40	38.70±3.535	+24.60%	P15	35.53±1.980	+14.39%
T45	38.50±3.550	+23.95%	P25	35.06±1.830	+12.88%
T50	38.38±3.863	+23.57%	P30	34.67±1.815	+11.62%
T55	38.82±2.639	+24.98%	MX	35.08±1.929	+12.94%
T60	38.67±2.828	+24.50%			

Of the 86 patients studied there were 37 patients were male accounting for 43.02%; 49 patients were female, accounting for 56.98%.

Age group: from 18 to 39 years old, there was 32 patients accounted for 37.21%; from 40 to 59 years old, there was 28 patients accounted for 32.56%; for ≥60 years old with 26 patients accounting for 30.23%.

ASA: there were 59 patients in ASA I accounting for 68.60%, 27 patients in ASA II accounted for 31.40% (Table 1).

BMI: 5 patients with low weight, 5 patients with obesity level 1 accounted for 5.81%; 16 pre-obesity patients accounted for 18.60%; 60 patients in the normal state accounted for 69.78%. Of the 86 patients studied the majority of patients with a healthy history (73.26%), hypertension accounted for 9.30%, gallstones accounted for 9.30% (Table 2). 29 cases of laparoscopic surgical excision of gallbladder accounted for 33.72%, 2 patients of umbilical cord cystoscopy surgery, accounting for 2.32% (Table 3).

TABLE 3 Surgical indications of the patient		
Surgical diagnosis	n	Percentage (%)
Laparoscopic cholecystectomy	29	33,72
Endoscopic appendectomy surgery	20	23,26
Surgical removal of colonoscopy	19	22,09
Ovarian cyst ovarian surgery	10	11,63
Reconstructive surgery of the abdominal wall	6	6,98
Laparoscopic surgical removal of the umbilicus	2	2,32
<b>Total</b>	<b>86</b>	<b>100</b>

PetCO<sub>2</sub> was highest at T20; increased 25.31% in compared to PetCO<sub>2</sub> at operation time.

PetCO<sub>2</sub> increase from the time of inflating until T120, after the deflating, PetCO<sub>2</sub> gradually reduced.

PetCO<sub>2</sub> remained high after the end of surgery, higher than the operation time at 12.94%.

#### Peak and Vt change of patients over time

Peak at peak T20; increased than Peak at the time of operation was 48.72%.

Vt at the time of T30 was lowest decrease, down to 4.41% compared to at the operation time.

Times	Peak (cmH <sub>2</sub> O)	% Compared to initial peak	Times	Peak (cmH <sub>2</sub> O)	% Compared to initial peak
Operation	17.24±1.762	100%	T70	25.43±1.988	+47.51%
Air inflating	22.27±3.104	+29.17%	T80	25.40±2.168	+47.33%
T5	24.15±3.657	+40.08%	T90	25.33±4.041	+46.93%
T10	24.66±3.794	+43.04%	T100	25.47±3.786	+47.74%
T15	25.51±3.180	+47.97%	T110	24.50±0.707	+42.11%
T20	25.64±3.256	+48.72%	T120	23.00±1.414	+33.41%
T25	25.19±3.569	+46.11%	Xa	19.36±2.097	+12.30%
T30	25.02±3.531	+45.13%	P5	18.29±2.119	+6.09%
T35	25.19±3.099	+46.11%	P10	18.02±1.958	+4.52%
T40	24.30±3.586	+40.95%	P15	17.86±1.816	+3.60%
T45	25.05±2.564	+45.30%	P20	18.65±2.120	+8.18%
T50	25.23±2.743	+46.34%	P25	18.12±2.233	+5.10%
T55	25.09±2.663	+45.53%	P30	17.82±2.270	+3.36%
T60	25.33±2.550	+46.93%	MX	17.56±1.799	+1.86%

Times	Vt (ml)	% compared to initial Vt	Times	Vt (ml)	% compared to initial Vt
PT	466.21±54.537	100%	T70	447.00±53.929	-4.12%
BH	451.95±58.624	-3.06%	T80	449.40±56.052	-3.61%
T5	448.28±57.608	-3.85%	T90	450.00±25.981	-3.48%
T10	449.00±56.490	-3.69%	T100	449.67±28.042	-3.55%
T15	449.95±54.286	-3.49%	T110	449.00±41.012	-3.69%
T20	448.77±53.765	-3.74%	T120	448.00±39.598	-3.91%
T25	449.38±54.786	-3.61%	Mx	457.85±54.629	-1.79%
T30	445.67±51.621	-4.41%	P5	459.30±52.503	-1.48%
T35	448.19±50.733	-3.87%	P10	458.27±49.490	-1.70%
T40	445.69±44.968	-4.40%	P15	459.05±49.060	-1.54%
T45	445.70±41.346	-4.40%	P20	459.50±49.685	-1.44%
T50	446.08±48.165	-4.32%	P25	459.33±49.383	-1.48%
T55	447.91±51.957	-3.93%	P30	459.56±49.069	-1.43%
T60	445.70±48.982	-4.40%	MX	465.23±49.065	-0.21%

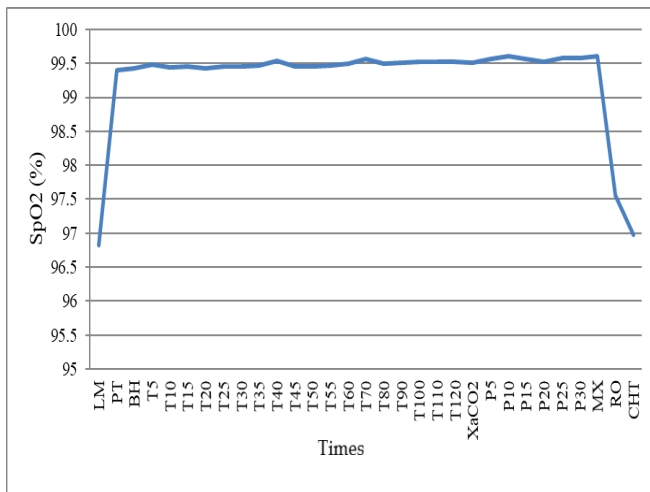


FIGURE 1. The patient's SpO2 changes over time.

## DISCUSSION

### General characteristics of the patients

#### Age, gender of patients

Of the 86 patients studied, the youngest and the oldest were 22 and 73 years, divided into three age groups: 18 to 39 years old (37.21%); 40-59 years old (32.56%);  $\geq 60$  years old (30.23%). Three age groups were fairly uniform rates. Current laparoscopic surgery is performed on many different ages from young to old person. For gender: male was 37/86 patients, accounting for 43.02%; women was 49/86 patients, accounting for 56.98%. The difference in male-female ratio was due to the fact that 10 patients with ovarian cysts were selected for the study.

#### Health status, condition and history of patients before surgery

The patients had study criteria for this study included patients without severe respiratory and cardiovascular diseases. The results obtained with the preoperative status of the patient were as follows: 68.60% of patients with ASA I (59 patients); 31.40% patients with ASA II (27 patients).

The condition of the patients was the normal general condition was 69.78% (60 patients); 5.81% (5 patients) underweight; 18.60% (16 patients) obese; 5.81% (5 patients) was obese with grade 1 and no one with obese of grade 2, 3.

Patient's history of surgery: the majority of patients underwent surgery had the healthy history of 63 patients (73.26%), 8 patients had hypertension (9.30%), 8 patients with gallstones (9.30%), 5 patients with gonorrhea (5.81%), 2 diabetic patients (2.33%). These conditions were mild, stable under treatment and could not affect the results of the present study [4-7].

### Fluctuation of PetCO2 in anesthesia patients undergoing laparoscopic surgery has CO2 inflating into the peritoneal cavity

PetCO2 is the final concentration of exhaled CO2 that is monitored through the respiratory gas analyzer.

PetCO2 monitoring is considered to indirectly measure PaCO2 in arterial blood. Numerous studies showed that the difference between PaCO2 and PetCO2 was  $2.4 \pm 1.5$  mmHg and there was no different between before, during and after air inflating. However, the variability of this change is greater when patients with impaired respiratory function or cardiopulmonary diseases. In this study, we performed the PetCO2 indicator and patients in the ASA I, ASA II class did not have any cardiopulmonary disease.

PetCO2 increased rapidly after inflating, increasing rapidly from 5 minutes after inflation to 25 minutes after that. The average PetCO2 in the study was at the highest level at T5: PetCO2 increased from  $31.06 \pm 2.517$  to  $38.92 \pm 2.114$  mmHg, increased by 25.31%. The period from 30 minutes after inflating to T120 PetCO2 increased less and more stable. This finding is consistent with that of Ton et al. [3]: PetCO2 increased rapidly in the first 10 minutes after inflating from  $28.46 \pm 2.88$  mmHg to  $36.13 \pm 3.1$  mmHg, low and stable after 30 minutes of surgery and adjusting the increase of CO2 by increasing the volume of gas flow or respiratory rate. The absorption of CO2 causes PetCO2 to rapidly increase in the first stage of the absorption by the body in a passive diffusion mechanism, from high pressure to low pressure; The second stage slows down due to increased abdominal pressure, pressure on the blood vessels, and increased blood vessel resistance.

After surgery, PetCO2 remained at a higher level than in PetCO2 at the time before operation. Therefore, monitoring patients in the recovery room is very important to avoid the risk of respiratory failure in patients after surgery in general and patients after surgery in laparoscopic surgery in particular [8-10].

In the present study, the tidal volume (circulating volume: Vt) decreased slightly from the moment after inflating, Mean Vt was decreased lowest at time T30; Vt was decreased from  $466.21 \pm 54,537$  to  $445.67 \pm 51,621$  mL, reduction of 4.41%. After 30 minutes of air inflating, Vt was still lower than the initial Vt and more stable. Immediately after discharge of CO2 inflating, Vt gradually was increased, stabilized and approached to the value of Vt at the time of surgery.

## CONCLUSION

The results of our study showed that, PetCO2 was increased from the time of CO2 inflating, increased sharply in the first 25 minutes after CO2 injection. The highest average mean PetCO2 was increased in T5. From 30 minutes after pumping to T120, PetCO2 was increased less and more stable.

In addition, PetCO<sub>2</sub> was gradually decreased from 5 minutes after CO<sub>2</sub> discharge to the end of surgery. At the time of operation, PetCO<sub>2</sub> was remained at a higher level than the initial CO<sub>2</sub> level. The peak increase from the moment of pumping CO<sub>2</sub> and during the period from T10 to T25. The peak was remained high until T120.

The peak was reduced as soon as CO<sub>2</sub> was released and gradually reached peak value before CO<sub>2</sub> was inflated. Volume of tidal volume (V<sub>t</sub>) was decreased slightly at the time of CO<sub>2</sub> inflating with the average V<sub>t</sub> fell lowest at T30. V<sub>t</sub> was then increased immediately after CO<sub>2</sub> discharge and gradually progresses to V<sub>t</sub> at the time when the surgery was completed.

## CONFLICT OF INTERESTS

The authors declare no conflict of interests for the present study.

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