



Comparison of Arterial Oxygenation Following Head-Down and Head-Up Laparoscopic Surgery

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Received 2017 July 24; Revised 2017 October 14; Accepted 2017 November 19.

Abstract

Background: Regarding the role of gas entry in abdomen and cardiorespiratory effects, the ability of anesthesiologists would be challenged in laparoscopic surgeries. Considering few studies in this area and the relevance of the subject, this study was performed to compare the arterial oxygen alterations before operation in comparison with after surgery between laparoscopic cholecystectomy and ovarian cystectomy.

Methods: In this prospective cohort, 70 consecutive women aged from 20 to 60 years who were candidate for laparoscopic cholecystectomy (n = 35) and ovarian cystectomy (n = 35) with reverse (20 degrees) and direct (30 degrees) Trendelenburg positions, respectively, with ASA class I or II were enrolled. After intubation and before operation, for the first time, the arterial blood gas from radial artery in supine position was obtained for laboratory assessment. Then, the second blood sample was collected from radial artery in supine position and sent to the lab to be assessed with the same device after 30 minutes from surgery termination. The measured variables from arterial blood gas were arterial partial pressure of oxygen (PaO₂) and Oxygen saturation (SpO₂) alterations.

Results: Total PaO₂ was higher in the first measurement. The higher values of PaO₂ in cholecystectomy (upward) than in ovarian cystectomy (downward) were not significant in univariate (P = 0.060) and multivariate analysis (P = 0.654). Furthermore, higher values of SpO₂ in cholecystectomy (upward) than in ovarian cystectomy (downward) were not significant in univariate (P = 0.412) and multivariate analysis (P = 0.984).

Conclusions: In general, based on the results of this study, the values of PaO₂ in cholecystectomy (upward) were not significantly higher than the values in cystectomy (downward) in laparoscopic surgeries when measured 30 minutes after surgery.

Keywords: Respiratory Function, Laparoscopic Surgery, Position

1. Background

In last decade, diagnostic and therapeutic use of laparoscopy increased, due to reduced postoperative pain, better cosmetic issues, faster return to routine life, shorter hospital stay, less medical costs, lower bleeding, less postoperative pulmonary adverse effects, lower rate of postoperative wound infection, less metabolic disorders, and better respiratory function (1-4).

Postoperative pulmonary side effects (atelectasis and so on) are seen in 2 to 19 percent of patients under elective abdominal surgeries (5-8) leading to increased mortality rate and hospital stay (8). Pain, spasm, and some reflexes would result in postoperative pulmonary side effects and a restrictive pattern or even a mix pattern in pulmonary function test (PFT) (3, 9-12). These would re-

solve faster in laparoscopic versus in open surgeries (13-15). These alterations during laparoscopy include decreased lung volume, increased peak pulmonary pressure, and reduced pulmonary compliance secondary to increased intra-abdominal pressure and position (16).

Despite some advances, the true effects of position during laparoscopy on pulmonary complications and oxygenation are not yet clear (1). However, different positions are regarded as a possible acting factor (17, 18). Cholecystectomy and ovarian cystectomy are two main laparoscopic procedures with reverse and direct Trendelenburg positions, respectively. While, some studies demonstrated the effects of positions on pulmonary function (2, 19-21); others did not (4, 22, 23). Pulmonary function tests or arterial blood gas (4, 20, 23) are routine tests for assessment of

lung function; use of SpO₂ is also recommended for simple non-invasive assessment (24). Regarding few studies in this area and the relevance of the issue, this study was performed to compare the preoperative and postoperative arterial oxygen alterations before operation in comparison with after surgery between laparoscopic cholecystectomy and ovarian cystectomy.

2. Methods

In this prospective cohort, 70 consecutive women aged from 20 to 60 years with ASA class of I or II, who were candidate for laparoscopic cholecystectomy (n = 35) in reverse (20 degrees) in Sina referral university hospital and ovarian cystectomy (n = 35) in direct (30 degrees) Trendelenburg positions, in Women referral university hospital, between Feb and Sep 2016, were enrolled. The exclusion criteria were SpO₂ less than 90% with room air; body weight less than 50 kg; BMI over 40 kg/m²; smoking (≥ 5 packed year); opium addiction (any kind of use or abuse); renal failure (creatinine ≥ 2 in preoperative measurements); moderate to severe heart failure (ejection fraction $\leq 45\%$); heart valve disease (\geq mild); lung disease (positive history or susceptible physical exam); pregnancy; breastfeeding; and sleep apnea. The study was approved by the local ethics committee and informed consent forms were obtained from all the patients. Helsinki Declaration was respected all over the study.

For all the patients, standard monitoring of ECG, non-invasive \pm invasive blood pressure monitoring, pulse-oximetry, end-tidal capnography, and airway pressure monitoring were done. IV Line was inserted for all the patients. Pre-oxygenation with mask by 3 - 5 liters per minute of oxygen 100% was performed for five minutes with routine respiration. Pre-medications were intravenous midazolam 0.02 mg/kg and fentanyl 2 mcg/kg. The general anesthesia with intravenous induction was induced by sodium-thiopental 5 mg/kg and atracurium 0.5 mg/kg, bag mask ventilation was used for ventilation. After 2 - 3 minutes when muscle relaxation was initiated according to train-of-four monitoring and when bispectral index (BIS) showed optimal depth, the tracheal intubation was performed, isoflurane 0.5 to 1.2% was prescribed, and initial ventilation was started with tidal volume of 10 ml/kg, respiratory rate of 10 - 15 per minute, and positive end expiratory pressure of 3 - 5 mmHg. The expiratory CO₂ was set at 35 and FiO₂ was 90%. Intra-peritoneal CO₂ was set at 12 mmHg. Surgical incision was finally anesthetized with bupivacaine.

After intubation and before operation (oxygen 90%) for the first time, the arterial blood gas from radial artery

in supine position was obtained for laboratory assessment. Extubation was performed by applying the "Open Lung Concept" (25). After extubation, all patients received 5 liter/minutes oxygen with facemask at post-anesthesia care unit. In patients with SpO₂ less than 93%, the oxygen was administered at a flow rate of 10 liter/minutes via a Venturi up to 30 minutes after surgery. Then, the second blood sample was obtained from radial artery in supine position and sent to the lab to be assessed with the same device after 30 minutes. The measured variables from arterial blood gas were PaO₂, SaO₂, and PaO₂/FiO₂ alterations.

Data analysis was performed on data of 70 subjects including 35 patients in laparoscopic cholecystectomy group and 35 subjects in ovarian cystectomy group. Data analysis was performed by SPSS (version 19.0) software [statistical procedures for social sciences; Chicago, Illinois, USA]. Independent T test, repeated measure ANOVA (univariate) and repeated measure ANOVA (multivariate) were used and considered statistically significant at P values less than 0.05.

3. Results

All participants remained in the study. Participants had statistically similar height, weight, and BMI, (Table 1) but age was different between groups of study (P = 0.000).

Mean (SD) duration of surgery was 152.0 (± 21.37) ranging from 90.0 to 220.0 minutes. The duration of surgery was similar across the groups. Total PaO₂ was higher in the first measurement. In addition, it was higher in cholecystectomy (upward) than in ovarian cystectomy (downward) without any significant difference in repeated measure ANOVA (univariate) by considering the confounding effect preoperative PaO₂ (P = 0.060), and by assessing the combined effects preoperative PaO₂, position, age and duration of surgery in a multivariate analysis model (P = 0.654).

Total SpO₂ was higher in first measurement. Also it was higher in cholecystectomy (upward) compared with ovarian cystectomy (downward) without significant difference in repeated measure ANOVA (univariate) by considering the confounding effect preoperative SpO₂ (P = 0.412) and by assessing the combined effects of preoperative SpO₂, position, age and duration of surgery in a multivariate analysis model (P = 0.984). (Table 2)

4. Discussion

This prospective cohort was performed to compare PaO₂, SpO₂, and PaO₂/FiO₂ before operation and 30 minutes after surgery across the laparoscopic cholecystectomy versus ovarian cystectomy with upward and downward positions, respectively. This study was solely performed among

Table 1. Independent Variables in Groups of the Study

	Cholecystectomy	Ovarian Cystectomy	Total	
	Mean (SD)	Mean (SD)	Mean (SD)	Range
Height (centimeters)	164.31 (7.69)	162.38 (7.88)	163.34 (5.78)	152 - 175
Weight (kg)	69.31 (9.17)	65.94 (10.39)	67.83 (10.37)	50 - 86
BMI (kg.m ⁻²)	27.96 (3.97)	24.39 (4.02)	25.68 (3.27)	19.4 - 31.8
Age (years)	41.45 (8.87)	31.20 (6.36)	44.0 (7.53)	22 - 60

Abbreviation: SD, standard deviation

Table 2. Comparison PaO₂ and SpO₂ Between Groups of Study

	Cholecystectomy Mean (SD)	Ovarian cystectomy Mean (SD)	Total Mean (SD)	P value ^a	P value ^b	P value ^c
PaO₂						
Preoperative	288.94 (65.32)	257.71 (64.54)	273.33 (66.35)	0.048	0.060	0.654
postoperative	257.49 (80.22)	201.05 (65.74)	229.27 (78.16)	0.002		
SpO₂						
Preoperative	99.17 (1.32)	98.56 (1.83)	98.86 (1.61)	0.111	0.412	0.984
postoperative	98.26 (2.11)	97.27 (2.51)	97.76 (2.35)	0.080		

Abbreviations: SD, standard deviation; PaO₂, arterial partial pressure of oxygen; SpO₂, Oxygen saturation

^aComparison of groups of the study based on independent T test

^bInteraction between groups of the study and time (preoperative vs. postoperative) based on repeated measure ANOVA (univariate)

^cInteraction between groups of the study and time (preoperative vs. postoperative) based on repeated measure ANOVA (multivariate) (after adjusting age and duration of operation)

women to eliminate the confounding role of gender. In addition, the confounding roles of age, height, weight, BMI, and duration of surgery were removed by multivariate analysis. Variation in age range in other studies is due to background disease leading to operation. It's seems that we should expect more hypoxemia and shunt development after head down laparoscopic surgeries. But, if we look at literature it is not proved yet (1, 26). Furthermore, considering the lung biomechanical rules it's could be more complicated; in head down position the zone I in the lung tolerates the highest direct compression by upward pushed diaphragm. But, in head up the maximum pressure is transferred to the zone III which is more vulnerable to pressure induced atelectasis.

Total PaO₂ was higher in the first measurement. In addition, it was higher in cholecystectomy (upward) than in ovarian cystectomy (downward) without any significant difference in univariate and multivariate analysis. Sprung et al. reported that PaO₂ was significantly different by body weight and pneumoperitoneum in patients with morbid obesity; however, the effect of position was not significant but with smaller amounts in downward position, which are similar to our results (26).

Total SpO₂ was higher in the first measurement. In addition, it was higher in cholecystectomy (upward) than in ovarian cystectomy (downward) without any significant difference in univariate and multivariate analysis. In general, the position had no effect on PaO₂, SpO₂, and PaO₂/FiO₂ ratio in our study. SaO₂ has been introduced as a good tool for assessment of perioperative lung function in different studies (27, 28). Despite search in Ovid, Pubmed, Pubmed Central, Science Direct, and Elsevier, there were no similar studies in this area to be compared for discussion and usually, PFT, PaO₂, and arterial blood gas analysis are used.

4.1. Limitations

In our study, the confounding role of gender was eliminated. Regarding some neglected variables, assessment of more variables in future studies is suggested. This study could not recognize any significant difference in oxygenation between two different positions in laparoscopic surgery in healthy-ASA I or II- patients, but the minor differences in oxygenation could be important in special groups of patients i.e. overweight individuals, patients with preexisting lung disease or chronic obstructive pulmonary dis-

ease (COPD), weak or old people, or others who are at risk of developing pulmonary complications. Our study has low power to reveal these minor but important differences in these selected groups of patients. It seems that larger sample sizes are necessary to develop more evidence in selected groups of patients.

Acknowledgments

This study was conducted in Tehran University of Medical Sciences. We appreciate staff and personal of operation rooms of women and Sina hospitals of Tehran University of Medical Sciences for their assistance in this study.

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