Effect of Recruitment Maneuvers on Oxygen Saturation, End Tidal Carbon Dioxide and Lung Mechanics in Pressure Control Ventilation Versus Volume Control Ventilation for Patient Undergoing Laparoscopic Sleeve Gastrectomy

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Summary:

Background: Atelectasis occurs regularly after induction of general anesthesia in bariatric surgery, persists postoperatively, and may contribute to significant postoperative morbidity. Intraoperative recruitment maneuver improve lung ventilation, oxygenation and lung mechanics.

Objectives: The aim of this study was to compare the effects of recruitment maneuver on oxygen saturation, end tidal carbon dioxide and lung mechanics in two Groups; the volume control group and pressure control group with fixed level of PEEP.

Patient and Method: Forty patients, BMI >35 kg/ m2, who have no major obstructive or restrictive respiratory disorders where allocated in two groups (volume group and pressure group). In both groups we tested the effect of recruitment maneuver on SpO2, ETCO2 and lung mechanics (The volume group of 20 patients and the pressure group of 20 patients).

Results: We found that alveolar recruitment effectively decreased Intraoperative EtCO2 in pressure group (P.value <0.05) while (P.value was>0.05) for volume group and increase Intraoperative SpO2in BOTH groups (P.value < 0.05) with more effect seen in pressure group. BUT, soon after extubation SpO2 decreases again and P.value was >0.05 for both groups.

Also we found that pulmonary mechanics (PIP, EXPvt) were significantly improved after recruitment (BOTH P.value < 0.05).

Conclusions: our data suggest that the use of alveolar recruitment maneuver may be an effective mode of improving intraoperative oxygenation in morbidly obese patients. Our results showed that the effect is to be short lived and end after extubation. with significant improvement in lung mechanics.

Keywords: recruitment ; oxygen saturation ;ETCO2 ; pressure control; ,volume control; laparoscopy; sleeve.

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Introduction:

Obesity is frequently considered to be a 'modern' disease—a reflection of the excesses of urbanized society. Overweight and obesity were important predictors of decreased longevity, much of which was attributed to cardiovascular disease. (1) Atelectasis develops after the induction of anesthesia, even in healthy subjects, and is associated with an increase in intraoperative shunt leading to impairment of gas exchange (2, 3, 4). These effects are exaggerated in morbidly obese patients (5,6). Arterial oxygenation (SpO2) is decreased during anesthesia to a greater extent in obese compared with normal-weight patients (7), and the impairment of gas exchange is directly related to the increase in body mass index (BMI). Various ventilatory strategies to improve gas exchange during general anesthesia have been proposed in morbidly obese patients (8, 9, 10).

A strategy of reopening atelectatic lung areas present during anesthesia with a "recruitment maneuver" was recommended (11).The ideal patient positioning, use of PEEP, and special modes of ventilation just before emergence and extubation to maintain pulmonary function and gas exchange after extubation have not been identified. Currently, there are no published guidelines to address the issues of maintenance of oxygenation and ventilatory mechanics in obese patients undergoing general anesthesia. (12)

Patient and Method:

We did a cross –sectional study, the study was conducted at Saint Raphael Hospital in Baghdad city between may 2011 and February 2012 and the study included 40 patients, 20 of them in PCV group and the other 20 in the VCV group, to quantify the effect of a lung recruitment maneuver on SpO2, EtCO2, lung mechanics. We recruited ASA class I or II patients, between 18 and 50 years old, with BMI >35 kg/m2. All patients signed an informed consent form to participate in the study. None of the patients had significant preoperative pulmonary disease or cardiac disease.

Mechanical ventilation and monitoring were conducted by Datex-Ohmeda S/5 Aespire Anesthesia Machine and monitor. Patients were selected to receive one of the following ventilatory

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regimens, either in the volume control group (n=20) or in the pressure control group (n=20).Repeated sighs at a regular interval (1-4 sighs every 15 minutes) till the end of the surgery or according to the end tidal CO2 measurement and every sigh last for 5-10 seconds; Provision was pre-established that peak airway pressure at any point during the recruitment maneuver not exceeded 50 cm H2O. After the recruitment maneuvers the PEEP was set at 5-8 cm H2O to keep the recruited alveoli patent in both groups. Data were collected for all parameters every 15 minutes till the end of the surgery.
The patients were discharged to the ward after fulfilling the recovery criteria.

Results:
No significant differences had been found regarding sex in both groups, P.value > 0.05, Table 1.

Table(1)Distribution of cases by groups and sex.(N=40).

Sex		Groups		Total	P.value
		Volume control	Pressure control		
Male	Number	5	4	9	0.5 (ns*)
	%	25%	20%	22.5%	
Female	Number	15	16	31	0.5 (ns)
	%	75%	80%	77.5%	
Total	Number	20	20	40	
	%	100%	100%	100%	

* ns = not significant.
No significant differences had been found either in age or BMI in both groups, P. Value > 0.05 in all comparisons,

Table(2)Descriptive statistics of age and BMI of both groups.

Variable		Groups		Total	P.value
		Volume control	Pressure control		
Age	Mean ± SD*	33.95± 9.4	33.3 ± 9.5	33.6± 9.36	0.82
	Range	20- 50	18 – 50	18 – 50	
BMI	Mean ± SD*	45.5 ± 6	50.1 ± 9.7	47.8 ± 8.3	0.085
	Range	34 – 58	38 - 69	34 - 69	

Table 3 shows the effect of recruitment on the lung mechanics, in volume control group, the mean pre recruitment PIP was (28.37 ± 4.8) cmH2O versus (26.2 ± 5.7) cm H2O for post recruitment and there was a significant difference of (2.17) cm H2O, P < 0.05.
In pressure control group the effect of recruitment was significantly noticed, where the mean pre and post recruitment difference in the EXPVt was (64) ml and the P.vlue were < 0.05.

Table(3) Comparisons of Pre and Post recruitment lung mechanics in both groups

Variable		Mean ± SD		Mean Difference	P.value
		Volume control	Pressure control		
PIP (cmH2O)	Pre Recruitment	28.37±4.8	-	2.17	0.0003
	Post Recruitment	26.2 ± 5.7	-		
EXPVt (ml)	Pre Recruitment	-	659 ± 38.2	64	0.0001
	Post Recruitment	-	725 ± 32.6		

By close view to the table 4 , intraoperatively, recruitment has a clear effect on the mean SpO2 in both groups, mean SpO2 increase significantly with recruitment within each group, from other point of view, by comparing between groups ; Pressure control group had a higher mean SpO2 than volume control group, both pre and post recruitment, in all comparisons P. value < 0.05.
Postoperatively, despite of that the mean SpO2 of pressure control group was higher than that of volume control group, but no significant difference had been found in both groups P > 0.05.
Regarding the ETCO2, also there was a beneficial effect for recruitment on the reduction of ETCO2 in both groups, but the effect had been seen in pressure control group, in which P value < 0.05. Where the P value was> 0.05 in volume control group.

Table(4) Pre and Post recruitment gas exchange comparison in both groups.

Variable		Mean ± SD		Mean Difference	P.value
		Volume control	Pressure control		
SpO2	Pre Recruitment	97.7 ± 0.64	98.7 ± 1.1	1	0.001
	Post Recruitment	98.4 ± 0.92	99.8 ±1.2	1.4	0.00018
	Mean difference	0.7	1.1	0.4	0.0001
	P.value	0.021	0.018	-	-
	Total Intraop (Mean±SD)	98.31 ± 0.73	99.1 ± 0.87	0.56	0.023
	Postoperative	94.14 ± 2.4	95.4 ± 1.7	1.26	0.1
ETCO2	Pre Recruitment	35.4 ± 2.4	33.3 ± 2.12	2.1	0.004
	Post Recruitment	33.8 ± 3.6	30.6 ± 3.8	3.2	0.003
	Mean Difference	1.6	2.7	1.1	0.0022
	P.value	0.1	0.008	-	-

Discussion :

This is the first local study comparing the effects of recruitment maneuver (RM) in two ventilator modes (VCV and PCV) during laparoscopic bariatric surgery.

Regarding the ideal ventilatory mode in laparoscopic bariatric surgery, there are no clear guidelines on the use of VCV or PCV in morbidly obese patients. There are only personal preferences guiding the choice between VCV and PCV, or the choice is based on institutional tradition and experience with ventilation in critically ill patients.

The selection of the optimal ventilation mode or the optimal control variable of ventilation for the obese patient is of interest to most of the anesthesiologists.

According to Campbell and colleagues in 1996 VCV and PCV are not different ventilatory modes, but are different control variables within a mode. During VCV, airway pressure increases in response to reduced compliance, increased resistance and may increase the risk of ventilator-induced lung injury. During PCV, the inspiratory flow and flow waveform are determined by the ventilator as it attempts to maintain an inspiratory pressure profile. The clinician should titrate the inspiratory pressure to the measured tidal volume. (13)

P. Cadi et al in 2008 found that Pressure-controlled ventilation improves oxygenation during laparoscopic obesity surgery compared with volume-controlled ventilation; the changes in oxygenation can only be explained by an improvement in the lungs ventilation/perfusion ratio. The decelerating inspiratory flow used in PCV generates higher instantaneous flow peaks and may allow a better alveolar recruitment.(14)

An RM has been proposed as valuable during pneumoperitoneum in obese patients.

Hesham F. Talab et al 2009 show that Intraoperative alveolar recruitment followed by PEEP 10 cm H2O is effective at preventing lung atelectasis and is associated with better oxygenation, shorter PACU stay, and fewer pulmonary complications in the postoperative period in obese patients undergoing laparoscopic bariatric surgery which support our finding.(15)

Whalen FX et al at 2006 said that the use of alveolar recruitment may be an effective mode of improving Intraoperative oxygenation in morbidly obese patients. The results showed the effect of RM to be short lived discontinued after tracheal extubation and associated with more frequent Intraoperative use of vasopressors which exactly support our findings.(16)

Many previous studies have investigated postoperative hypoxemia in the PACU.

Mathes et al in 2001 found that, on arrival to the PACU, 20% of patients may have an oxygen saturation <92% and in 10% the saturation may be <90%.(17)

Finaly we can conclude that The RM with PEEP was effective in providing good oxygenation and gas exchange in both groups with more effect seen in PCV than VCV due to the decelerating inspiratory flow used in PCV generates higher instantaneous flow peaks and may allow a better alveolar recruitment.

We recommend the use of PCV with PEEP as a mode of ventilation with use of recruitment maneuver to improve oxygenation in morbid obese patient. And since recruitment effects lost after extubation, we recommend the use of CPAP in the PACU to improve oxygenation.

Although the efficacy of CPAP need to be investigated with more studies.

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