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Comparative study between intra-operative ventilatory techniques to prevent postoperative pulmonary complications in obese patients undergoing laparoscopic surgery

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DoaaMosaad Ahmed Awad Allah

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List of Abbreviations

ABG	:	Arterial blood gases
ARDS	:	Acute respiratory distress syndrome
ARMs	:	Alveolar recruitment maneuvers
BMI	:	Body mass index
CO	:	Cardiac output
CPAP	:	Continuous positive airway pressure
CT	:	Computerized tomography
$EtCo_2$	:	End tidal carbondioxide
FEV_1	:	Forced expiratory volume in one second
FRC	:	Functional residual capacity
FVC	:	Forced vital capacity
GFR	:	Glomerular filteration rate
HR	:	Heart rate
IBW	:	Ideal body weight
ICU	:	Intensive care unit
IM	:	Intramuscular
LV	:	Left ventricle
MAP	:	Mean arterial pressure
MRI	:	Magnetic resonant imaging
MV	:	Minute ventilation
OHS	:	Obesity hypoventilation syndrome
OSA	:	Obstructive sleep apnea
$P(A\text{-}a)O_2$	:	Alveolar-arterial oxygen gradient
$PaCo_2$	:	Arterial partial pressure of carbon dioxide
PACU	:	Postanesthesia care unit
PaO_2	:	Arterial partial pressure of oxygen
PCA	:	Patient controlled analgesia
PCV	:	Pressure controlled ventilation
PEEP	:	Positive end expiratory pressure

List of Abbreviations (Cont.)

PEEPi	:	Intrinsic positive end expiratory pressure
RM	:	Recruitment maneuver
SC	:	Subcutaneous
SD	:	Standard deviation
TBW	:	Total body weight
TED	:	Thromboembolic device
TOF	:	Train of four
VCV	:	Volume controlled ventilation
Vd	:	Volume of distribution
Vt	:	Tidal volume
VTE	:	Vascular thrombo embolism

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Comparative study between intra-operative ventilatory techniques to prevent postoperative pulmonary complications in obese patients undergoing laparoscopic surgery

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Background: Managing ventilation and oxygenation during laparoscopic procedures in morbidly obese patients undergoing surgery represents many challenges. There is no specific guideline on the ventilation modes for this group of patients. Although several studies have been performed to determine the optimal ventilatory settings for those patients, the answer is yet to be found. The aim of this study was to determine which mode of ventilation is more effective in improvement of intraoperative oxygenation and prevention of postoperative pulmonary atelectasis with its consequences is PEEP 10cmH_2O alone is effective or Recruitment maneuver followed by PEEP 10 cmH_2O has better results.**Aim of the Work:**The study will be performed to compare different intra-operative ventilatory techniques that prevent early postoperative pulmonary complicationsespescially atelectasis in obese patients undergoing laparoscopic surgery.**Patients and Methods:**Thisprospective, interventional, therapeutic, randomized clinical studywas conducted at Ain Shams University Hospitals, operating theatre department on 100 morbidly obese adult patients of ASA physical status II, admitted to Ain Shams university hospital, scheduled for elective laparoscopic surgery either bariatric or non bariatric. The study was carried out after approval of the departmental ethical committee.The patients were subdivided into 4 groups A, B, C and D, (25) patients for each group. **Results:** Regarding the value of PO2/ Fi O2, there is no statistically significant difference between all groups in the preoperative and intra operative values. But there is statistically significant increase in group D and group C respectively compared to group A and B in both post operative and 6 hours post operative values. Regarding CT chest,Group A showed the highest number of both lobar and segmental atelectasis followed by group B which showed also a high number of segmental atelectasis. In despite, group C showed a higher number of plate and lamellar atelectasis followed by group D that showed a high number of lamellar atelectasis but the lowest number of other atelectasis scores. **Conclusion:** In conclusion, repeated Recruitment Maneuvers combined with 10 cmH2O of PEEP have beneficial effects on oxygenation continued into the early recovery period and decrease pulmonary complications in the early post operative period in morbid obese patients undergoing laparoscopic surgery. **Recommendations:** Further studies on a larger scale of patients are needed to confirm the results obtained by this work.

Key words: intraoperative ventilatory, pulmonary, obese, laparoscopic surgery

Introduction

The number of obese patients undergoing surgery is increasing, the pathophysiological changes induced by obesity make these patients prone to peri-operative complications espescially pulmonary complications which are the main cause of overall peri-operative morbidity and mortality following general anesthesia. Pulmonary complications include atelectasis, carbon dioxide retention and pneumonia, these complications may extend to the postoperative period leading to delay discharge from post anesthesia care unit, increase the need for respiratory physiotherapy or non- invasive ventilation and also increase the probability of intensive care unit admission.Prevention of these complications would improve the quality of medical care, decrease hospital stay and costs ***(Tianzhu et al., 2014).***

Reduction in peri-operative morbidity is the major advantage of laparoscopic surgery, as it preserves pulmonary function when compared to open surgery, laparoscopic surgery also decreases cardiac and wound complications and reduces organ- system impairment, the hypermetabolic stress response of surgery that lead to increase myocardial O2 demand, energy expenditure, pulmonary work load and renal work load, is also attenuated in laparoscopic surgery as the magnitude of this stress response is directly related to the magnitude of tissue injury ***(Philip and Sayeed, 2001)***.

Obese patients are more prone to develop pulmonary atelectasis due to decreased chest wall and lung compliance, and decreased functional residual capacity with impairment of pulmonary gas exchange and subsequent hypoxia, These changes often occur after induction of general anesthesia and may persist for 24 hours (hr) post operatively, the degree of hypoxemia is directly related to Body Mass Index (BMI) (***Khalid and Mohamed, 2011).***

Different strategies have been investigated to re-expand collapsed lung during general anesthesia to optimize oxygenation and to improve respiratory mechanics. The positive end expiratory pressure PEEP has been shown to counterbalance the diaphragm cranial shift increasing functional residual capacity and decreasing respiratory system elastance***(Gilda et al., 2013).***

The other strategy is recruitment maneuver which is performed by the anesthetistby inflating the patient’s lungs to an airway pressure of 40 cmH2o, this increased air way pressure must be maintained for duration of 7-8 seconds, this maneuver is used to increase the patient’s lung volumes and restore their pulmonary function to a pre- anesthetic state***(Deborah et al., 2013).***

In laparoscopic surgery, the recruitment maneuver should be done after pneumoperitoneum as its effect may be lost it is done before pneumoperitoneum, which necessitates a further recruitment maneuver to keep the alveoli opened***(Talab et al., 2009)***.

Aim of the Work

The study was be performed to compare different intra-operative ventilatory techniques that prevent early postoperative pulmonary comlpicationsespescially atelectasis in obese patients undergoing laparoscopic surgery.

Obesity and Co- existing diseases

Obesity is a metabolic disease in which adipose tissue represents a proportion of body tissue greater than normal (more than 30% of body weight).

Inclinical practice, several methods are used to assess excess body weight :

1) Height/weight tables
2) Calculation of the ratio between actual and ideal weight, for calculation of ideal weight in kg, one can substract (100) for men and (105) for women from the patient's height in cm
3) Calculation of body mass index (BMI), itis simply calculated as weight/ height (kg/m2)***(Adams and Murphy, 2000).***

Table(1): World Health Organization classification of obesity

Body mass index; kg.m^2	Classification
< 18.5	Underweight
18.5 – 24.9	Normal
25.0–29.9	Overweight
30.0–34.9	Obese 1
35.0–39.9	Obese 2
> 40.0	Obese 3 (previously ‘morbid obesity’)

(Nightingale et al., 2015).

Morbidity and mortality increase sharply when BMI is >30 kg m^{-2}, particularly in smokers, and risk is proportional to duration of obesity. For a given BMI, men are at higher risk of cardiovascular complications than women. Obesity is described classically as an android or gynaecoid fat distribution (apples and pears). The gynaecoid fat distribution involves more fat distributed in peripheral sites (arms, legs, and buttocks). An android fat distribution involves more central fat (intraperitoneal fat, including involvement of the liver and omentum) ***(Nightingale et al., 2015).***

Causes of obesity

The causes of obesity are multifactorial and include genetic and environmental components. The regulation of appetite and satiety is a complex process under the control of multiple hormonal and neurological mechanisms integrated and centrally processed in the hypothalamus. leptin which is produced by adipocytes and stimulate satiety is found with high plasma concentrations in obese patients, but frequently have leptin insensitivity. Adiponectin has a similar signalling role to leptin, but concentrations are not increased in obesity. Both leptin and adiponectin regulate long-term changes in appetite, whereas short-term effects are signalled by insulin acting on the hypothalamus***(Sharmeen and Mark, 2008).***

Satiety is also signalled by a further group of peptides, including ghrelin which is released by the wall of the stomach when stretched by eating,suppresses ghrelin production and reduceshunger. The energy balance and appetite reflexes are mediated via the autonomic nervous system***(Sharmeen and Mark, 2008).***

Co-existing diseases

Obesity is associated with hypertension, dyslipi-daemia, ischaemic heart disease, diabetes mellitus, osteoarthritis, liver diseaseand Respiratory disorders. BMI alone is a poor predictor of comorbidity, surgical, or anaesthetic difficulty where fat distribution is more useful; waist or collar circumference are more predictive of cardiorespiratory comorbidity than BMI. An android distribution makes intra-abdominal surgery more difficult and is associated with increased fat deposition around the neck and airway and is associated with more cardiovascular complications. The risk of co-existing diseases increase with the duration of obesity, but it may be masked by sedentary lifestyle and only discovered in the peri-operative period ***(Masmiquel et al., 2016).***

1) <u>Obesity and Respiratory system</u>

Effects of obesity on respiratory mechanics

Obesity is associated with increased work of breathing as a consequence of increased airways resistance and reduced respiratory system compliance.Lung volume falls as a result of the increased abdominal volume and visceral fat. Respiratory system compliance in the obese can be reduced by up to 35% due to:

(I) The restrictive effect of mass loading on the chest wall.
(II) A tendency to breathe at low lung volumes.
(III) The effect of fat distribution that contributes to high pleural pressures and leads to low end-expiratory

volumes with expiratory flow limitation when supine ***(Luke et al., 2015)***.

The decrease in overall compliance, however, is principally driven by a decrease in lung compliance, in turn, being the result of an increased pulmonary blood volume. Breathing at low volumes increases airway resistance with expiratory flow limitation and gas trapping due to early airway closure and subsequent generation of intrinsic positive end-expiratory pressure (PEEPi) and ventilation-perfusion mismatching, especially when supine and asleep. hense increase work of breathing ***(Luke et al., 2015).***

These physiological changes are heightened during sleep in the supine position due to the negative impact on the pulmonary mechanics of diaphragm impedance by the abdomen with a change in lung volume. This impairs the capacity of obese patients to tolerate apneic episodes with early onset oxygen desaturation. All these changes in pulmonary mechanics result in the obese patient having a lower functional residual capacity (FRC) and expiratory reserve volume (ERV) compared with normal weight subjects with forced vital capacity (FVC), forced expired volume in one second (FEV_1) and forced mid-expiratory flow reduced in the morbidly obese ***(Luke et al., 2015).***

Airway function:

Despite an association with increased BMI, airway function as measured by spirometry is little affected by obesity except in morbidly obese individuals. However, the use of spirometry to evaluate lung function in morbidly obese