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Fiberoptic Evaluation of Oro-tracheal Distal End Migration during Video-Laparoscopic Bariatric Surgery

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Abstract

Background: After intubation, tracheal tube position requires special precaution especially during patients positioning, as migration of orotracheal tube may result in endobroncheal intubation. This problem increases in video assisted laparoscopic bariatric surgery. Although following guidelines for optimal confirmation of ETT position appears simple to practice, at certain circumstances it becomes confusing. Meanwhile fiber-optic bronchoscopy represents a proper method for confirmation of endobroncheal tip position. The primary goal of this study was to detect and measure the changes in the position of distal end of endotracheal tube after abdominal gas insufflation during laparoscopic bariatric surgery. The secondary goal is to find a warning sign that may help in prediction of tubal end migration.

Methods: 70 patients were included in this study. Basic monitoring with pulse oximetry, noninvasive blood pressure, capnography and ECG were attached to the patients. The adequate position of endotracheal tube was confirmed first by direct visualization of the cuff of the tube to pass below vocal cords with the guide mark at the level of the vocal cords, capnography, and auscultation. After that, a fiberoptic bronchoscopy was performed, with a flexible pediatric bronchoscope. The distance from the tip of the endotracheal tube to the tracheal carina was measured after insertion of endotracheal tube and after creation of pneumoperitoneum and after repositioning also the incidence of endobroncheal intubation was recorded.

Results: The distance from the tip of the endotracheal tube to the tracheal carina was shorter after creation of pneumo-peritonium and after repositioning when compared to basal value. Endotracheal intubation incidence was also higher after creation of pneumo-peritonium and after repositioning. Both peak and plateau pressures after creation of pneumo-peritonium were significantly higher when compared to the basal values.

Conclusions: In obese patients undergoing gastroplasty, insufflation of the pneumoperitoneum in videolaparoscopic procedures reduces the distance between ETT tip and the carina with higher incidence of endobroncheal intubation. Rising of peak and plateau pressures above 30% and of basal value may be an indicative of endobroncheal intubation.

Keywords: Fiberoptic; Orotracheal; Videolaparoscopic; Bariatric surgery

Introduction

Proper positioning of Tracheal tube tip requires special consideration as migration of the orotracheal tube tip beyond the carina is usually detected in certain types of surgeries including laparoscopic and neurosurgery. Another co factors my help in increasing tubal migration as frequent surgical manipulation, certain surgical positions and obesity. This condition, of endobroncheal intubation can result in lung collapse with subsequent hypoxemia, hypercapnia, pneumothorax, shock or trauma. Conversely too shallow insertion may damage the vocal cords or become dislodged [1-3].

The standard method to confirm the tube position is chest five-point auscultation together with fixation of the tube between 20 and 23 cm at the corner of the mouth, or between 21 cm and 23 cm, at the upper incisor teeth as suggested by Dronen et al. and Owen et al., respectively [4-6]. Following these guidelines for optimal insertion of an ETT is time consuming, confusing with some possibility of endobroncheal intubation or undesired tracheal malpositioning [7]. Also endobroncheal tube migration during video assisted laparoscopic bariatric surgery following abdominal insufflation is commonly observed and needs to occasionally repositioning [8].

To overcome these problems, fiber-optic bronchoscopy represents rapid, safe, reliable and cost-effective diagnostic method for confirmation of endotracheal tip position by direct visualization of carina which can detect an incorrect positioning of the tube [9,10]. Previous studies have detected tubal end migration after creation of pneumoperitonium, but most of them could not detect any endobroncheal intubation, change in tube position after repositioning of patients and finding a reliable indicator for endobroncheal intubation.

We hypothise that creation of pneumopretonium in obese patients is highly associated with endobroncheal tube migration and malpositioning. The primary goal of this study was to detect endobroncheal intubation and measure the change in the position of

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distal end of endotracheal tube after abdominal gas insufflation during video assisted laparoscopic bariatric surgery. The secondary goal is to find an early reliable sign for diagnosis of tubal end migration that required repositioning.

Patients and Methods

This study was conducted in bariatric surgery unit, Mansoura University Hospital after obtaining the institutional board review approval and an informed consent from all patients. Any adult patient (more than 18 years old) of either sex, ASA physical status I and II, body mass index more than 35 and planned for video assisted laparoscopic gastroplasty between September 2016 and December 2018 was included in the study.

Patients were excluded if there was any disagreement, cardiac, hepatic or renal diseases, pregnant or lactating females or any pulmonary abnormality. On arrival to operative theater, 18-G venous cannula was placed in non-dominant hand and standard monitoring (peripheral oxygen saturation, non-invasive blood pressure, and ECG) was initiated.

After positioning in supine position, all patients were pre-oxygenated for 3 minutes during which a bolus of fentanyl 2 $\mu g.kg^{-1}$ was administered followed by propofol 2 $mg.kg^{-1}$ and mask ventilation of 100% oxygen and 5% sevoflurane. Rocuronium 1 $mg.kg^{-1}$ (according to lean body weight) was given to obtain complete muscle relaxation and facilitation of endotracheal intubation. After intubation using C-MAC video-laryngescopy with or without boogie, adequate position of endotracheal tube was confirmed first by direct visualization of the cuff of the tube passing below vocal cords with the guide mark at the level of the vocal cords, capnography, and 5 points auscultation and if the breath sounds decreased on one side, the tube was readjusted.

Pneumo-peritonium was created and patient's lungs were ventilated with positive pressure ventilation mode and anesthesia was maintained with sevoflurane, fentanyl and additional rocuronium was given incrementally as required guided by TOF readings. After that, a lubricated fiber-optic bronchoscop, size 3.6 mm (Karl Storz, Germany) was used to check distal tube end position. Proper position of the tube is confirmed by visualization of tracheal carina with the tip of the tube lying above it.

After creation of pneumo-peritonium, patients were repositioned in anti-trendlenburge position in order to facilitate the surgical approach. In order to measure the distance between the tip of the endotracheal tube and carina, the fiberoptic bronchoscope tip is advanced until it reaches the carina.

The fiberoptic shaft is marked at that position. Then, the bronchoscope was pulled until the distal tip of orotracheal tube was visualized, a second mark was put on the shaft of the fiberoptic bronchoscope and the distance between the two marks was measured. This distance was measured after insertion of endotracheal tube, after creation of pneumo-peritoneum and after repositioning. The incidence of endobroncheal intubation was recorded. Both peak and plateau pressured were measured before, after creation of pneumo-peritoneum and after repositioning.

Sample size calculation

The sample size was estimated to be of at least 61 patients, the number required for an alpha error of 5%, according to an earlier study that found the migration distance of the tube was 1.4 ± 0.5 cm after insufflation of pneumo-peritoneum. We increased the sample to 70 cases to compensate for possible dropouts. Calculations were made using PS software for Windows version 10.

Statistical analysis

Statistical analyses was performed using IPM SPSS for Windows (Chicago, USA), version 18. Data was tested for normality by Klomogorov-Smirnov test. Data was analyzed using chi-square test for qualitative data, one sample t-test and independent sample t-test for quantitative data. Subsequently, the Statistical significance was considered at $p<0.05$.

Results

Data were collected from 70 patients who all had completed the study. There was no significant differences between both groups as regard age, gender, height, weight and body mass index (Table 1).

Patient characteristics	Study group	P value
Age (year)	45.06 ± 0.85	0.645
Gender M/F	31/39	0.47
Height (cm)	164.31 ± 1.02	0.378
Weight (kg)	114.63 ± 1.15	0.272
BMI	37.56 ± 1.09	0.541

Table 1: Patient characteristics of the overall study population. Data are presented as mean ± SD, number and %.

The distance from the tip of the endotracheal tube to the tracheal carina was shorter after creation of pneumo-peritonium and after repositioning of the patient (1.84 and 1.95 respectively) when compared to basal values (2.88 cm) (Figure 1).

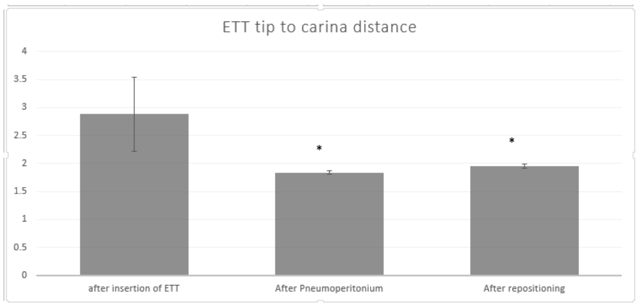

Figure 1: The distance from the tip of the endotracheal tube to the tracheal (cm) carina in the study group. Data are expressed as mean ± SD.

Also, the incidence of endobroncheal intubation was significantly higher after creation of pneumo-peritonium and after repositioning (9 and 8 cases) (Figure 2).

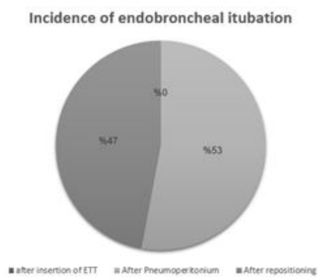

Figure 2: The incidence of endobroncheal migration in the study group. Data are expressed as number and %; *P<0.05 when values are compared endobroncheal and non endobroncheal groups.

When endobroncheal intubation occurs, both peak and plateau pressures readings increased significantly when compared to same readings from cases without endobroncheal intubation (19.38, 12.37) (Figure 3).

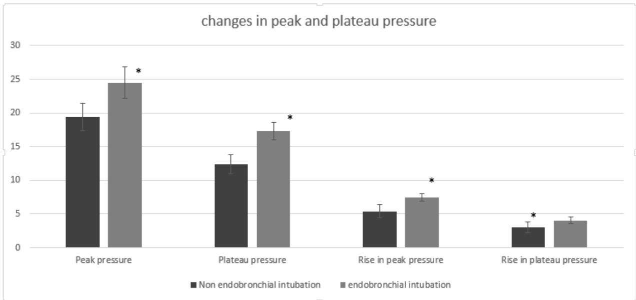

Figure 3: Changes in peak and plateau pressure (cm H_2O in case of endobroncheal intubation. Data are expressed as mean ± SD.

No differences were found in values of peripheral oxygen saturation and end tidal CO_2 in cases with or without endobroncheal intubation (Figures 4 and 5).

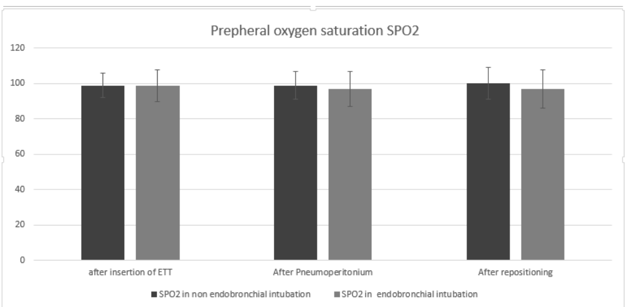

Figure 4: Peripheral oxygen saturation SpO_2 (%) in study cases. Data are expressed as mean ± SD.

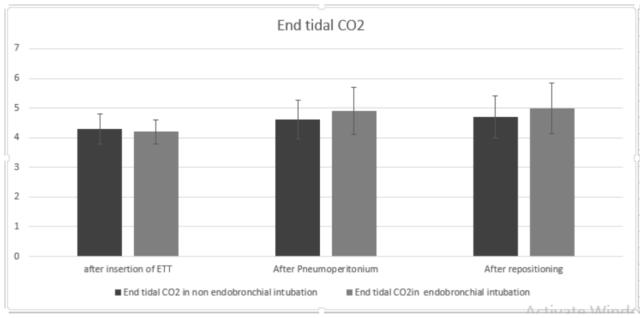

Figure 5: End tidal CO_2 in study cases. Data are expressed as mean ± SD.

Discussion

Obesity represents an important risk factor during anesthesia, since those people already have a reduced functional residual capacity and disturbance of ventilation/perfusion during normal ventilation [11]. In the same way, cephalic migration of the diaphragm during pneumo-peritoneum creation causes upward displacement of the lung and major airways which causes different deleterious effects. Firstly, the functional residual capacity decreased with increased volume of closure of the small airways, that results in more disturbance of ventilation/perfusion and increase of intrapulmonary shunt. Moreover, ventilatory mechanisms are altered in view of the reduction in lung compliance, with consequent increase in airway resistance [12].

Secondly, the tip of the tube will slide downward along the bronchial tree instead of moving upward with the lungs as a result of fixation of the tube to the mouth. Lastly, the tip of the tube can move away from the carina while the head position remain unchanged, resulting in migration of the tube away from the carina causing damage to vocal cords and/or recurrent laryngeal nerve [13].

During ETT, multiple different methods can be followed to ensure proper positioning of the tube end. For example, ensuring the guide mark which lies at 1.5 cm proximal to tube cuff is just placed below the vocal cords. Withdrawing the tube end 15 mm after a fixed length of the tube is passed through the mouth based on a formula or hospital protocols. The distance of 15 mm is based on Cavo's study, which demonstrate that the common part of recurrent laryngeal nerve liable to cuff damage is 6-10 mm below the posterior border of the vocal cords. Lastly, the tube could be inserted intentionally into the main bronchus, then withdrawn about 4 cm, and then fixed. The 4 cm distance ensure that broncheal intubation is effectively prevented as long as the tip of the tube is placed more than 3.4 cm above the carina [14-16].

In the current study, after intubation with the guide mark at the level of the vocal cords, the tube-cranial distance was shorter after creation of the pneumo-peritoneum and repositioning of patient when compared to basal values. Similarly, the incidence of accidental endobroncheal intubation was clinically insignificant after creation of the pneumo-peritoneum and did not change after patient's repositioning in comparison to basal values.

Different studies were conducted to detect changes in ETT position after creation of pneumoperitonium. Similar to our study, Ardypa et al., proved reduction of tube-cranial distance from 20 mm to 5 mm after creation of the pneumo-peritoneum at IAP of 10 mmHg. ETT was placed with the guide mark at the level of the vocal cords. Only four of the 21 patients were at impending risk of bronchial intubation but in our study, higher incidence of endobronchial intubation was detected and this may be related to different insufflation pressures (15 *vs* 10 mmHg) [17]. Also, Heinonejn et al., in his study reported significant tube migration occurred 5 min after insufflation and no further change in tube position with further increase in IAP from 10 mmHg to 20 mmHg. This may indicate that the displacement of the lungs by peritoneal insufflation is maximal within 5 min and with an IAP of 10 mmHg [18].

Another study created by Hwang and his colleagues reported that the tip of ETT come close to the carina after installation of the pneumoperitoneum, with a significant risk of causing endobroncheal intubation [19].

Usually high incidence of endobroncheal intubation is observed in neuro-anaethesia which is essentially related to repeated head manipulation during the surgery itself and prone position. Similarly but with different mechanism, gynecological video-laparoscopic operations are significantly association with endobroncheal intubation resulting from pneumo-peritoneum creation while the patient in trendelenburge position. In these operations, a measurable reduction of 1.6 cm of distance between ETT tip and the carina after insufflation of the pneumoperitoneum was reported, with higher incidence of of selective bronchial intubation (8 out of 30 patients undergoing video-laparoscopic gynecologic surgery [20]. The higher incidence of endobroncheal intubation in comparison to our study (9 out of 70 cases) can be related mainly to trendelenburge position used in this study *vs* anti-trendelnburge position in our study.

In the same line, in a study that examined chest radiographs before and after peritoneal insufflation at 10 mmHg, cephalic drives of ETT of 1.1 ± 0.4 cm as a result of increased intra-abdominal pressure were measured [21]. In the current study, patients reposition did not have any influence on tubal end position. It was suspected that position changing from supine to reverse Trendelenburg position with left lateral tilt may abolish the untoward effect of artificial pneumoperitonium on tube migration. However, the effect of surgical positioning may either be small enough to be masked by abdominal insufflation or may be non-existent [18]. Fiberoptic bronchoscopy was used to detect broncheal intubation in this study however, the standard method, recommended by the American Heart Association, for the diagnosis of bronchial intubation is still bilateral auscultation of the chest [22]. Achieving a definitive diagnosis of bronchial intubation by auscultation when suspected, usually causes further delay. This may be attributed to uncertainty about the symmetry of breath sounds, the presumption of either artefact or instrument failure or the desire not to interrupt surgery [23]. Also inaccuracy of auscultation method for checking the proper tube tip position was reported by a study by Sugiyama et al., in which ETT tip migrates inside one of the main bronchi without any changes in lung auscultation pattern [24].

Although endobroncheal intubation can be suspected by arterial oxygen desaturation and changes in end-tidal CO_2 concentration or waveform [25], none of these signs is reliable and conclusive. In this study the only indicator of endobroncheal tubal migration was the rising of peak and plateau pressures above 38.10% and 28.09% when compared to basal values. This finding is no matching with other studies by Gaba et al. and Gandhi SK et al., in the former one a change in the pulse oximeter with arterial desaturation alone in 65.5% of the cases was diagnosed as endobroncheal intubation [23]. Meanwhile in the second one, changes in the end-tidal CO_2 waveforms has been considered as an early warning of bronchial intubation. Indeed, a change in the end-tidal carbon dioxide waveform could be a delayed sign, also CO_2 concentration in association with bronchial intubation may increase or decrease [25].

Low incidence of endobroncheal intubation in this study prevented us from finding an accurate methods of predicting endobroncheal intubation which was one of the main purposes of this study. Although we recommend that rising of peak and plateau airway pressures more than 30% represents a reliable warning signs of endobroncheal tube migration which necessities rechecking of tube position by fiberoptic bronchoscopy.

Conclusion

In conclusion, in obese patients undergoing gastroplasty, insufflation of the pneumoperitoneum in videolaparoscopic procedures reduces the distance between the tip of ETT and the carina using intra-abdominal pressure around 15 mmHg with increased liability of endobroncheal intubation. Rising of peak and plateau pressures above 30% of basal value may be an indicative of endobroncheal intubation.

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