

Capnothorax During Laparoscopy in Trendelenburg Position: A Rare Case Study

Capnotórax Durante Laparoscopia em Trendelenburg: Um Caso Clínico Raro



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ABSTRACT

Pneumothorax is an infrequent complication of laparoscopic surgery. Most cases occur during upper abdominal surgery, since a head-down position (Trendelenburg) pushes the liver and peritoneum against the diaphragm, reducing gas release. When it is due to CO₂ diffusion across congenital diaphragmatic defects, it usually resolves itself spontaneously after de-insufflation of the pneumoperitoneum. Increasing positive end-expiratory pressure to counteract intra-abdominal pressure is an effective measure when a pulmonary origin is excluded. We report a case of right-sided hypertensive capnothorax due to a diaphragmatic defect, during lower abdominal surgery, which was successfully managed without the need for chest drainage. This case highlights the importance of maintaining active vigilance and a high index of suspicion for pneumothorax during laparoscopic surgery.

Keywords: Head-Down Tilt/adverse effects; Laparoscopy; Pneumothorax/etiology; Positive-Pressure Respiration

RESUMO

O pneumotórax é uma complicação pouco frequente da cirurgia laparoscópica. A maioria dos casos ocorrem em cirurgias da região abdominal superior, uma vez que a posição de Trendelenburg por empurrar o fígado e o peritônio contra o diafragma, reduz a perda de gás. Quando a causa é a difusão de CO₂ através de um defeito diafragmático congénito, habitualmente resolve espontaneamente, após a desinsuflação do pneumoperitônio. Quando se exclui uma causa parenquimatosa pulmonar o aumento de *positive end-expiratory pressure* para contrabalançar a pressão intra-abdominal é uma medida eficaz. O caso clínico que apresentamos refere-se a um caso de capnotórax hipertensivo que ocorreu devido à presença de um defeito diafragmático congénito, durante uma cirurgia abdominal inferior e que foi tratado com sucesso sem recorrer ao uso de dreno torácico. Este caso salienta a importância de manter uma vigilância ativa e alto índice de suspeição para o pneumotórax durante a cirurgia laparoscópica.

Palavras-chave: Decúbito Inclinado com Rebaixamento da Cabeça/efeitos adversos; Laparoscopia; Pneumotórax/etiologia; Respiração com Pressão Positiva

INTRODUCTION

Capnothorax is defined by the presence of carbon dioxide in the pleural space, and its incidence is low.^{1,2} It can be caused by direct injury or by passage through congenital defects, foramina or via the subperitoneal route. The increased abdominal pressure during laparoscopy can open weak points in the diaphragm, creating a pleuroperitoneal communication. The gas present in the abdominal compartment will then move into the pleural space due to a pressure gradient, usually resulting in right-side capnothorax. Unlike the pneumothorax caused by creation of bronchopleural conduit due to barotrauma, in the event of pneumothorax caused by CO₂ the use of positive end-expiratory pressure (PEEP) can be helpful.^{3,4} Although most cases can be managed conservatively, capnothorax can be a life-threatening situation. Anesthesiologists should be aware of this complication because successful management depends on early recognition and treatment.⁵

CASE REPORT

A healthy 30-year-old female patient, diagnosed with deep endometriosis was referred for elective intraabdominal laparoscopic exploration, under general anesthesia.

She had no surgical or medical history. General balanced anesthesia induction was performed, and rocuronium was administered to facilitate tracheal intubation. After 25 minutes post-induction, the first trocar was inserted and the abdominal cavity was insufflated at a pressure of 20 mmHg. Following this, a pneumoperitoneum of 12 mmHg was uneventfully established. The patient was then placed in Trendelenburg position for surgery. At that moment blood pressure and oxygen saturation decreased, ET-CO₂ increased, while airway pressure rose suddenly to unacceptable levels. Moreover, auscultation revealed absent breath sounds on the right hemithorax. Endobronchial intubation was excluded, and we assumed a diagnosis of hypertensive pneumothorax. We then shifted to manual ventilation with 100% inspired oxygen and asked surgeons to release the pneumoperitoneum. This improved hemodynamics, oxygen saturation and ventilatory mechanics. With no further clinical events, surgeons slowly increased CO₂ insufflation up to 10 mmHg, inspected the upper abdomen and were able to visualize a diaphragmatic defect of the right hemidiaphragm.

After laparoscopic aspiration of the capnothorax and increased PEEP, surgery was completed safely. Before

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extubating, an x-ray confirmed re-expansion of the lung with minimal presence of pneumothorax. The patient was safely extubated and discharged home two days later.

DISCUSSION

Despite its rareness, pneumothorax complicates up to 2% of all laparoscopic surgeries.² The incidence after gynecologic laparoscopy appears to be lower, 0.14% - 0.24%.⁶

It can occur due to bullae rupture or passage of air during abdominal insufflation. When it results from direct injury to the diaphragm, it is usually left sided, since the liver gives protection to the right hemithorax. Right-side pneumothorax is most frequently caused by the passage of carbon dioxide through weak diaphragmatic points or congenital diaphragmatic defects.⁷ Risk factors include old age, abdominal insufflation with pressures above 15 mmHg and prolonged operating time (> 200 minutes). Hirata *et al* hypothesized that diaphragmatic defects occur more frequently in patients with endometriosis, because they share a common embryonic development process.⁶

Capnothorax caused by the opening of congenital defects usually occurs in upper abdominal procedures since head-up positioning pushes the liver and omentum downward, exposing the diaphragm. In our case, it occurred in head-down position during lower abdominal surgery, which is not frequent. After laparoscopic aspiration of the capnothorax, we maintained the Trendelenburg position allowing the liver to occlude the defect.

Clinical findings included increase in the end-tidal CO₂ and airway pressure, together with decrease in pulse oximetry and absent ipsilateral breath sounds. Treatment consisted of prompt deflation of the pneumoperitoneum, inspired 100% oxygen, and confirmation of proper placement of the orotracheal tube. If the increase in intrathoracic pressure is sufficient to hinder venous return and reduce ventricular filling, the patient may become hemodynamically unstable. In the case of hypertensive pneumothorax, immediate treatment is mandatory. However, if it is caused by CO₂ or N₂O, and pulmonary trauma is excluded, the pneumothorax should resolve itself within 60 minutes, without thoracentesis.⁴ We chose not to insert a chest tube since our treatment was effective and allowed us to proceed with laparoscopic surgery.

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It is important to distinguish a pneumothorax caused by parenchymal defect from a pneumothorax caused by carbon dioxide escaping into the pleural space. In the first case, use of PEEP can exacerbate clinical findings. In the second case, the addition of PEEP will help re-expand the collapsed lung, and if equivalent to intra-abdominal pressure, it will reduce pressure difference and gas passage into the chest. In our case, releasing the pneumoperitoneum improved hemodynamic and ventilatory status, while breath sounds returned to the right hemithorax, which was suggestive of the absence of parenchymal origin.

CONCLUSION

In summary, capnothorax is rare but a potentially serious complication of laparoscopic surgery. Active monitoring is crucial since a high index of suspicion is needed to diagnose it. Treatment must be immediate if hemodynamic instability persists. Chest decompression is not mandatory however, since it usually resolves itself after releasing the pneumoperitoneum, with PEEP being a helpful measure to re-expand the lung and reduce air leak.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

INFORMED CONSENT

Obtained.

CONFLICTS OF INTEREST

All authors report no conflict of interest.

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