

Flickering diaphragm sign, an indicator of laparoscopy-associated pneumothorax secondary to pleural breach

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ABSTRACT

During laparoscopic mobilisation of the oesophagus around hiatus in transhiatal oesophagectomy; commonly the pleura is breached causing iatrogenic pneumothorax. Often small breaches in pleura goes unnoticed till the attention is drawn by anaesthetist when pressures drop with building up of end-tidal CO₂ (etCO₂) and other haemodynamic changes occur. We describe the flickering movements of the diaphragm associated with the pleural breach, a useful sign to alert the surgeon and anaesthetist to detect pneumothorax earlier than it is clinically evident.

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Key words: Laparoscopy-associated pneumothorax, pleural breach, pneumothorax

BACKGROUND

Pneumothorax is an abnormal accumulation of air or gases between the two layers of pleurae. It can cause compromise of ventilation. Most pneumothoraces are due to the rupture of emphysematous bullae, trauma to the diaphragm during a surgical procedure or secondarily due to the diffusion of CO₂ through the anatomical pathways during laparoscopy. Pneumothorax is a common complication of laparoscopic abdominal surgery. It commonly occurs in procedures that involve laparoscopic mobilisation of the proximal stomach and gastro-oesophageal junction.^[1] In general, every laparoscopic procedure that requires dissection of the oesophageal hiatus frequently breaches parietal pleura and results in pneumothorax.^[2] The typical

symptoms of pneumothorax, such as chest pain and shortness of breath, are not delineable in an anaesthetised patient. Thereby, the majority of iatrogenic pneumothoraces escape the attention of anaesthetist and surgeon and are detected only when respiratory and haemodynamic parameters deteriorate.

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CASE REPORT

We describe a report of a patient of 72 years who underwent laparoscopic transhiatal oesophagectomy for carcinoma gastro-oesophageal junction. The CO₂ pneumoperitoneum was created with intra-abdominal pressure (IAP) set at 14 mmHg, and flow at 12 L/min. After laparoscopic mobilisation of stomach and D2 lymphadenectomy, hiatal dissection was started. There was an inadvertent breach of pleura during the procedure, which was not noticed initially, and led to the development of capnothorax. There were small quick (flickering) fine movements of the diaphragm seen more vividly on the left side, with decreased thoracic-pulmonary compliance and increased peak airway pressures from 24 cm H₂O to 33 cm H₂O. There was also an increase in end-tidal CO₂ (etCO₂) and PaCO₂. Initially, blood pressure dropped to 85/60 mmHg, and mild tachycardia to around 110/min, which was corrected with volume supplements and low-dose noradrenaline infusion. These haemodynamic changes confirmed the development of tension pneumothorax. There was no drop-in oxygen saturation. A small rent in pleura bilaterally was found. With the placement of bilateral chest tubes, the flickering movements of diaphragm disappeared. We also observed this sign in four other patients who underwent laparoscopic-assisted transhiatal oesophagectomy in the event of pleural tear and pneumothorax. Informed consent was obtained from all the subjects for publication, and patients' anonymity is preserved. A short-edited video has been shared for better understanding of this sign [Video 1].

DISCUSSION

Laparoscopic surgery is becoming more popular with its expanding indications. In laparoscopy, capnothorax is created for adequate space for surgery. During an uneventful CO₂ pneumoperitoneum, the partial pressure of arterial CO₂ progressively increases to reach a plateau 15–30 min after the beginning of CO₂ insufflation. A significant increase in PaCO₂ after this period requires a search for a cause independent of or related to CO₂ insufflation.

Peritoneal insufflation to IAP higher than 10 mmHg induces a decrease in cardiac output due to decreased venous return, and rise in heart rate with the elevation of systemic and pulmonary vascular resistance. The increased airway pressure with decreased respiratory

compliance, ventilation and perfusion mismatch, high etCO₂ and decrease in arterial oxygen saturation with other haemodynamic changes can be used as a primary indicator of laparoscopy-induced pneumothorax.^[3]

Most pneumothoraces are due to CO₂ diffusion through the channels of communication between peritoneal and pleural embryonic sacs which are the areas of least resistance, defects in the aortic and oesophageal hiatus or alveolar ruptures, trauma to the diaphragm during surgery. Pneumothorax also frequently develops due to pleural tears occurring during laparoscopic procedures involving gastro-oesophageal junction. The real challenge is that the entry point in pleura is not always evident, and the paradoxical ballooning of the hemidiaphragm on the affected side remains the only evidence of intraoperative pneumothorax or the changes in respiratory dynamics as noticed by the anaesthetist.^[4]

'Floppy diaphragm' sign was described as an intraoperative indicator of CO₂ presence above the diaphragm, which disappears with the desufflation of pneumoperitoneum as the diaphragm bulges inferiorly.^[5] Floppy diaphragm is an outward bulging of the diaphragm into the abdominal cavity with the collection of CO₂ in the pleural cavity occurring spontaneously through anatomical channels without any breach of pleura. Often small breaches in pleura go unnoticed till the attention is drawn by anaesthetist when airway pressures rise with building up of etCO₂ and falling blood pressure and rise in heart rate.

We describe the flickering movements of the diaphragm associated with pleural breach during laparoscopic mobilisation of hiatus. It is a useful sign that should alert the surgeon and anaesthetist to detect pneumothorax earlier than it is clinically evident. There are flickering movements of the diaphragm which can be observed directly by the operating surgeon as well as the anaesthetist soon after the rent in the hiatus and CO₂ escapes into the pleural cavity. The accumulation of CO₂ in the pleural cavity via the pleural rent with the building of positive pressure in thorax with the relaxed diaphragmatic muscle under the influence of muscle relaxant and continuous insufflation of CO₂ in the peritoneal cavity and the positive pressure ventilation could be the possible reasons for the turbulence created in the pleural cavity leading to diaphragmatic flickering. This sign is generally more easily and clearly seen on the left side because the presence of liver obscures the

right diaphragm. Even though it is known that CO₂ absorption from the pleural cavity is higher than that of peritoneum leading to rising etCO₂, it takes some more time before it is evident in the capnography and to the attention of the anaesthetist. And there is always a risk of the development of tension pneumothorax leading to significant haemodynamic changes. This sign could help us to temporarily terminate CO₂ insufflation earlier and prevent the anticipated changes by the timely placement of chest tubes intra-operatively.

CONCLUSION

Flickering of the diaphragm is a useful sign to detect pneumothorax secondary to pleural rent in laparoscopic procedures involving the mobilisation of hiatus and can alert the anaesthetist and surgeon to take appropriate action before significant respiratory and haemodynamic changes become evident.

Ethics committee approval

The content of the article has not been published or submitted for publication elsewhere. The study was approved by the ethics committee of the Basavatarakam Indo American Cancer Hospital and Research Institute and conformed to the provisions of the Declaration of Helsinki in 1995. Informed consent was obtained from all the subjects, and patients' anonymity is preserved.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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