Case Report

Pneumomediastinum, pneumothorax and subcutaneous emphysema complicating MIS herniorrhaphy

John Browne FFARCSI,
Deirdre Murphy MRCPI FFARCSI,
George Shorten MD

Purpose: Videoscopic herniorrhaphy is being performed more frequently with advantages claimed over the conventional open approach. This clinical report describes a pneumothorax, pneumomediastinum and subcutaneous emphysema occurring at the end of an extraperitoneal videoscopic herniorrhaphy.

Clinical Features: A 25 yr old ASA I man presented for elective extraperitoneal videoscopic hernia repair. Following intravenous induction with fentanyl, midazolam and propofol a balanced anesthetic technique using enflurane in N₂O and O₂ was used. Apart from a prolonged operating time (195 min), the procedure and anesthetic was uneventful.

At the conclusion of the operation, prior to reversal of neuromuscular blockade extensive subcutaneous emphysema was noted on removal of the surgical drapes. Chest radiography revealed a pneumomediastinum and pneumothorax. A 25 FG intercostal tube was inserted and connected to an underwater seal drain. Sedation and positive pressure ventilation was maintained overnight to permit resolution and avoid airway compromise. The clinical and radiological features had resolved by the next morning and the patient's trachea was extubated. His subsequent recovery was uneventful.

Conclusion: Pneumothorax and pneumomediastinum are well recognised complications of laparoscopic techniques but have not been described following extraperitoneal herniorrhaphy. In this report we postulate possible mechanisms which may have contributed to their development, including inadvertent breach of the peritoneum and leakage of gas around the diaphragmatic herniae or tracking of gas retroperitoneally. The case alerts us to the possibility of this complication occurring in patients undergoing videoscopic herniorrhaphy.

Objectif : L'herniorraphie vidéooscopique est réalisée plus souvent, avec les avantages qu'on lui reconnaît sur l'intervention externe traditionnelle. Le présent résumé clinique décrit un cas de pneumothorax, pneumomédiastin et emphysème sous-cutané se produisant à la fin d'une herniorraphie vidéooscopique extrapéritonéale.

Éléments cliniques : Un homme de 25 ans (ASA I) s'est présenté en chirurgie élektive pour la réparation vidéooscopique et extrapéritonéale d'une hernie. Après l'induction intraveineuse de l'anesthésie avec du fentanyl, du midazolam et du propofol, une technique anesthésique balancée comprenant de l'enflurane dans un mélange de N₂O et d'O₂ a été utilisée. Mis à part la durée prolongée de l'intervention (195 min), l'opération et l'anesthésie se sont bien déroulées.

À la fin de l'opération, avant la neutralisation du bloc neuromusculaire, un emphysème sous-cutané étendu a été noté lors du retrait des champs opératoires. La radiographie du thorax a révélé un pneumomédiastin et un pneumothorax. Un tube intercostal de calibre 25 a été inséré et connecté à un drain étanche sous l'eau. La sédation et la ventilation à pression positive ont été maintenues toute la nuit pour permettre la résolution spontanée de l'épanchement et éviter des lésions des voies aériennes. Les signes cliniques et radiologiques ont indiqué un retour à la normale le matin suivant, ce qui a permis l'extubation endotrachéale. La récupération ultérieure a été sans incident.

Conclusion : Le pneumothorax et le pneumomédiastin sont des complications bien connues de l'emploi des techniques laparoscopiques, mais n'ont pas été rapportés à la suite d'herniorraphie extrapéritonéale. Nous avançons ici que certains mécanismes peuvent avoir contribué à leur développement. Il peut s'agir d'une brèche involontaire du péritoine et d'une fuite de gaz autour de la hernie diaphragmatique ou dans l'espace rétropéritonéal. Le cas nous rappelle que cette complication peut survenir chez les patients qui subissent une herniorraphie vidéooscopique.

From the Department of Anaesthesia and Intensive Care Medicine, Cork University Hospital and University College Cork, Wilton, Cork, Ireland.

Address correspondence to: Dr. Deirdre Murphy, Phone: 353-021-922135; Fax: 353-021-343307

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VIDEOSCOPIC inguinal herniorrhaphy is a procedure being performed with increasing frequency. The advantages claimed for this approach over an open approach include earlier recovery, less postoperative discomfort, ability to treat bilateral hernias at one operation, ease of performance in the obese patient, and a lower recurrence rate.^{1,2}

Two techniques using laparoscopy are described, a transabdominal preperitoneal approach³ or an intraperitoneal approach using an on-lay mesh over the defect.⁴

The patient described in this case report had an extraperitoneal "laparoscopic" herniorrhaphy.⁵ When this technique is used, laparoscopy is not performed and the peritoneum remains intact. A "pneumoeextraperitoneum" is established using CO₂ gas. Although technically more difficult, this, in theory, avoids the complications associated with laparoscopy.⁵

Case history

A 25 yr old ASA I man (75 kg) presented for elective extraperitoneal videoscopic inguinal hernia repair. Anesthesia was induced with 0.1 mg fentanyl, 2 mg midazolam, 150 mg propofol and maintained using enflurane (0.8-1.5% ET concentration) in N₂O 70% and O₂ 30%. Muscle relaxation was achieved using 8 mg vecuronium and maintained with 2 mg increments of vecuronium. Standard monitoring of ECG, NIBP, SPO₂, P_{ET}CO₂ and multigas analysis using a Datex AS/3 was used throughout. Tracheal intubation was performed easily (Cormack and Lehane Grade 1) and was atraumatic.

The surgical procedure was prolonged, lasting 195 min. The patient was hemodynamically stable throughout. There was no decrease in SpO₂ and P_{ET}CO₂ was maintained < 40 mmHg. Peak inflation airway pressures were consistently < 25 mmHg and did not increase during the case.

Prior to emergence from anesthesia, and reversal of neuromuscular blockade, the surgical drapes were removed. Extensive subcutaneous emphysema involving the scrotum, abdomen, thorax and neck was noted. There were no abnormal clinical signs on chest examination. A chest radiograph (Figure 1) revealed a pneumomediastinum and left sided pneumothorax. A 24 French gauge intercostal tube was inserted in the left 5th intercostal space, midaxillary line and connected to an underwater seal drain. Sedation and positive pressure ventilation were continued overnight to permit resolution of the surgical emphysema, pneumomediastinum and pneumothorax and to avoid airway compromise.

On the first postoperative day a repeat chest radiograph (Figure 2) revealed resolution of the pneumothorax and a decrease in the amount of mediastinal air. The surgical emphysema had largely resolved. There was an audible leak around the ET tube. The trachea was extubated and the intercostal tube removed. Subsequent recovery was uneventful and he was discharged from hospital the following morning.

Discussion

Pneumothorax, particularly right sided, and pneumomediastinum are well recognised, rare complications of laparoscopic procedures.⁶⁻¹¹ Neither complication has been reported following laparoscopic herniorrhaphy using an extraperitoneal approach. However, it should be considered in patients undergoing laparoscopy who show an increase in peak inflation pressures, a decrease in compliance, or unexpected hypoxemia or hypercarbia.⁸

There are many possible routes for gas to enter the thoracic cavity during pneumoperitoneum.^{6,9,10} Postulated sites for this to occur are via the pleuroperitoneal hiatus (Foramen of Bochdalek), around the esophageal and aortic hiatus, via any congenital diaphragmatic defect (e.g. Foramen of Morgagni). In addition, any procedure that can damage the falciform ligament (e.g. during insertion of a Veress needle), may provide a route for gas or fluid to enter the thoracic cavity.

Other causes of pneumothorax unrelated to the laparoscopic technique should be borne in mind. It may result from barotrauma, injury to the trachea during intubation, spontaneous rupture of a congenital bulla or as a complication of central venous line insertion. In this case it is unlikely that any of these factors contributed to the development of pneumothorax or pneumomediastinum.

As a pneumoperitoneum was not used in this case the routes outlined for gas to traverse the diaphragm should not have been available. The peritoneum may have been inadvertently breached. This has been described with the extraperitoneal approach and can cause potential complications including bladder and bowel injury intraoperatively, and postoperative adhesions.⁵

The duration of the surgical procedure was long, 195 min. The average duration of the procedure for unilateral herniorrhaphy in one series was 111 min⁵. Technical difficulties causing an increased operation time may have resulted from leakage of gas into the peritoneum. However, the duration of the procedure has not been shown to affect the diffusion of CO₂ into the body.^{1,2}

Alternatively, the peritoneum may not have been breached and the gas may have tracked retroperitoneally, causing the pneumomediastinum and pneu-

FIGURE 1 Chest radiograph, taken immediately postoperatively showing left pneumothorax and pneumomediastinum, with extensive subcutaneous emphysema.

mothorax.¹³ Three cases have been described¹⁴ in which patients undergoing laparoscopic herniorrhaphy (TAPP approach) developed subcutaneous emphysema of the neck and pharyngeal emphysema. The authors postulated that the myopectineal dissection could have provided a route for carbon dioxide to track retroperitoneally and access the neck. The scrotal emphysema could be explained by gas tracking along Scarpa's fascia.

The role of nitrous oxide in expanding pneumothoraces is well described. This is due to its water solubility relative to that of nitrogen (blood/gas coefficient 0.47 and 0.15 respectively). For this reason it diffuses into a closed gas space 30 times more rapidly than nitrogen diffuses out.

Using nitrous oxide 70% the volume of a pneumothorax may double in 10 min.¹⁵ It is unclear if nitrous oxide can be implicated in expanding a pneumothorax caused by carbon dioxide gas.¹¹ Graham's law of diffusion states that the rate at which different gases diffuse is inversely proportional to the square roots of their molecular masses, other factors being kept constant.¹⁶ As nitrous oxide and carbon dioxide have the same molecular mass, it is likely that the use of nitrous oxide would not expand a carbon dioxide containing closed space. The rapid resolution of the clinical and radiological findings is highly suggestive of a capnothorax and capnomediastinum.

FIGURE 2 Chest radiograph, taken on the first postoperative day showing complete resolution of the pneumothorax with improvement in the pneumomediastinum.

This case illustrates the possibility of pneumothorax developing during videoscopic herniorrhaphy, even if a pneumoperitoneum is not employed. The anesthesiologist should consider this possibility, even if the intraoperative course is unremarkable and, in particular, if the patient develops subcutaneous emphysema. The fact that such a potentially serious complication can arise may raise questions as to the validity of this technique over the open technique, particularly in unilateral, non-complicated hernia repairs. In an analytical cohort study,² Dion suggested that the increased cost of the laparoscopic repair might not be justified by the advantages of the technique, particularly for primary, unilateral herniae. Anesthesiologists caring for patients undergoing videoscopic herniorrhaphy should be aware of the potential development of pneumomediastinum and pneumothorax, whether deliberate creation of a pneumoperitoneum is planned or not.

References

- 1 Ger R, Mishrick A, Hurwitz J, Romero C, Oddsen R. Management of groin hernias by laparoscopy. *World J Surg* 1993; 17: 46-50.
- 2 Dion Y-M. Laparoscopic inguinal herniorrhaphy: appraisal of a cohort study. *Can J Surg* 1996; 39: 229-32.
- 3 Litwin DEM, Pham QN, Oleniuk FH, Kluftringer AM, Rossi L. Symposium on the management of inguinal hernias. 3. Laparoscopic groin hernia surgery: The TAPP procedure. *Can J Surg* 1997; 40: 192-98.

- 4 Winchester DJ, Dawes LG, Modelski DD, et al. Laparoscopic inguinal hernia repair. A preliminary experience. *Arch Surg* 1993; 128: 781–86.
- 5 Smith CD, Tiao G, Beebe T. Intraoperative events common to videoscopic preperitoneal mesh inguinal herniorrhaphy. *Am J Surg* 1997; 174: 403–5.
- 6 Prystowsky JB, Jericho BG, Epstein HM. Spontaneous bilateral pneumothorax – complication of laparoscopic cholecystectomy. *Surgery* 1993; 114: 988–92.
- 7 Cunningham AJ, Brull SJ. Laparoscopic cholecystectomy: anesthetic implications. *Anesth Analg* 1993; 76: 1120–33.
- 8 Cunningham AJ, Richards W. Anaesthesia for minimally invasive therapy. *Current Opinion in Anaesthesiology* 1994; 7: 485–94.
- 9 Gabbott DA, Dunkley AB, Roberts FL. Carbon dioxide pneumothorax occurring during laparoscopic cholecystectomy. *Anaesthesia* 1992; 47: 587–8.
- 10 Doctor NH, Hussain Z. Bilateral pneumothorax associated with laparoscopy. A case report of a rare hazard and review of literature. *Anaesthesia* 1973; 28: 75–81.
- 11 Hasel R, Arora SK, Hickey DR. Intraoperative complications of laparoscopic cholecystectomy. *Can J Anaesth* 1993; 40: 459–64.
- 12 Mullet CE, Viale JP, Sagnard PE, et al. Pulmonary CO₂ elimination during surgical procedures using intra- or extraperitoneal CO₂ insufflation. *Anesth Analg* 1993; 76: 622–6.
- 13 Wabba RWM, Tessler MJ, Kleiman SJ. Acute ventilatory complications during laparoscopic upper abdominal surgery. *Can J Anaesth* 1996; 43: 77–83.
- 14 Chien GL, Soifer BE. Pharyngeal emphysema with airway obstruction as a consequence of laparoscopic inguinal herniorrhaphy. *Anesth Analg* 1995; 80: 201–3.
- 15 Eger EI II, Saidman LJ. Hazards of nitrous oxide anesthesia in bowel obstruction and pneumothorax. *Anesthesiology* 1965; 26: 61–6.
- 16 Strickland D. Physical Principles Part 1: Mechanical Quantities. In: Scurr C, Feldman S (Eds.). *Scientific Foundations of Anaesthesia*, 3rd ed. London: William Heinemann, 1982: 90–2.