Case Report

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Subcutaneous emphysema during extended totally extraperitoneal inguinal hernia repair: A case report

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Abstract

Laparoscopic inguinal hernia repair is increasingly performed because of reduced postoperative pain and faster recovery compared with open surgery. However, carbon dioxide (CO_2) insufflation may lead to specific complications, including subcutaneous emphysema (SE). A 65-year-old man underwent elective totally extraperitoneal extended view repair for right inguinal hernia. Fifty minutes after CO_2 insufflation, a progressive rise in end-tidal CO_2 reaching 60 mmHg was observed, accompanied by mild oxygen desaturation. Physical examination revealed subcutaneous crepitus extending to the patient's neck. Ventilatory adjustments were performed, and the insufflation pressure was reduced. Subcutaneous catheters were inserted into the supraclavicular region. The procedure was successfully completed. Postoperative chest radiography confirmed extensive SE without pneumothorax or pneumomediastinum. The patient remained clinically stable and was conservatively managed. Complete resolution was confirmed radiologically, and the patient was discharged on the third postoperative day. SE is an uncommon but increasingly recognized complication of extraperitoneal laparoscopic hernia repair. Vigilant intraoperative monitoring allows for early detection and appropriate management, preventing unnecessary morbidity.

Keywords

End-tidal carbon dioxide, inguinal hernia repair, laparoscopic surgery, subcutaneous emphysema, totally extraperitoneal approach

Introduction

Subcutaneous emphysema (SE) is defined as the presence of gas in the subcutaneous tissues. It most commonly involves the chest wall and the neck. During laparoscopic surgery, SE results from carbon dioxide (CO_2) extravasation into the subcutaneous plane.

Clinically, SE is often suspected when there is a sudden rise in end-tidal carbon dioxide ($EtCO_2$) and is confirmed by the detection of crepitus on physical examination or by imaging studies.[1,2] Although frequently benign and self-limited, severe cases may lead to hypercapnia and respiratory compromise.

This case report describes a case of extensive SE occurring during extended totally extraperitoneal (eTEP) inguinal hernia repair and discusses its risk factors, pathophysiology, and management.

Case Presentation

A 65-year-old man presented with a right inguinal hernia for elective laparoscopic repair. He was classified as American Society of Anesthesiologists II, with a body mass index of 19.5 kg/m^2. His medical history was significant for smoking and a prior median laparotomy performed 15 years earlier for a perforated duodenal ulcer and peritonitis.

The eTEP approach was selected to avoid intraperitoneal adhesiolysis.

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General anesthesia was then administered. Standard intraoperative monitoring included electrocardiography, noninvasive blood pressure, oxygen saturation, heart rate, respiratory rate, and continuous $EtCO_2$ monitoring.

The eTEP approach used in this case is based on the principles of extraperitoneal repair initially described by Jorge Daes for inguinal hernia surgery, with extension of the dissection to create a wider retromuscular and preperitoneal working space, allowing improved visualization and instrument maneuverability compared with the conventional totally extraperitoneal (TEP) technique.[3]

A 10-mm optical trocar was placed 3 cm above and lateral to the left umbilicus. CO_2 insufflation was initiated at 8 L/min with a maximum pressure of 12 mmHg. After blunt telescopic dissection of the retromuscular space, two additional 5-mm trocars were inserted. Dissection of the preperitoneal space revealed an indirect right inguinal defect.

Fifty minutes after insufflation, a gradual increase in $EtCO_2$ was observed, which reached 60 mmHg. The oxygen saturation decreased from 100% to 96%. Ventilatory adjustments were performed by increasing the respiratory rate to 25 breaths per minute, increasing the flow to 15 L/min, and setting the fraction of inspired oxygen to 100%. The intra-abdominal pressure was reduced to 10 mmHg. However, $EtCO_2$ remained elevated despite these measures.

Physical examination revealed subcutaneous crepitus extending to the patient's neck. Given the extensive cervicothoracic extension of SE and persistent hypercapnia despite ventilatory optimization, two 16-G subcutaneous catheters were inserted in the supraclavicular region as a temporary decompressive adjunct to facilitate gas evacuation. This maneuver was used in a selective manner and is not considered a routine treatment for SE.

Approximately 30 min later, the hernia was reduced, and a 15 cm × 12 cm mesh was placed. The procedure was completed without any complications. The patient was extubated after the respiratory parameters were normalized.

Postoperative chest radiography revealed bilateral SE involving the chest wall, neck, and upper abdominal wall without evidence of pneumothorax or pneumomediastinum [Figure 1].

The patient remained hemodynamically stable, with oxygen saturation between 94% and 97% on room air. Conservative management with oxygen therapy, analgesia, and respiratory physiotherapy was instituted. Follow-up chest radiography confirmed the complete resolution of the effusion. The patient was discharged on the third postoperative day.

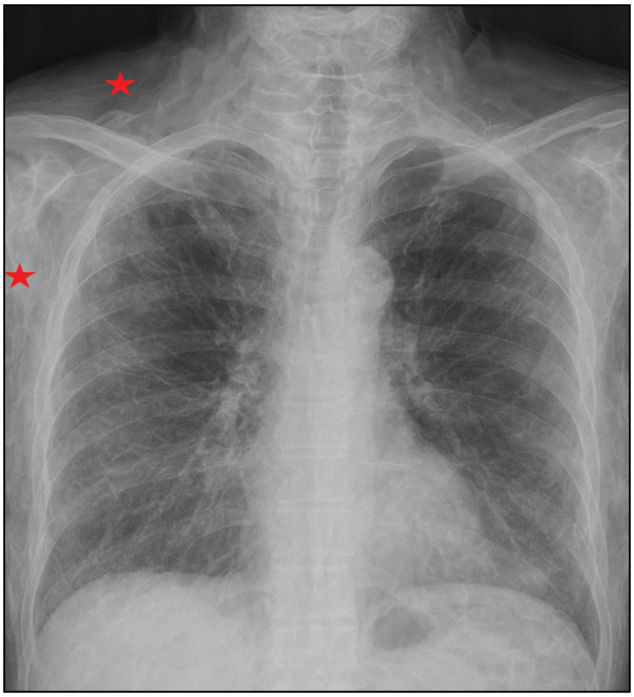


Figure 1: Postoperative chest radiograph demonstrating extensive subcutaneous emphysema involving the cervical, thoracic, and upper abdominal regions (stars indicate areas of subcutaneous air), without evidence of pneumothorax or pneumomediastinum

Discussion

The increasing adoption of laparoscopic surgery has improved postoperative recovery and reduced pain compared with open techniques. However, insufflation-related complications are frequently encountered.

SE occurs when insufflated CO_2 escapes into the subcutaneous tissue planes. This phenomenon may be facilitated by the use of sharp trocar obturators, which can create microdefects in fascial planes, allowing gas to track into subcutaneous tissues. The reported incidence varies widely, with rates of up to 23% in laparoscopic and robotic abdominal procedures when systematically screened.[4]

In the context of extraperitoneal laparoscopic surgery, CO_2 insufflated into the preperitoneal space may dissect along loose areolar tissue planes under pressure gradients. The gas can track superiorly along the fascial layers, particularly through the transversalis fascia and endothoracic fascia, leading to cervicothoracic extension of SE. The retromuscular space created during eTEP procedures may further

facilitate rapid gas diffusion due to the continuity of anatomical planes.

Differences between laparoscopic approaches may also influence the risk and extent of gas-related complications. From a physiological standpoint, the TEP and eTEP techniques involve continuous CO_2 insufflation within confined, extraperitoneal planes. Because these spaces lack a confining serosal boundary, the gas can easily dissect and diffuse along continuous fascial layers, increasing the likelihood of SE. In contrast, the transabdominal preperitoneal (TAPP) approach utilizes the intraperitoneal cavity, where the peritoneum acts as a partial barrier that may limit the extent of subcutaneous gas diffusion. However, direct comparative evidence regarding the incidence of SE between TEP/eTEP and TAPP remains limited, and further studies are required to establish definitive differences.[5]

Several risk factors have been identified, including advanced age, low body mass index, prolonged operative duration, robotic approach, and elevated insufflation pressures exceeding 15 mmHg.[2,6,7] In addition, inadequate neuromuscular relaxation may increase abdominal wall resistance, leading to higher extraperitoneal pressures and favoring gas extravasation.[8]

Technical variables encompassing both operative technique and equipment design significantly contribute to these outcomes. Specifically, procedural factors such as trocar placement, multiple punctures, and elevated CO_2 flow rates exacerbate patient risk.[9] Furthermore, mechanical limitations inherent to certain insufflation systems must be accounted for; the absence of automated pressure regulation or integrated gas evacuation mechanisms can precipitate excessive CO_2 accumulation, thereby increasing the incidence of gas-related complications.[10]

Recent evidence from a large retrospective cohort study further supports these findings, demonstrating that SE following TEP may significantly impact intraoperative respiratory parameters.[11]

Clinically, a sudden increase in $EtCO_2$ is typically the earliest sign of SE.[2] It is important to emphasize that a rise in $EtCO_2$ may represent both increased systemic CO_2 absorption secondary to SE and early warning of excessive extraperitoneal gas diffusion, rather than an isolated anesthetic event.

Isolated SE generally does not cause significant hypoxemia or increased airway pressure, distinguishing it from pneumothorax.[12] Nevertheless, extensive SE may lead to severe hypercapnia and, in rare cases, progression to capnothorax or tension pneumothorax, particularly when CO_2 dissects along fascial planes into the thoracic cavity.[13]

Similar complications have been reported following TEP repair, including cases of bilateral pneumothorax and pneumomediastinum managed conservatively in hemodynamically stable patients, highlighting the potential for extensive CO_2 dissection beyond subcutaneous tissues.[14]

The management of SE is primarily supportive. The reduction of insufflation pressure and increased minute ventilation are usually sufficient.[4,6,7] If respiratory or hemodynamic compromise occurs, evaluation for pneumothorax is mandatory, and chest tube placement may be required.[13]

Preventive strategies include minimizing operative duration, limiting insufflation pressure, avoiding multiple trocar attempts, and ensuring proper fascial sealing.[2,15,16] In this case report, continuation of the procedure was considered safe as the patient remained hemodynamically stable, with no evidence of pneumothorax or cardiovascular compromise. The decision to proceed was based on close anesthetic–surgical communication and continuous monitoring of ventilatory parameters.

This case report highlights several important learning points: the potential for rapid and extensive SE during eTEP repair, the importance of recognizing persistent hypercapnia as an early warning sign, and the need for awareness of both surgical and anesthetic factors that may contribute to CO_2-related complications in extraperitoneal laparoscopic surgery. Awareness of these technical, anesthetic, and equipment-related factors is essential to minimize the risk of CO_2-related complications during extraperitoneal laparoscopic surgery.

Conclusion

SE is an uncommon but recognized complication of extraperitoneal laparoscopic hernia repair. Although typically benign, early identification through careful intraoperative monitoring of $EtCO_2$ and physical examination is essential to prevent serious complications and ensure safe treatment.

Author contributions

RB conceived the study, performed the surgery, collected the clinical data, and drafted the manuscript. NSI contributed to the manuscript revision, literature review, and final approval of the manuscript. AB contributed to investigation and methodology. NB contributed to investigation and methodology. All authors read and approved the final manuscript.

Ethical policy and Institutional Review Board statement

The study was conducted in accordance with theethical principles of the Declaration of Helsinki. This is a single case report describing standard clinical care, without any experimental intervention. According to the policy of the Institutional Review Board (IRB) of EHS UMC Oued Tlelat, Oran, Algeria, formal ethics approval is not routinely required for such reports. Written informed consent for publication was obtained from the patient.

Declaration of patient consent

The authors certify that they have obtained appropriate patient consent. The patient has given consent for his clinical information and images to be reported in this journal. The patient understands that his name and initials will not be published and that due efforts will be made to conceal his identity, although anonymity cannot be guaranteed.

Data availability statement

The data supporting the findings of this study are available within the article. No additional datasets were generated or analyzed during the current study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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List of abbreviations

$EtCO_2$	End-tidal carbon dioxide
eTEP	Extended totally extraperitoneal
SE	Subcutaneous emphysema
ASA	American Society of Anesthesiologists

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