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CASE REPORT **REGIONAL ANESTHESIA**

Massive pneumomediastinum and pneumoperitoneum during peroral endoscopic myotomy

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Abstract

Peroral endoscopic myotomy (POEM) is a newly developed endoscopic intervention for esophageal achalasia. We present a case of a patient undergoing POEM, who suffered intra operative hemodynamic collapse due to massive pneumomediastinum as well as massive pneumoperitoneum requiring emergent needle decompression.

Key words: Peroral endoscopic myotomy; Endoscopic; Pneumomediastinum; Pneumoperitoneum; Needle decompression

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1. Introduction

Peroral endoscopic myotomy (POEM) is an increasingly popular treatment for esophageal achalasia. Despite the minimally invasive approach, severe complications have been reported.[1-9] We describe a patient who developed pneumomediastinum and massive pneumoperitoneum during a POEM leading to sudden collapse of her hemodynamic parameters. Her rapid deterioration was readily identified and managed with an emergent percutaneous needle decompression with a 14-gauge angiocath placed in the subxiphoid region. A significant amount of intra-abdominal gas was evacuated. This led to a prompt improvement in the patient's clinical status; oxygen saturation, PIP, and hemodynamics normalized.

2. Case report

A 63-years-old female with achalasia, eosinophilic esophagitis, anxiety, and asthma underwent a POEM procedure under general anesthesia. She had failed multiple medical therapies and had limited benefit from esophageal dilatations in the past. After uneventful intubation, patient was placed on positive pressure volume control ventilatory mode with tidal volume (TV) = 450 ml, respiratory rate (RR) =10/ min and positive end-expiratory pressure (PEEP) = 5 cm H2O. Anesthesia was maintained with sevoflurane and rocuronium. The patient remained hemodynamically stable and tolerated the procedure and CO_2 insufflation (flow rate between 1.5 to 3 L/min) well. The insufflation pressure was not continuously maintained. As after two hours into the case the patient started becoming progressively hypotensive. Her BP dropped from 130/70 mmHg to 71/50 mmHg. It was simultaneously associated with a decrease in oxygen saturation from 99% to 86%. Her peak inspiratory pressure (PIP) increased from 18 cmH2O to 36 cmH2O along with a drop in end tidal carbon dioxide ($EtCO_2$) from 40 mmHg to 26 mmHg. Immediately, the fraction of inspired oxygen (FiO_2) was increased to 100%, an intravenous fluid bolus (one liter) was administered. In addition, repeated doses on phenylephrine 100 µg and ephedrine 10 mg were administered intravenously. The procedure was suspended and CO_2 insufflation was terminated.

Physical examination revealed extensive crepitus involving the area over neck, upper chest wall, bilateral arms and significant abdominal distention.

The clinical findings indicated towards esophageal perforation, pneumomediastinum and free air in the abdomen. Due to the rapid deterioration of the patient's clinical condition, an emergent percutaneous needle decompression was performed. A 14-gauge angiocath was emergently placed in the subxiphoid region; a significant amount of intra-abdominal gas was evacuated. This led to a prompt improvement in the patient's clinical status; oxygen saturation, PIP, and hemodynamics normalized. A chest X-ray demonstrated large amounts of diffuse subcutaneous emphysema, trace pneumomediastinum and residual pneumoperitoneum (Figure 1).

The patient was extubated at the conclusion of the case, transferred to the post-operative care unit (PACU) and kept overnight for observation. A fluoroscopic esophagogram obtained on postoperative day (POD) 1 showed no appreciable leak or esophageal perforation requiring further clinical intervention.

3. Discussion

Peroral endoscopic myotomy is an increasingly common surgical treatment for esophageal achalasia. It is performed under general anesthesia with endotracheal intubation. Endoscopic esophageal insufflation is maintained with carbon dioxide (CO_2). The POEM procedure involves separation of the inner circular muscular layer from the outer longitudinal layer of the esophageal wall.[1-9] A submucosal dissection of the inner circular muscle is made, allowing for the circular muscle bundles responsible for achalasia to be severed; followed by creation of a submucosal tunnel, endoscopic myotomy, and closure of mucosal entry with endoscopic clips.[1, 2]

During the procedure, the outer longitudinal muscle is vulnerable to injury as delineation between the inner and outer layers is often unclear.[1-2] Longitudinal muscle laceration during the myotomy may also occur. The outer longitudinal muscle is the only barrier between the esophageal lumen and mediastinum.[1] Even small perforations in the longitudinal muscle may result in subcutaneous emphysema, pneumomediastinum, pneumothorax, pneumoperitoneum, and abdominal compartment syndrome.[1, 2]

Pneumoperitoneum and pneumomediastinum are known occurrences in the operating rooms for the anesthesiologists. However, it is rare to encounter massive pneumoperitoneum during an esophageal endoscopy. Though esophageal injury occurs in the mediastinal compartment, gas may travel into the abdominal compartment through the Foramen of Morgagni; a small defect in the posterior aspect of the anterior thoracic wall between the sternal and costal attachments of diaphragm. Identifying massive pneumoperitoneum in a timely manner can be both challenging as well as lifesaving. Imaging may not always be available to the clinician immediately. Therefore, vigilant hemodynamic monitoring, exploration of physical examination findings, and an intimate understanding of the surgical procedure are crucial in order to make a timely diagnosis.

In our case, the esophageal defect led to pneumomediastinum and persistent massive pneumoperitoneum, despite the termination of esophageal endoscopic insufflation. Emergent needle decompression released a large amount of air from the abdominal compartment. Subsequently, the patient's oxygen saturation, blood pressure, peak inspiratory pressure, and end tidal CO_2 quickly returned to normal levels.

Prevention and management of an esophageal perforation or transmural gas leak include increasing PEEP prior to endoscopic insufflation, decreasing the risk of entraining gas in the mediastinum. Judicious selection of insufflation rate and total insufflation pressure are crucial in preventing excessive esophageal wall distension and pneumatic perforation. Moreover, the upper abdomen should be checked periodically during the procedure in an effort to detect pneumomediastinum and pneumoperitoneum. In the event of a tension pneumoperitoneum and subsequent hemodynamic compromise, a needle decompression can be a lifesaving intervention.

Over the course of three decades, CO_2 has replaced room air (atmospheric air) as the preferred and superior mode of insufflation for endoscopic procedures. Room air is poorly absorbed and must be suctioned from the GI tract or pass via flatus at the end of the procedure.[11] In comparison, CO_2 is more readily absorbed from the intestinal lumen and can be eliminated via respiration.[11] CO_2 allows for the bowel to decompress more rapidly, thereby reducing risk of complications such as subcutaneous emphysema, pneumoperitoneum, pneumothorax, pneumomediastinum, and gas embolization. CO_2 insufflation compared to air insufflation has also been shown to decrease intraprocedural stimulation, sedation requirements, procedure time, post procedural abdominal discomfort, recovery time, and reduce risk of fire with cautery use.[11-15]

Though the application of CO_2 for insufflation has improved numerous aspects of endoscopy, more could be done to improve endoscopic safety.[11] Endoscopic insufflation involves a CO_2 regulation unit to deliver carbon dioxide. This CO_2 regulator has visual and audible alarms for low gas reserve or low-pressure. However, it lacks over-pressure alarms, indicators for CO_2 flow start/stop, and delivered quantity of CO_2.[12] Further, they are not able to automatically adjust the flow rate and maintain a constant pressure. The leading manufacturers of CO_2 regulator models (Olympus, Medivators, and Bracco Diagnostics) all have similar limitations. The absence of intraluminal pressure monitoring during endoscopic procedures poses a risk to the patient. Currently, due to the lack of safety alarms, the surgeon solely relies on the anesthesiologist for diagnosis of esophageal perforation.

4. Conclusion

Though peroral endoscopic myotomy (POEM) is a minimally invasive endoscopic intervention, the risk of esophageal perforation is estimated to be 5-10%. Even small esophageal wall perforations may result in hemodynamic collapse due to pneumomediastinum or tension pneumoperitoneum. Prompt recognition of endoscopic perforation and its sequelae are essential to a successful patient outcome.

5. Conflict of interests

None declared by the authors.

6. Authors' contribution

DK, AH: Literature review, Preparation of the manuscript

DV: Provision of anesthetic care, literature review, and preparation of the manuscript

GRCR: Provision of anesthetic care, literature review, preparation of manuscript, and guidance to primary authors

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