

## CASE REPORT

## ANESTHESIOLOGY

# Massive pneumomediastinum and pneumoperitoneum during peroral endoscopic myotomy

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## Abstract

Peroral endoscopic myotomy (POEM) is a minimally invasive, and newly developed endoscopic intervention for esophageal achalasia. This technique has replaced open surgical techniques in centers, where expertise is available. It is comparatively a new procedure, so our knowledge about its short term and long term complications is yet very limited. We present a case of a patient undergoing POEM who suffered from hemodynamic collapse due to pneumomediastinum and massive pneumoperitoneum requiring emergent needle decompression.

**Abbreviations:** POEM – Peroral endoscopic myotomy; TV – Tidal volume; PEEP – Positive end-expiratory pressure; PIP – Peak inspiratory pressure; PACU – Post-operative care unit

**Key words:** Pneumomediastinum; Mediastinal emphysema; Subcutaneous emphysema; Hypercapnia; Pneumoperitoneum; Endoscopy; Esophagogastroduodenoscopy; Peroral endoscopic myotomy; POEM

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## 1. Introduction

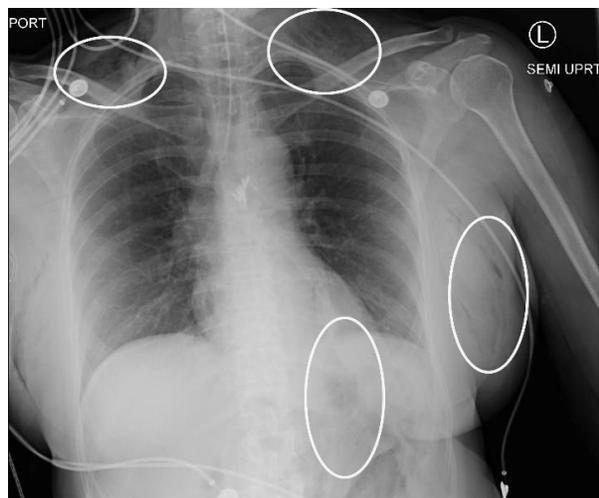
Peroral endoscopic myotomy (POEM) is an increasingly popular treatment for esophageal achalasia. Despite the minimally invasive approach, few severe complications have been reported in the literature. Still our knowledge about its long term side effects and complications remains limited. We describe the management of a patient who developed pneumomediastinum and massive pneumoperitoneum during a POEM. Early recognition and prompt intervention saved the life of the patient. As the procedure gains wide-spread acceptance, the number of surgeries will definitely rise, so the anesthesiologist must keep the possibility of every complication in mind to allow him early intervention.

## 2. Case report

A 63-year-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 dilations in the past. After uneventful

intubation, the patient was placed on positive pressure volume controlled ventilatory mode with tidal volume (TV) = 450 ml, respiratory rate (RR) = 10/min and positive end-expiratory pressure (PEEP) = 5 cmH<sub>2</sub>O. Anesthesia was maintained with sevoflurane and rocuronium. The patient remained hemodynamically stable and tolerated the procedure and CO<sub>2</sub> insufflation (flow rate between 1.5 to 3 L/min) well. The insufflation pressure was not continuous. However, two hours into the case the patient started becoming progressively hypotensive; blood pressure falling from 130/70 mmHg to 71/50 mmHg. This was simultaneously associated with a decrease in oxygen saturation from 99% to 86%. The peak inspiratory pressure (PIP) increased to 36 from 18 cmH<sub>2</sub>O, along with a drop in end tidal carbon dioxide (EtCO<sub>2</sub>) level to 26 mmHg from 40 mmHg.

Immediately the fraction of inspired oxygen (FiO<sub>2</sub>) was increased to 100%, an intravenous fluid bolus (one liter) was administered. In addition, repeated doses of phenylephrine (100 mcg and ephedrine 10 mg) were administered intravenously. The procedure was suspended and CO<sub>2</sub> insufflation was terminated.



**Figure 1: Intraoperative radiograph after abdominal needle decompression demonstrating bilateral supraclavicular subcutaneous emphysema and left axilla emphysema, as well as evidence of trace pneumomediastinum and pneumoperitoneum.**

Physical examination revealed extensive crepitus involving the area over neck, upper chest wall, bilateral arms, and significant abdominal distention. The clinical findings indicated the 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 esophagram obtained on postoperative day 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<sub>2</sub>). The POEM procedure involves separation of the inner circular muscular layer from the outer longitudinal layer of the



**Figure 2: Postoperative radiograph showing residual bilateral supraclavicular subcutaneous emphysema and improvement in pneumoperitoneum. Esophageal endoscopic clips used for closure of mucosal entry are also visualized.**

esophageal wall.<sup>1-2</sup> 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.<sup>1-2</sup>

During the procedure, the outer longitudinal muscle is vulnerable to injury as delineation between the inner and outer layers is often unclear.<sup>1-2</sup> Longitudinal muscle laceration during the myotomy may also occur. The outer longitudinal muscle is the only barrier between the esophageal lumen and mediastinum.<sup>1</sup> Even small perforations in the longitudinal muscle may result in subcutaneous emphysema, pneumomediastinum, pneumothorax, pneumoperitoneum, and abdominal compartment syndrome.<sup>1-10</sup>

Pneumoperitoneum and pneumomediastinum are known occurrences in the operating room for anesthesiologists. However, it is rare to encounter massive pneumoperitoneum during an esophageal endoscopy. Through esophageal injury occurring 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 and lifesaving. Imaging may not always be available to the clinician. 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<sub>2</sub> level quickly returned to normal levels.

Prevention and management of an esophageal perforation or transmural gas leak include increasing PEEP prior to endoscopic insufflation, and 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<sub>2</sub> 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.<sup>11</sup> In comparison, CO<sub>2</sub> is more readily absorbed from the intestinal lumen and can be eliminated via respiration.<sup>11</sup> It allows for the bowel to decompress more rapidly, thereby reducing the risk of complications such as subcutaneous emphysema, pneumoperitoneum, pneumothorax, pneumomediastinum, and gas embolization.<sup>12</sup> CO<sub>2</sub> 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.<sup>11,13, 14</sup>

Though the application of CO<sub>2</sub> for insufflation has improved numerous aspects of endoscopy, more could be done to improve the endoscopic safety.<sup>11</sup> Endoscopic insufflation involves a CO<sub>2</sub> regulator unit to deliver carbon dioxide. This CO<sub>2</sub> regulator has visual and audible alarms for low gas reserve or low-pressure. However, it lacks over-pressure alarms, indicators for CO<sub>2</sub> flow start/stop, and delivered quantity of CO<sub>2</sub>.<sup>12</sup> Further, they are not able to automatically adjust the

flow rate and maintain a constant pressure. The CO<sub>2</sub> regulator models by the leading manufacturers (Olympus, Medivators, and Bracco Diagnostics), all have similar limitations. The absence of intraluminal pressure monitoring during endoscopic procedures poses a risk to the patient. The risk of esophageal perforation is estimated to be 5-10%. Currently, due to the lack of safety alarms, the endoscopist solely relies on the anesthesiologist for the diagnosis of esophageal perforation. Continuous vigilance is the price of safety.

## 4. Conclusion

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

## 5. Conflict of interest

Nil declared by the authors.

## 6. Authors' contribution

All authors helped in research, manuscript writing, reviewing and editing.

## 7. References

1. Ren Z, Zhong Y, Zhou P, Xu M, Cai M, Li L, et al. Perioperative management and treatment for complications during and after peroral endoscopic myotomy (POEM) for esophageal achalasia (EA) (data from 119 cases). *Surg Endosc*. 2012 Nov;26(11):3267-72. [PubMed] DOI: [10.1007/s00464-012-2336-y](https://doi.org/10.1007/s00464-012-2336-y)
2. Eleftheriadis N, Inoue H, Ikeda H, Onimaru M, Yoshida A, Hosoya T, et al. Training in peroral endoscopic myotomy (POEM) for esophageal achalasia. *Ther Clin Risk Manag*. 2012;8:329-42. [PubMed] DOI: [10.2147/TCRM.S32666](https://doi.org/10.2147/TCRM.S32666)
3. Alexiou K, Sakellariadis T, Sikalias N, Karanikas I, Economou N, Antsaklis G. Subcutaneous emphysema, pneumomediastinum and pneumoperitoneum after unsuccessful ERCP: a case report. *Cases J*. 2009 Feb 3;2(1):120. [PubMed] DOI: [10.1186/1757-1626-2-120](https://doi.org/10.1186/1757-1626-2-120)
4. Maunder RJ, Pierson DJ, Hudson LD. Subcutaneous and mediastinal emphysema. Pathophysiology, diagnosis, and management. *Arch Intern Med*. 1984 Jul;144(7):1447-53. [PubMed]
5. Symeonidis N, Ballas K, Pavlidis E, Psarras K, Pavlidis T, Sakantamis A. Tension pneumoperitoneum: a rare complication of upper gastrointestinal endoscopy. *JSLs*. 2012 Jul-Sep;16(3):495-7. [PubMed] DOI: [10.4293/108680812X13462882736655](https://doi.org/10.4293/108680812X13462882736655)

6. Griffiths EA, Ellis A, Mohamed A, Tam E, Ball CS. Surgical treatment of a Morgagni hernia causing intermittent gastric outlet obstruction. *BMJ Case Rep.* 2010 Nov 5;2010:bcr0120102608. [PubMed] DOI: [10.1136/bcr.01.2010.2608](https://doi.org/10.1136/bcr.01.2010.2608)
7. Falidas E, Anyfantakis G, Vlachos K, Goudeli C, Stavros B, Villias C. Pneumoperitoneum, retroperitoneum, pneumomediastinum, and diffuse subcutaneous emphysema following diagnostic colonoscopy. *Case Rep Surg.* 2012;2012:108791. [PubMed] DOI: [10.1155/2012/108791](https://doi.org/10.1155/2012/108791)
8. Frias Vilaça A, Reis AM, Vidal IM. The anatomical compartments and their connections as demonstrated by ectopic air. *Insights Imaging.* 2013 Dec;4(6):759-72. [PubMed] DOI: [10.1007/s13244-013-0278-0](https://doi.org/10.1007/s13244-013-0278-0)
9. Baron TH, Wong Kee Song LM, Zielinski MD, Emura F, Fotoohi M, Kozarek RA. A comprehensive approach to the management of acute endoscopic perforations (with videos). *Gastrointest Endosc.* 2012 Oct;76(4):838-59. [PubMed] DOI: [10.1016/j.gie.2012.04.476](https://doi.org/10.1016/j.gie.2012.04.476)
10. Ahmed Y, Othman MO. Peroral endoscopic myotomy (POEM) for achalasia. *J Thorac Dis.* 2019 Aug;11(Suppl 12):S1618-S1628. [PubMed] DOI: [10.21037/jtd.2019.07.84](https://doi.org/10.21037/jtd.2019.07.84)
11. Dellon ES, Hawk JS, Grimm IS, Shaheen NJ. The use of carbon dioxide for insufflation during GI endoscopy: a systematic review. *Gastrointest Endosc.* 2009 Apr;69(4):843-9. [PubMed] DOI: [10.1016/j.gie.2008.05.067](https://doi.org/10.1016/j.gie.2008.05.067)
12. Lo SK, Fujii-Lau LL, Enestvedt BK, Hwang JH, Konda V, Manfredi MA, et al. The use of carbon dioxide in gastrointestinal endoscopy. *Gastrointest Endosc.* 2016 May;83(5):857-65. [PubMed] DOI: [10.1016/j.gie.2016.01.046](https://doi.org/10.1016/j.gie.2016.01.046)
13. Tu S, Huang S, Li G, Tang X, Qing H, Gao Q, et al. Submucosal tunnel endoscopic resection for esophageal submucosal tumors: a multicenter study. *Gastroenterol Res Pract.* 2018 Dec 2;2018:2149564. [PubMed] DOI: [10.1155/2018/2149564](https://doi.org/10.1155/2018/2149564)
14. Li, Xuan, et al. Sa1035 co 2 insufflation vs air insufflation for esd: a meta-analysis of randomized controlled trials. *Gastrointest Endosc.* 2018;87(6 Suppl):AB152-AB153. DOI: [10.1016/j.gie.2018.04.1386](https://doi.org/10.1016/j.gie.2018.04.1386)