Massive pneumoperitoneum after cardiopulmonary resuscitation, a case report

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ABSTRACT

Background: Complications from cardiopulmonary Resuscitation (CPR) are common and can add to morbidity and mortality. A pneumoperitoneum after CPR is an uncommon complication. The majority of previously reported cases of gastric perforation after CPR were associated with difficult airway management or positive pressure ventilation in association with chest compressions.

Case Presentation: We present a case of a massive pneumoperitoneum in a 53-year-old woman after resuscitation following attempted hanging. During and following basic and advanced life support, a massive swelling of the abdomen due to massive pneumoperitoneum was observed, most likely caused by gastric perforation after bag-valve mask ventilation on an obstructed airway. The pneumoperitoneum resolved after conservative measures and insertion of an intra-abdominal drain; no surgery was necessary. The patient made a good and full recovery.

Conclusion: This case emphasizes the importance of maintaining vigilance for gastric perforation with abdominal distention after CPR, in particular when difficult airway management is encountered. Prevention of gastric dilation and perforation can be achieved by diligent airway management and prevention of high inspiratory pressures. Conservative management using only an abdominal drain can be effective in selected cases when perforation is limited and in the absence of peritonitis.

Keywords: Resuscitation, Pneumoperitoneum, bag-valve mask ventilation, airway obstruction, prevention, conservative management.

Type of Article: CASE REPORT **Specialty:** Emergency Medicine

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Introduction

High-quality cardiopulmonary Resuscitation (CPR) is the cornerstone of Basic Life Support (BLS) and Advanced Life Support (ALS) [1]. Although CPR and manual chest compressions are essential in cardiac arrest, they can also cause harm. Complications from CPR include rib fractures, hemothorax, and pneumothorax. Hepatosplenic injuries and cardiac contusion or laceration are less common complications [2]. A pneumoperitoneum after CPR is an uncommon but possibly life-threatening complication.

Case Report

A 53-year-old woman with a history of depression and failed back surgery syndrome attempted suicide by hanging from the radiator unit in the basement of her home. Her husband found her 10 minutes after they last spoke. After calling the emergency services, he initiated BLS. Paramedics, arriving 7 minutes after the first call, continued chest compressions and started bag-valve mask ventilation. The initial rhythm was asystole. The standard non-shockable rhythm ALS algorithm was initiated [1]. With each ventilation, the abdomen distended progressively, and ventilation became more difficult. Laryngoscopy showed a dental prosthesis lodged in the oropharynx of the patient in front of the laryngeal inlet. After removal of the dental prosthesis, bag-valve mask ventilation clearly improved. A medical team with an emergency physician arriving 6 minutes after the ambulance was able to obtain a patent airway after placement of a supraglottic airway (SGA) (I-gel®, Intersurgical, Berkshire, UK). After placement of the SGA, no high-pressure alerts were registered. Nasogastric tube placement through the SGA failed to decompress the abdomen. Adrenaline 1 mg was administered after intravenous (IV) access was obtained. In total, 2 mg adrenaline IV was administered during CPR. Return of spontaneous circulation (ROSC) was achieved 4 minutes after securing the airway. After

stabilization on scene, the patient was transferred to the emergency department (E.D.). The SGA was removed, the patient was intubated endotracheally, and a nasogastric tube was inserted. Despite the placement of a nasogastric tube, the abdomen remained distended and tympanic to percussion. Chest X-ray and Computed tomography (CT) examination of the abdomen confirmed a massive pneumoperitoneum. (Figures 1 and 2)

We decided to abstain from explorative laparoscopy. The abdominal surgeon inserted an abdominal drain (Cystofix®, B. Braun Medical, Diegem, Belgium) infra-umbilical; subsequently, the abdomen deflated rapidly.

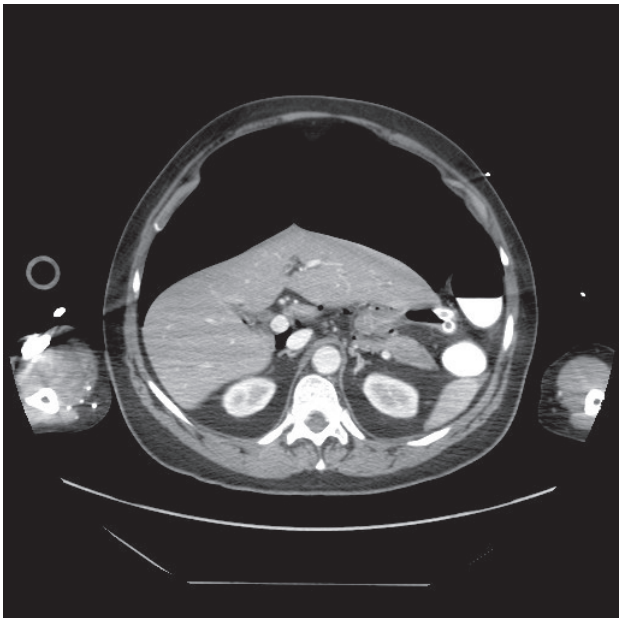

Figure 1. *Transverse image of CT abdomen: massive dilatation of the abdomen and pneumoperitoneum. No apparent free fluid, no perforation or contrast extravasation of the stomach could be detected.*

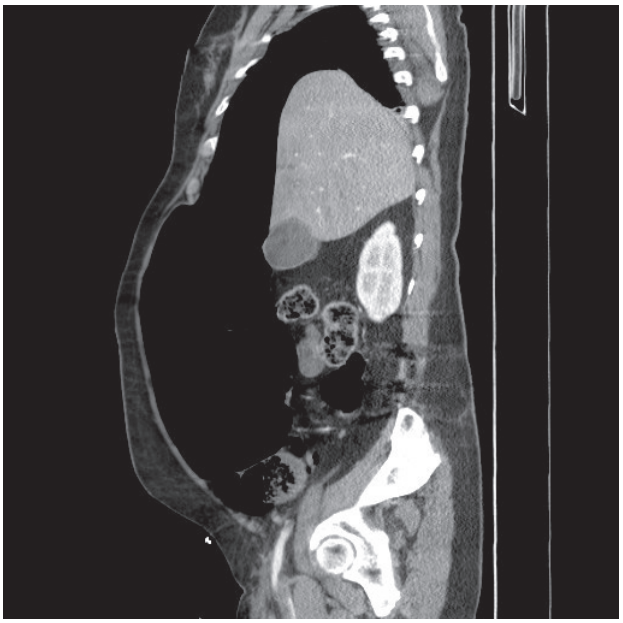

Figure 2. *Sagittal image of the CT abdomen: the extent of peritoneum and elevation of the diaphragm, causing increased inspiratory driving pressure and decreased ventilation volumes.*

The patient remained sedated and mechanically ventilated for the next 24 hours in the Intensive Care Unit. Antibiotics (amoxicillin-clavulanic acid) and high-dose proton pump inhibitors (pantoprazole) were started.

The next day, a fluoroscopy of the upper digestive tract, using 500 ml of contrast dye (Telebrix® - joxitalamaat 300mg/1ml) via the nasogastric tube, showed no leakage. Sedation was stopped, and the patient was weaned from the ventilator. She regained consciousness and made a full recovery without any neurological sequelae. On day 4, the abdomen was no longer distended nor tender to touch. There was no residual pneumoperitoneum on a control CT abdomen. Gastroscopy excluded a significant lesion, showing only a hiatus hernia and mucosal injury of the posterior portion of the corpus of the stomach. Based on these results, the intraperitoneal drain and nasogastric tube were removed. Oral feeding, using liquids first, was reintroduced. No further therapeutic interventions were necessary, and the patient could be discharged home after 9 days of hospitalization. Pantoprazole 40 mg by mouth twice daily was continued for 8 weeks. At consultation a few weeks later the patient showed no signs of complication (Table 1).

Discussion

The overall incidence of CPR-related complications ranges from 21% to 65% [3-5]. Abdominal complications can be observed in up to 30% of all cases. Gastric distention during mouth-to-mouth or bag-valve mask ventilation is very common and can be found in 29% of cases [5]. Gastric mucosal injuries occur in 9% to 12% of the patients who receive CPR [3,4,6-9]. Gastric rupture, however, is a rare complication with an incidence of less than 1% [10,11].

Gastric rupture can cause additional morbidity due to its potential to cause pneumoperitoneum, peritonitis, and septic shock [6]. It is commonly caused by excessive intragastric pressure and external chest compressions or difficult airway management (failure to intubate, esophageal intubation, blocked upper airway, forceful or prolonged bag-valve mask or mouth-to-mouth ventilation) [3,6,9,12,13]. Pneumoperitoneum can result in tension pneumoperitoneum compressing the inferior vena cava, decreasing venous return, and thereby compromising the hemodynamic stability of the patient. Moreover the diaphragm can be displaced upward, increasing intrathoracic pressure and thereby impairing ventilation. Pneumoperitoneum during CPR is commonly caused by gastric rupture as a result of excessive intragastric pressure and external chest compressions. Most cases are associated with difficult airway management: failure to intubate, esophageal intubation, blocked upper airway, forceful or prolonged bag-valve mask or mouth-to-mouth ventilation

Table 1. *Clinical timeline summarizing important timeframe, associated major interventions and events.*

Timetable	Procedure	events
First contact - discovery by partner	Start BLS	Asystole due to asphyxiation
Arrival ambulance	Start ALS Removal of dental prosthesis	Inflation of the abdomen due to airway obstruction
Arrival Medical Emergency team	ALS Placement IV and IV adrenaline Placement SLA	ROSC - persisted dilatation of the abdomen
Arrival at E.D.	Removal of SLA and endotracheal intubation Placement of nasogastric probe CT scan abdomen	Improvement of ventilation, no deflation of the abdomen Discovery of massive pneumoperitoneum
Intensive care unit	Placement abdominal drain Post-reanimation care Re-imaging and gastroscopy Weaning and removal of the drain	Deflation of the abdomen Full recovery

Furthermore, active compression/decompression devices and the Heimlich maneuver have been associated with gastric perforation [6,11]. Note that CPR-related pneumoperitoneum can also be caused by pulmonary barotrauma and air displacement through the diaphragmatic hiatus [7,9].

Gastric perforation can occur when the intraluminal pressure reaches 120-150 mmHg, which corresponds to an intragastric volume of approximately 4 l [3,4,6,9]. In case of a mechanical obstruction or distortion of the airway, the resistance to airflow of the esophagus becomes less than that of the glottis. If positive pressure during bag mask ventilation exceeds the closing pressure of the upper esophageal sphincter (approximately 20 mmHg) air can be forced into the stomach. As a result, air is forced into the stomach. Mechanical obstruction, vigorous ventilation, tracheal or oropharyngeal injury, and alteration of the gastro-esophageal junction acting as a mechanical valve may prevent air from leaving the stomach as it becomes more and more dilated [3,6,11]. Most cases of gastric perforation after CPR occur at the small curvature of the stomach, usually close to the gastro-esophageal junction, where the stomach wall is least elastic. In this area, there are fewer mucosal folds, and the stomach is fixed by the hepatogastric ligament [4,6,7,8,9,12].

Symptoms in the conscious patient are abdominal pain, a distended and tympanic abdomen, and sometimes hematemesis. In the unconscious patient, the abdomen is tympanic and distended. In a CPR setting, the distention may be rapidly progressive. Persistence of abdominal distention and bloody aspirate after insertion of a nasogastric tube should raise suspicion of gastric perforation, especially in cases with known difficult airway management [3,4,6].

Pneumoperitoneum is a clinical diagnosis. Free intra-abdominal air can be confirmed on abdominal sonography, chest X-ray, preferably performed in a sitting position, or CT scan [3,4,6,7]. POCUS of the abdomen can be a fast way to discriminate fluid from air in the ED. Other diagnostic examinations, such as contrast X-ray studies, endoscopy, and surgery, can be useful in confirming the diagnosis, detecting the location of perforation, and guiding causal treatment. However, the site of perforation cannot always be clearly identified by fluoroscopy of the upper digestive tract, gastroscopy, or surgery [6].

Distention of the abdomen during CPR is treated urgently by insertion of a nasogastric tube to prevent the development of gastric rupture and subsequent (tension) pneumoperitoneum. If this measure fails to decompress the abdomen, a 14-G cannula can be inserted just below the umbilicus to deflate the abdomen (9). The most common treatment of gastric perforation was surgical debridement and primary closure of the perforation either by laparotomy or laparoscopy [13,14]. A more recent case report with a comprehensive oversight of all published cases showed an increasing occurrence of conservative management [12]. Prophylactic antibiotic therapy and antacids should be started early to prevent peritonitis. Fluoroscopy of the upper digestive tract and gastroscopy can be performed in a second stage to locate the source of the lesion or perforation. In the absence of signs of peritonitis, we would advise against explorative surgery and propose a conservative approach (watchful waiting) [4,9,12].

Gastric distention and consequential gastric rupture and pneumoperitoneum during CPR can be and should be prevented. Correct airway management is essential: correct positioning of the jaw, air entry and exit by observing chest movements, avoidance of excessive ventilation volumes and high insufflation pressure, and checking the upper airway for obstruction if adequate ventilation is not possible. The use of ventilation airway adjuncts (oropharyngeal or nasopharyngeal) should be considered. If these do not help in obtaining good bag-valve mask ventilation and the care provider is proficiently trained, the patient should be intubated. After confirmation of correct endotracheal intubation

(capnography, auscultation, and direct visualization of vocal cord passage), an oro- or nasogastric tube should be placed.

Conclusion

Early recognition of abdominal distention during resuscitation should prompt consideration of gastric perforation. A high index of suspicion for gastric perforation is required if airway management is difficult and abdominal distention develops during resuscitation. In the event of gastric perforation, early diagnosis and management are of paramount importance to prevent further complications. Conservative management may be appropriate in stable patients with limited perforation and in the absence of signs of peritonitis.

What is new?

Gastric perforation is a rare complication during resuscitation. The mainstay treatment after ROSC was laparotomy. Early treatment with a percutaneous abdominal drain without previous surgery can be performed if imaging shows no apparent intra-abdominal lesions and in the absence of signs of peritonitis.

List of Abbreviations

ALS	Advanced Life Support
BLS	Basic Life Support
CPR	Cardiopulmonary resuscitation
CT	Computed tomography
E.D.	emergency department
IV	Intravenous
mg	Milligram
POCUS	Point of care ultrasound
ROSC	Return of spontaneous circulation
SGA	Supraglottic airway

Conflicts of interest

The authors declare that they have no conflict of interest regarding the publication of this case report.

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Informed Consent

Written consent was obtained from the patient.

Ethical approval

Ethical approval was obtained from our hospital's Ethics Committ ee and is available on request.

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Summary of case

1	Patient (gender, age)	53 years, female
2	Final diagnosis	Massive pneumoperitoneum due to gastric rupture
3	Symptoms	Massive dilation of the abdomen
4	Medications	Pantoprazole, amoxicillin-clavulanic acid
5	Clinical procedure	Percutaneous drainage was inserted infra-umbilical
6	Specialty	Emergency medicine - anesthesiology