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Tension Pneumoperitoneum Due to Sigmoid Diverticulum Perforation: A Case Report

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Abstract —Tension pneumoperitoneum is a rare, life-threatening condition in which intra-abdominal free air causes increased intra-abdominal pressure, compromising organ function. When secondary to sigmoid diverticulum perforation, it can be particularly dangerous. We present the case of a 74 year old male who developed tension pneumoperitoneum following a perforated sigmoid diverticulum, leading to severe aortic compression and hemodynamic instability. Rapid diagnosis and emergency surgical intervention led to a favorable outcome. This case underscores the importance of early recognition and intervention in tension pneumoperitoneum, especially when complicated by vascular compression. It also highlights the rare but critical association of elevated intra-abdominal pressure with aortic compression.

Keywords *— tension pneumoperitoneum; sigmoid diverticulum perforation; intra-abdominal hypertension; aortic compression; emergency laparotomy.*

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INTRODUCTION

Tension pneumoperitoneum is a rare surgical emergency characterized by massive accumulation of free intraperitoneal air under pressure, leading to elevated intra-abdominal pressure (IAP). Unlike simple pneumoperitoneum, this condition can result in compromised venous return, decreased cardiac output, and multi-organ dysfunction. Perforation of a sigmoid diverticulum is a common cause of free air in the abdomen but rarely progresses to a tension state. Even more uncommon is significant vascular compression, such as of the abdominal aorta, which can contribute to hemodynamic instability and ischemia.

CASE PRESENTATION

A 74-year old male with a history of chronic constipation and known diverticulosis presented to the emergency department with sudden onset of severe abdominal pain, distension, and respiratory distress. On initial examination, the patient was in distress, hypotensive (BP: 82/50 mmHg), tachycardic (HR: 122 bpm), and tachypneic (RR: 28/min) with cold extremities and poor peripheral pulses. His abdomen was markedly distended, tympanic to percussion, and rigid on palpation. Initial laboratory workup revealed leukocytosis (WBC: 18,000/µL), metabolic acidosis (lactate: 5.8 mmol/L), and elevated serum creatinine (1.7 mg/dL). An upright urgent abdominal X-ray demonstrated gross pneumoperitoneum with diaphragmatic elevation (Figure 1). A contrast-enhanced CT scan of the abdomen and pelvis showed massive free intra-abdominal air causing downward displacement and compression of abdominal organs. Free fluid and air were visualized in the abdominal cavity (Figures 2 and 3). These findings were consistent with tension pneumoperitoneum, likely secondary to gastrointestinal perforation. Associated pneumobilia and large-volume ascites raised concern for peritonitis. Collapse of bowel loops and the inferior vena cava (IVC) supported a possible hypovolemic or septic shock state.

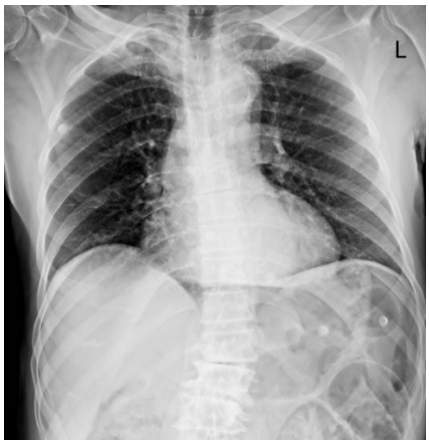


Figure 1. Upright abdominal X-ray showing gross pneumoperitoneum with elevation of both hemidiaphragms (continuous diaphragm sign). This finding is highly suggestive of gastrointestinal perforation and was the initial imaging clue to tension physiology.

The patient was immediately taken to the operating room for emergency laparotomy. Upon decompression of the abdominal cavity through a midline incision, a large rush of air escaped, resulting in immediate hemodynamic improvement. Exploration revealed a 1.5 cm perforation in the sigmoid colon, consistent with a ruptured diverticulum. A sigmoid colectomy with end colostomy (Hartmann's procedure) was performed. The compressed segment of the abdominal aorta regained normal pulsatility post-decompression, which helped restore perfusion to the kidneys and mesentery, thereby reducing the risk of ischemic injury. The patient stabilized postoperatively and was managed in the intensive care unit. He was extubated on postoperative day 2, and renal function gradually improved. A follow-up CT scan confirmed normalization of the aortic caliber. He was discharged home in stable condition on postoperative day 10 with outpatient follow-up arranged.

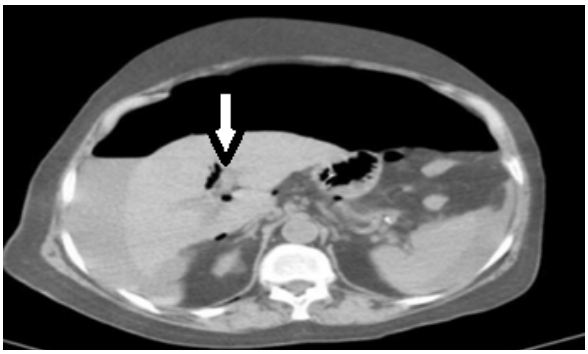


Figure 2. (axial CT): Large volume of free intraperitoneal air throughout the abdominal cavity, with air-fluid levels and pneumobilia (white arrow). The small bowel loops and colon are collapsed.

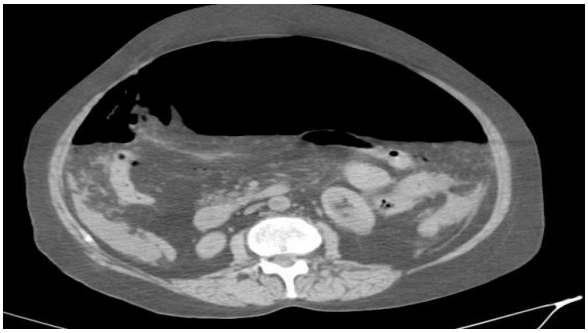


Figure 3. (axial CT at a different level): Collapsed inferior vena cava (IVC) (white arrow), indicating hypovolemia or impending shock. The abdominal aorta appears compressed but regained normal pulsatility after surgical decompression.

DISCUSSION

Tension pneumoperitoneum is a rare surgical emergency characterized by massive accumulation of free intraperitoneal air under pressure, leading to elevated intra-abdominal pressure (IAP). Unlike simple pneumoperitoneum, this condition can result in compromised venous return, decreased cardiac output, and multiorgan dysfunction [1]. Perforation of a sigmoid diverticulum is a common cause of free air in the abdomen but rarely progresses to a tension state. Even more uncommon is significant vascular compression, such as of the abdominal aorta, which can contribute to hemodynamic instability and ischemia [2].

Comparison with other reported cases: Tension pneumoperitoneum due to spontaneous colonic perforation is exceedingly rare. A review of the literature reveals fewer than 20 cases of tension pneumoperitoneum secondary to diverticular perforation. Most previously reported cases did not describe direct aortic compression with hemodynamic collapse as the dominant feature. In contrast, our patient exhibited marked aortic compression that resolved immediately upon decompression, emphasizing the mechanical rather than purely septic etiology of shock in tension pneumoperitoneum. This unique feature highlights the need for rapid decompression before sepsis becomes the predominant driver of instability.

Diverticular disease is one of the most common gastrointestinal conditions in Western countries, particularly among older adults. It affects approximately 50% of individuals over the age of 60, with the sigmoid colon being the most frequently involved segment due to its higher intraluminal pressure [3]. While most patients with diverticulosis remain asymptomatic, an estimated 10% to 25% will develop complications, which may include diverticulitis, abscess formation, fistulae, or perforation. Among these, colonic perforation is one of the most serious complications and often necessitates emergency surgical intervention [4]. Sigmoid diverticulitis is a leading cause of these perforations [5].

Tension pneumoperitoneum is an extremely rare but life-threatening condition. While the presence of free intraperitoneal air is common in cases of gastrointestinal perforation, the development of tension physiology where air accumulates under pressure to the point of causing hemodynamic compromise is exceedingly rare [6]. Most reported cases of tension pneumoperitoneum have occurred in iatrogenic or traumatic settings. Cases associated with spontaneous colonic perforation, including perforation secondary to diverticulitis, are particularly uncommon [7].

Diverticula are outpouchings of the colonic mucosa and submucosa that develop at weak points in the intestinal wall, often as a result of increased intraluminal pressure. Inflammation of these diverticula, known as diverticulitis, can lead to either microperforation or macroperforation [8]. Microperforations are often walled off by surrounding tissues, but macroperforations can result in generalized peritonitis. Contributing factors to diverticular perforation include fecal impaction, bacterial infection, localized ischemia of the diverticulum, and the use of medications such as NSAIDs or corticosteroids [9].

Tension pneumoperitoneum arises when free air accumulates rapidly within the peritoneal cavity and is not absorbed or released, leading to a dramatic rise in intra-abdominal pressure. This elevated pressure causes compression of intra-abdominal organs, elevation of the diaphragm, and reduced venous return to the heart due to compression of major vessels such as the inferior vena cava and abdominal aorta [10]. In our patient, this compression directly compromised aortic blood flow, which likely contributed to renal hypoperfusion (elevated creatinine) and lactic acidosis. The resulting decrease in cardiac output can lead to shock and multiorgan dysfunction. In the context of colonic perforation, gas may enter the peritoneal cavity through a one-way valve mechanism or may be produced in large quantities by gasforming bacteria [11].

Clinical presentation

Patients with perforation of a sigmoid diverticulum typically present with sudden onset of severe abdominal pain, most often localized to the left lower quadrant. They may also exhibit systemic signs such as fever, nausea, vomiting, and signs of localized or generalized peritonitis, including abdominal tenderness, guarding, and rebound tenderness [12]. In severe cases,

hypotension and tachycardia may develop due to sepsis or peritoneal inflammation [13]. In contrast, tension pneumoperitoneum presents with more dramatic findings. Patients often exhibit marked abdominal distension and tympany on percussion, along with respiratory distress caused by diaphragmatic elevation. Hemodynamic instability, such as hypotension, tachycardia, and decreased urine output, may develop rapidly [14]. Vascular compression, particularly of the abdominal aorta or inferior vena cava, may result in diminished peripheral pulses and further compromise perfusion, potentially leading to shock [1].

Diagnostic Evaluation

Initial diagnostic evaluation includes laboratory testing, which may reveal an elevated white blood cell count, indicating an inflammatory response. Lactic acidosis may also be present and is suggestive of tissue hypoperfusion [13]. In advanced cases, renal dysfunction may be indicated by elevated creatinine levels [10]. Bedside ultrasound may be used in unstable patients to detect free intraperitoneal fluid, but it has limited utility for detecting free air [6].

Imaging studies play a critical role in diagnosis. An upright abdominal or chest x-ray can demonstrate free air under the diaphragm, which is highly suggestive of gastrointestinal perforation [5]. A computed tomography (CT) scan with intravenous contrast is the most sensitive and specific imaging modality. It allows for identification of the site of perforation, the presence of free air or fluid, and any associated abscesses [7]. In cases of tension pneumoperitoneum, the CT scan may also reveal organ displacement and compression of major vascular structures, such as the abdominal aorta or inferior vena cava [2].

Management

Management of sigmoid diverticulum perforation depends on the severity of the clinical presentation. In patients with localized peritonitis or contained perforations, conservative management with intravenous antibiotics and, if necessary, percutaneous drainage of abscesses may be appropriate [4]. However, in patients with generalized peritonitis or fecal contamination, surgical intervention is required [9]. A Hartmann's procedure, which involves resection of the affected sigmoid colon and creation of an end colostomy, is commonly performed, particularly in unstable patients [3]. In selected stable patients with minimal contamination, primary resection and anastomosis may be considered [10].

In cases of tension pneumoperitoneum, immediate decompression is critical to relieve intra-abdominal pressure and restore organ perfusion. In emergency settings, needle decompression using a large-bore needle inserted into the left upper quadrant or infraumbilical midline can serve as a temporizing measure [11]. Definitive treatment requires urgent laparotomy to decompress the abdomen, control the source of perforation, and perform peritoneal lavage [8]. The surgical approach should also include resection of the affected bowel segment and appropriate diversion, depending on the degree of contamination and patient stability .Postoperative management includes intensive monitoring, broad-spectrum antibiotics, and supportive care to manage sepsis, renal dysfunction, or respiratory compromise[12].

CONCLUSION

Perforation of a sigmoid diverticulum is a serious complication of diverticular disease and can, in rare cases, lead to tension pneumoperitoneum. This condition can cause severe intra-abdominal hypertension, resulting in diaphragmatic elevation, respiratory compromise, and even compression of major vascular structures such as the aorta. Direct aortic compression can impair renal and mesenteric perfusion, leading to ischemic injury if not rapidly reversed. Early diagnosis through imaging and prompt surgical decompression are essential to prevent irreversible organ damage and death. This case highlights the importance of considering tension pneumoperitoneum in patients presenting with acute abdominal distension and hemodynamic instability, and the need for swift surgical management in such scenarios.

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