

Beyond breathless: a case of air infiltrating every cavity

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Abstract

Hawaii attracts 10 million tourists annually, with non-residents accounting for 9% of trauma cases, half of which are water-related. We experienced a SCUBA tank injury, causing extensive trauma from pressurized air release. A 53-year-old female, post-Scuba diving, fell onto a SCUBA tank, causing rapid pressurized air discharge. She presented with perineal pain, bloating, and extensive subcutaneous emphysema. CT revealed air in every possible cavity. Thoracostomies and exploratory laparotomy performed, revealing an 80-90% anal sphincter transection. An overlapping anal sphincteroplasty with diverting loop ileostomy was performed. Recovery was uncomplicated. This unique case involves a traumatic SCUBA

tank air release causing extensive damage. The patient avoided direct anorectal entry, preventing catastrophic damage but sustained an anal sphincter complex injury. Air likely entered the peritoneum through the levator ani, causing pneumoperitoneum and pneumothoraces. The extensive damage emphasizes the need for safe water sports practices. The patient's recovery highlights the human body's resilience in unique situations.

Introduction

Approximately 10 million tourists visit Hawaii annually, with non-residents comprising about 9% of trauma cases.¹ Water-related injuries constitute nearly 50% of these cases. We present a rare case of a fall onto a SCUBA tank, causing a significant release of highly pressurized air and resulting in extensive trauma.

Case Report

The patient is a 53-year-old female who went SCUBA diving in Hawaii. As they returned to the dock, she stepped off the boat and lost her balance with her gluteus landing on a SCUBA tank. The SCUBA tank dispersed gas into the perineum for a few seconds. She then complained of perineal and abdominal pain, and bloating symptoms.

In the emergency room, her blood pressure was stable, she was tachycardic in the 120s, O₂ saturation at 98%. On exam, she was in severe pain, with some respiratory distress. She had crepitus across her entire mid-body and a puncture wound next to her anus was seen with no active bleeding (Figure 1). Her labs were significant for a WBC count of 12000/uL. An immediate CXR and KUB showed extensive bilateral pneumothoraces and pneumoperitoneum, with extensive subcutaneous emphysema along the chest, abdomen, and upper thighs. CTA chest, CT abdomen pelvis, and CT T/L spine showed extensive pneumomediastinum, pneumothoraces, pneumoperitoneum, retroperitoneal air, as well as subcutaneous emphysema throughout her body (Figure 2 and 3). Emergency interventions involved bilateral chest tube placement and an exploratory laparotomy. Intra-operatively, no identifiable bowel or vascular injury was seen. Therefore, her abdomen was left open and transferred to the Level 1 trauma center for further management.

She was sent to the SICU intubated and sedated for vitals monitoring. She then proceeded to the OR with the trauma surgeon and colorectal surgeon within 24 hours after arrival. We did note two small disruptions in the sigmoid mesentery, which were presumed to be the points of rupture from the retroperitoneum (Figure 4). We additionally identified the hiatal defect without any incarceration of tissue. Fortunately, the intestines appeared healthy, and there was no evidence of perforation. However, the patient sustained an 80-90% transection of the external and internal anal sphincters with an adjacent perineal wound tracking superiorly into the retroperitoneum.

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Patient consent for publication: the patient gave her written consent to use her personal data for the publication of this case report and any accompanying images.

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Therefore, an overlapping anal sphincteroplasty was performed with a diverting loop ileostomy. A drain was placed in the pelvis, the fascia was closed. Postoperatively, she was extubated in the ICU and downgraded on POD 1. Over the next week, both chest tubes were removed and she was managed for an expected post-operative ileus. Subsequently, her drain was removed and her midline wound was closed in a delayed primary closure fashion. She was discharged to rehab on POD 9. She was seen in the trauma clinic in a week with no complaints with plans to fly home for continued rehab.

A few months later, she had anorectal manometry, which showed marginal sphincter tone; therefore, she was referred to a colorectal surgeon. About 6 months later she received an open ileostomy takedown. Postoperatively, she had incontinence for about a month, but it has since improved. She has not returned to baseline, but has regular bowel function and even plans to return to Hawaii in the future.

Discussion

Traumatic reports secondary to high-pressure injury to the human body are scarce, with this unfortunate incident involving a partially used scuba tank. These tanks, pressurized to 3,000 psi with



Figure 1. External visualization of the perianal wound.

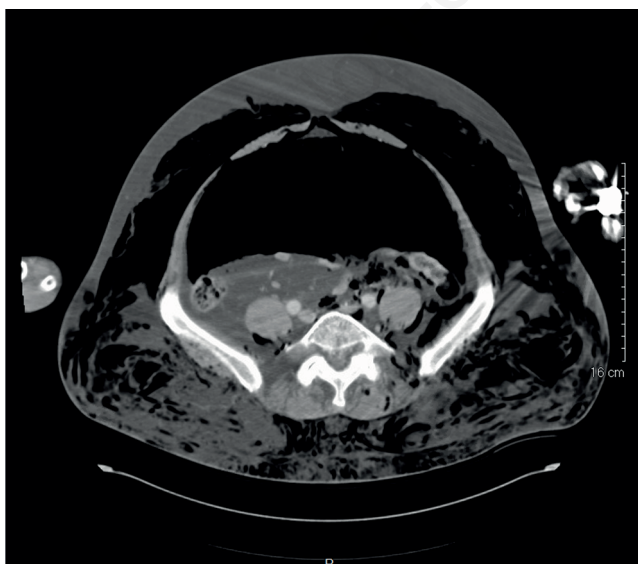


Figure 2. Axial views from the CT abdomen pelvis showing pneumoperitoneum occupying half of the cavity with the intra-abdominal organs pushed posteriorly.

a combination of nitrogen and oxygen, substantially contrast to laparoscopic insufflation settings at 15 mmHg, which is 0.29 psi, with a max flow rate of 40 mmHg (0.77 psi). When abdominal pressure exceeds > 20 mmHg, this meets the diagnosis of abdominal compartment syndrome, characterized by hemodynamic instability and organ dysfunction.² At sea level which is 1 ata (or 14.7 psi) are needed to ventilate the lungs.³ As the diver descends, pressure rises by 14.7 psi for every 33 feet (10 meters) of depth. At 33 feet, it reaches around 29.4 psi; at 66 feet, approximately 44.1 psi, and so forth. When used appropriately with a regulator, the flow that a SCUBA diver inhales ranges around 1-10 ata, which is 14.7-147 psi. There's a significant difference between surgical insufflation and the traumatic dispersal of gas-causing pneumoperitoneum.

A prior case involved pneumatic colon injury from a blow gun dust cleaner, with pneumatic pressure causing a transverse colon perforation.⁴ The researchers estimated the pneumatic pressure to



Figure 3. Sagittal views from the CT Chest showing a portion of the stomach herniating through the diaphragm hiatus vs diaphragm injury, also shows pneumothoraces, pneumomediastinum, and pneumoperitoneum.

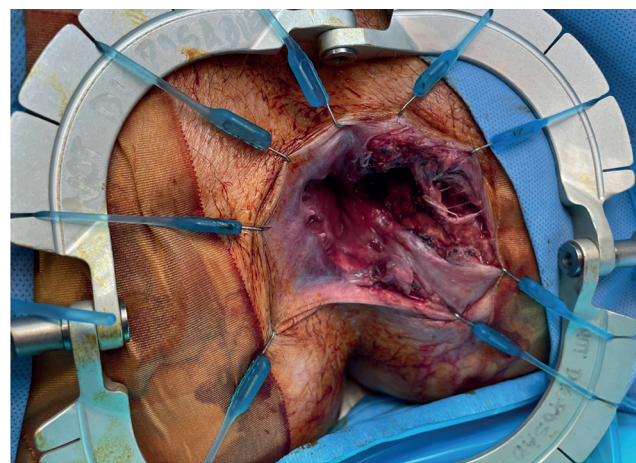


Figure 4. Intraoperative findings of the devastating anorectal damage.

range from 50 psi (3.5 kg/cm²) to 125 psi (8.8 kg/cm²), resulting in a transverse colon perforation. Notably, the patient was a 4-year-old, making the pediatric colon smaller and less elastic than in adults. A retrospective study analyzing 3,000 colonoscopies postulated that intraluminal insufflation flow rates greater than 1.46 L/m at 80 mmHg⁵ and absolute pressures of 4-6 psi were sufficient to induce a colonic perforation.^{6,7} Therefore, a direct entry into the anorectal canal would have caused immense intraluminal pressure, resulting in complete destruction of the canal. Despite entering subcutaneous tissue, the SCUBA tank's pressure disrupted the sphincter complex and dissected its own planes leading to pneumoperitoneum, pneumoretroperitoneum, pneumothorax, pneumomediastinum, and subcutaneous emphysema.

Because the peritoneum is a self-contained cavity, we suspect the air penetrated through the levator ani muscles along the TME plane into the perirectal fascia to enter the peritoneum. We suspect the sigmoid mesenteric injury was the air's entry point into the peritoneum. While retroperitoneal entry is possible, most of the air was intraperitoneal. An entirely retroperitoneal injury would have lifted the retroperitoneal structures like the ascending and descending colon and kidneys, and isolated the aorta or inferior vena cava.

She presented with bilateral pneumothoraces, left worse than right. We suspect air entered through a diaphragmatic hernia. The presence of a pre-existing hiatal hernia or trauma-induced hernia remains uncertain. Though no leak was seen in the hiatal hernia space during laparotomy, we suspect air entered the thoracic cavity through the mediastinum. Perforation of the hernia sac is not entirely ruled out. Another possibility is pneumothorax traveling inward via subcutaneous tissue.

Conclusions

We present a rare case of a traumatic fall onto a SCUBA tank, resulting in a high-pressure air release. This case highlights the rare occurrence of a traumatic SCUBA tank injury resulting in multi-cavity air discharge. Though managed successfully, the extensive damage emphasizes the need for safe water sports practices. We are glad that she could make a full recovery, which includes the reversal of her ostomy.

References

1. Hawai'i State Department of Health, Emergency Medical Services Injury Prevention System Branch, Injury Prevention and Control Section. Injuries in Hawaii 2007 - 2011. Available from: <https://health.hawaii.gov/injuryprevention/files/2013/10/Databook-FINAL-Sept-20121.pdf>
2. Newman RK, Dayal N, Dominique E. Abdominal compartment syndrome. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-.
3. David A. Score et al. The National Oceanic and Atmospheric Administration (NOAA) Diving Manual. Office of Marine and Aviation Operations. Apr 5, 2017.
4. Sy ED, Chiu YI, Shan YS, Ong RL. Pneumatic colon injury following high pressure blow gun dust cleaner spray to the perineum. *Int J Surg Case Rep* 2015;6C:218-21.
5. Woltjen JA. A retrospective analysis of cecal barotrauma caused by colonoscope air flow and pressure. *Gastrointest Endosc* 2005;61:37-45.
6. Burt CAV. Pneumatic rupture of the intestinal canal. *Arch Surg* 1931;22:875-902.
7. Rosenberg IL, Smiddy FG. Insufflation injury of the bowel. *Arch Surg* 1972;105:113-5.