CHEST

A 26-Year-Old Man on Prolonged Mechanical Ventilatory Support With a Sudden Elevation in Peak Pressures

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VIDEO

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The patient is a 26-year-old man with a history of epidermolysis bullosa and extensive skin lesions complicated by squamous cell carcinoma in multiple sites, status post left above knee amputation with a percutaneous endoscopic jejunostomy tube placement for enteral nutrition, which was complicated by frequent dislodgment. The patient was initially admitted for aspiration pneumonia and sepsis that led to prolonged mechanical ventilation and subsequent tracheostomy.

On day 60 of admission, the ventilator alarm was persistently showing high plateau and peak pressures. A clinical algorithm was followed to evaluate the etiology of the elevated pressures. A suction catheter was passed without difficulty through the tracheostomy tube, and the patient was suctioned with no change in pressures, and no mucus production was noted. Lung ultrasound was performed to rule out pneumothorax in multiple areas on both anterior lung spaces. Sliding lung was present throughout with A-line pattern in the anterior lung fields (Video 1). Video bronchoscopy was subsequently performed, which showed minimal granulation tissue just below the tracheostomy tube in the trachea, but no endoluminal obstruction of the tracheostomy tube. The high pressures did not resolve with repositioning the tracheostomy tube. Through the day, the peak and plateau pressures remained elevated, and the only notable change in the physical examination was increasing distention of the abdomen. Ultrasound survey of the abdomen was limited because the patient was heavily bandaged because of his skin condition. The limited clips of the abdomen are shown in Videos 2 and 3. Video 2, although limited only to 5 seconds, is representative of a full minute ultrasound survey.

Question: Based on these videos, the clinical history, and the clinical and ultrasound examination, what is the cause of the elevation in plateau pressures?

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Next steps: The presence of ascites, the lack of intestinal peristalsis, and the suggestion of pneumatosis intestinalis implies that the patient had abdominal compartment syndrome, which led to the development of increased plateau pressures. This was confirmed by both a significantly increased bladder pressure (> 30 mm Hg) and CT scan, which showed extensive small bowel necrosis.

Discussion

Intestinal pneumatosis (IP) usually indicates an irreversible injury and transmural necrosis. Traditionally, abdominal radiography, especially CT imaging, has been used to diagnose IP.[1] The first reported case of ultrasound being used to diagnose IP was in 1985.[2] Most of the reports use endoscopic ultrasound[3-5] or advanced Doppler imaging techniques,[1] which are beyond the purview of the intensivist. On abdominal ultrasound, the circle sign[6] was described in three patients, with the pattern being recognized when extensive gas bubbles were seen in the entire circumference of the bowel wall. Unfortunately, the demonstration of this sign requires high-resolution ultrasonography. The extremely low BMI of the patient along with the presence of ascites allowed us to demonstrate presence of air bubbles in the bowel wall even with the phased array probe (Fig 1). Ultrasound has also been used to demonstrate extraluminal intraperitoneal air, which can be distinguished from intraluminal air by the presence of an increased echogenicity of the peritoneal stripe and multiple reflection artifacts, including a characteristic comet tail artifact.[7] Also, other nonspecific signs of bowel pathology, such as bowel wall thickening (> 3 mm), may also be seen.[8] Gas bubbles seen on an echocardiogram[9] or in the hepatic venous system[10] have been used to diagnose IP as well.

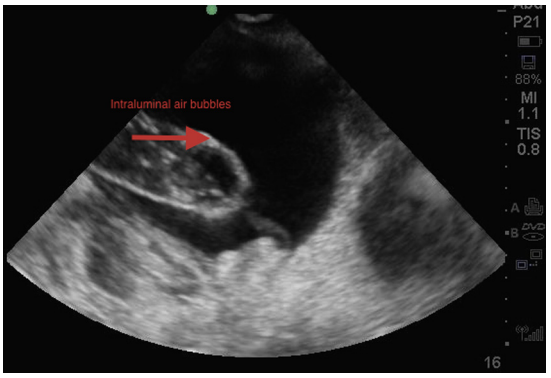

Figure 1 – *Hypoechoic collection which represents ascites. Bowel can be seen with hyperechoic bubbles in the bowel wall analogous to air bronchograms seen in lung ultrasound, representing intestinal pneumatosis.*

In this case, the echocardiogram and the lung ultrasound were normal. The patient's body habitus and extensive bandaging mandated limited visualization of the abdominal cavity. Video 2 shows complete absence of peristalsis. This sign is also seen with small bowel obstruction, and ultrasound is a valuable tool in the diagnosis of the same.[11] The presence of echogenic well circumscribed opacities in the bowel wall in Figure 1 suggest the diagnosis of IP. The right upper quadrant was not able to be imaged in the patient, and the decision for advanced imaging was easily made with the high pretest probability and the limited ultrasound clips.

The diagnosis of IP was confirmed on CT scanning, which showed extensive small bowel necrosis. The patient became more hypotensive, requiring escalating doses of pressors, and cardiac ultrasound was performed in a goal-directed fashion. Parasternal long-axis view (Video 4) was normal, as was the short-axis parasternal view (Video 5). The apical four-chamber view (Video 6) was also normal. The subcostal view and the inferior vena cava view could not be obtained because the patient had severe small bowel distention at this point and developed a significant lactic acidosis. Surgery was consulted; however, considering the patient's comorbidities, he was not a good surgical candidate. Subsequently, the patient expired 2 days later. (Video 7, discussion).

Reverberations

1. *IP is best visualized on CT scanning; however, ultrasound is a good screening tool for the same. Ultrasound can visualize bowel wall thickening and other indirect signs which point toward IP.*
2. *The diagnostic yield is increased in the presence of ascites because the hypoechoic fluid provides a good contrast against the bowel wall and the echogenic air bubbles.*
3. *Point-of-care ultrasound is a useful tool when abdominal compartment syndrome is suspected because it provides an estimation of ascites, helps in ruling out intestinal obstruction, and also helps in identifying additional pathology.*

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Additional information: To analyze this case with the videos, see the online article.

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