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# Massive Pneumoperitoneum After Scuba Diving

Pneumoperitoneum usually indicates rupture of a hollow viscus and considered a surgical emergency. But air may also enter the peritoneum from the lung or the genital organs in female without visceral perforation. While scuba diving, the rapid ascent is usually controlled by placing in a decompression chamber and the excess gas volume is exhaled. Failure to allow this excess gas to escape will result in overdistension of air passage, which may rupture resulting in pulmonary interstitial emphysema or, if air enters the circulation, air embolus can occur. Pneumoperitoneum is a rare complication of diving accidents. While the majority of cases are not related to an intraabdominal catastrophy, more than 20% have been the result of gastric rupture. We report a 42-yr-old male patient with massive pneumoperitoneum after scuba diving, who presented himself with dyspnea and abdominal distension. Knowledge of this rare condition and its benign course may allow the emergency physician and surgeon to order appropriate studies to help avoid unnecessary surgical treatment. It is important to determine promptly whether the air emanated from a ruptured viscus or was introduced from an extraperitoneal source. Free air in the abdomen does not always indicate a ruptured intra-abdominal viscus.

Key Words : *Pneumoperitoneum; Diving; Decompression Sickness*

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## INTRODUCTION

Pneumoperitoneum, especially when associated with abdominal pain and distension, is almost always interpreted as an evidence of the rupture of a hollow viscus and as an indication for immediate surgical intervention. Less frequently considered is pneumoperitoneum that results from causes that do not require surgical treatment. We present the case of a 42-yr-old man who was admitted to our emergency department with a massive pneumoperitoneum with only an acute episode of abdominal pain and distension after scuba diving. The emergency physician is often the first to recognize free intraperitoneal gas, and thus should readily aware of the non-surgical causes of pneumoperitoneum and play a decisive role in preventing needless emergency laparotomy.

## CASE REPORT

A 42-yr-old male was referred to our emergency department by a primary care physician because of abdominal distension and dyspnea for two hours after scuba diving. He had been submerged for 10 min at a depth of 27 m when he recognized a fault in his breathing apparatus. When he ascended to the surface too quickly because of ingestion of water through his mouthpiece, he immediately experienced an intense abdominal distension accompanied by dyspnea.

The vital signs at presentation were; blood pressure of 130/85 mmHg, pulse rate of 98 beats/min and respiration rate of approximately 24 breaths/min. Physical examination revealed a grossly distended, tympanic abdomen, with a loss of hepatic dullness. There was no localized abdominal tenderness and bowel sounds were normal. There was no subcutaneous emphysema on the whole body.

Laboratory findings included a hematocrit 45.7%, white blood cell count of 8,900/$\mu$L with of 47% neutrophils, 43% lymphocytes, 3% monocytes, and 2% eosinophils, and platelet count of 286,000/$\mu$L. The arterial blood gases were normal. Chest and abdominal radiography films showed a large quantity of free intraperitoneal gas (Fig. 1), but no evidence of pneumothorax or pneumomediastinum. The patient was not placed in a decompression chamber but was treated conservatively with a nasogastric tube and intravenous infusion. A 18-gauze needle was inserted into the peritoneal cavity under local anesthesia, through which about 500 mL of gas was aspirated, with immediate relief of symptoms. After 24 hr he could drink. Abdominopelvic computed tomography (Fig. 2), upper gastrointestinal series, and small bowel follow-through examination were performed (Fig. 3) to exclude intra-abdominal visceral perforation. The intra-abdominal

Fig. 1. Chest PA film showing a large quantity of free intraperitoneal gas in a sports diver.

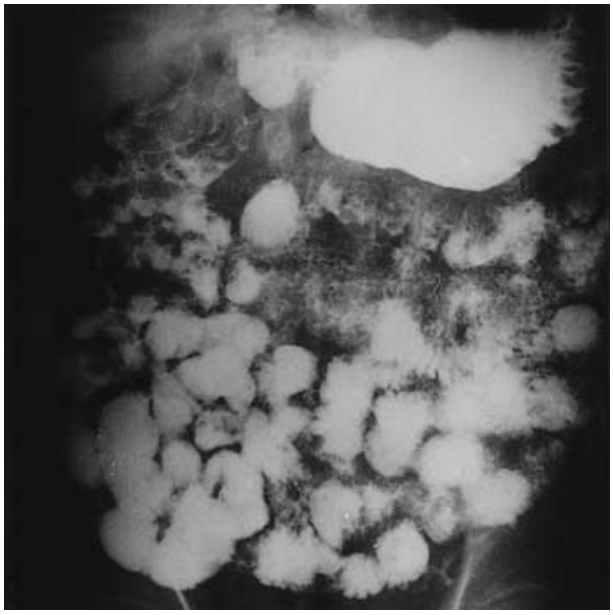

Fig. 3. Upper gastrointestinal series showing no definite abnormality.

organs were normal, without evidence of perforation.

The patient's vital signs and physical examination findings remained stable. A regular diet was started, which was well tolerated. Chest and abdominal radiography showed persistent free abdominal air, which took 21 days to resolve. The patient was discharged on the 8th hospital day and advised not to dive again. He was followed up on a weekly basis after discharge, and was doing well at two months.

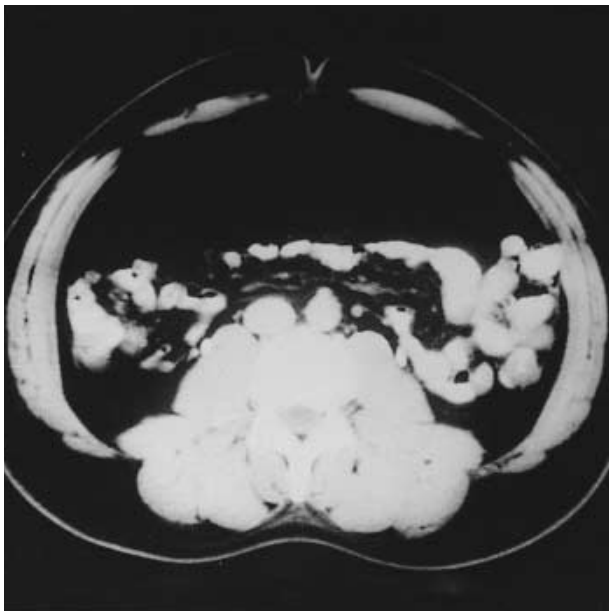

Fig. 2. Abdominal computerized tomography showing a large intraperitoneal gas without intraperitoneal pathology.

## DISCUSSION

Pneumoperitoneum is almost always interpreted as an evidence of the rupture of a hollow viscus and an indication for immediate surgical intervention. Two cases of pneumoperitoneum have been previously reported in scuba divers (1, 2). Rapid ascent puts the drivers at risk of developing decompression sickness which usually managed well by placing in a decompression chamber. Pulmonary barotrauma can occur when the gas rapidly expands after a rapid ascent after underwater diving. According to Boyle's law (PV=k), ascent to the surface (1 bar) from a depth of 35 m (4.5 bar) results in an increase in volume of any gas in the lung or gastrointestinal tract (2). Retroperitoneal emphysema and pneumoperitoneum have occurred in this circumstance. In these cases, it is most likely that the intraperitoneal air has originated from the lungs. Danohoe et al. (3) showed that the air from ruptured pulmonary alveoli in rats dissected along vessel sheaths, and may leak into the pleural space, the retroperitoneum, the peritoneum, and subcutaneous tissues. This occurs when the gas under pressure is forced into the retroperitoneum along the esophagus and great vessels. This theory was confirmed by Macklin and Macklin (4), who showed that intraperitoneal air was developed from the sequence of events when the gas under pressure was applied to the trachea of cats. The air first leaked out by the rupture of the overdistended alveoli, then moved into the underlying perivascular sheaths and towards the mediastinum to form a mediastinal emphysema. As the pressure continued, the gas escaped through the mediastinal pleura onto the pleural space, causing a pneumothorax. Dissection in the fascial planes of the neck and chest produced

a subcutaneous emphysema. At the same time, the air escaped retroperitoneally into the abdomen and eventually burst into the peritoneal cavity. So, they suggested that mediastinal emphysema, pneumothorax, subcutaneous emphysema, and pneumoperitoneum could all occur in labor, straining at stool, lifting, and coughing. Brown and Keenan (5) reported a case of spontaneous pneumoperitoneum without pneumothorax, pneumomediastinum, or bowel perforation. At postmortem examination, the patient had pulmonary interstitial emphysema with air in the lymphatic system. They hypothesized that free air spread from the perivascular sheaths into the lymphatic system, with a retrograde flow into the peritoneum. In our case, we postulated that the rapid ascent had caused hyperexpansion and rupture of a bulla of the lung producing free air, which under pressure, spread along vessel sheaths into the mediastinum.

The most reliable tools to detect pneumoperitoneum are erect chest radiograph and computerized tomography (CT). Contrast studies and endoscopy could help clinicians to decide whether there is a perforation or not. In addition, it has been suggested that needle paracentesis and peritoneal lavage can be used to detect intraperitoneal contamination from gastrointestinal perforation. These techniques may be enhanced by adding methylene blue via a nasogastric tube.

Any patient who presents with symptoms suggesting decompression sickness should be managed with recompression. Secondray pneumoperitoneum, presenting without other manifestations of barotrauma, may be managed expectantly, but only after more serious etiologies have been ruled out (6).

There are many factors known to be associated with the development of spontaneous pneumoperitoneum. Particularly during scuba diving the main cause of spontaneous pneumoperitoneum is, although unconfirmed, barotrauma. Therefore, the fact that pneumoperitoneum can develop in the absence of organ perforation, as in the present case, must always be kept in mind to avoid unnecessary operative interventions.

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