RUPTURE OF THE STOMACH IN A DIVING ACCIDENT WITH ATTEMPTED RESUSCITATION

A Case Report

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Spontaneous rupture of the normal stomach is a relatively rare event. Theoretically, diving with compressed gas may impose such a danger; however, to our knowledge there is only one report in the English literature of the actual occurrence of gastric rupture during diving (Cramer and Heimbach, 1982). Indeed, most textbooks dealing with diving medicine do not mention this complication (Bennett and Elliott, 1975; Strauss, 1976). Cardiopulmonary resuscitation has been reported to cause gastric rupture (Demos and Poticha, 1964). We present a case of a diver who sustained pulmonary barotrauma and rupture of the stomach. The two possible aetiologies of gastric rupture in this patient are discussed.

CASE REPORT

The patient was a 44-year-old SCUBA (Self Contained Underwater Breathing Apparatus), diver who dived to 6 m. He was an obese, inexperienced person, in poor physical condition and suffering from mild systolic hypertension adequately controlled with oxprenolol.

The patient dived alone in an attempt to recover his dive boat's anchor. Approximately 30 min later he was spotted by his friends, floating on the surface in his inflated life jacket, apparently pulseless and apnoeic. He was taken by boat to the shore and from there to a nearby hospital. Mouth-to-mouth ventilation and external cardiac massage were performed during transit.

In the emergency room at the receiving hospital, the face and upper thorax were noted to be deeply cyanotic. ECG was isoelectric, pupils were maximally dilated and unresponsive to light. The abdomen was fat, distended and tympanic. The trachea was intubated without difficulty and blood-stained frothy fluid was seen to well up the tube. A nasogastric tube yielded minimal air and deoxygenated blood.

Despite adequate ventilation and external cardiac massage, no effective cardiac action could be restored. A chest x-ray revealed free air under the diaphragm, and pulmonary oedema. A 14-gauge cannula inserted through the linea alba yielded air under pressure, resulting in considerable deflation of the abdomen. Continued resuscitation remained unsuccessful.

Postmortem examination revealed four tears along the lesser curvature of the stomach. There were two full-thickness tears, one 6 cm long, starting at the gastro-oesophageal junction, and one 3.5 cm long below it. Between them there were two 1-cm long mucosal lacerations. In the posterior wall there were two further mucosal tears, 1.5 cm and 2.5 cm long. A 5 × 10 cm submucosal haemorrhage was found in the lesser curvature. There was no other pathology in the stomach.

SUMMARY

A compressed air diver suffered pulmonary barotrauma with arterial air embolization; resuscitation was unsuccessful. Attempts at resuscitation included mouth-to-mouth ventilation and cardiac massage. A chest radiograph taken during resuscitation revealed free intraperitoneal air. Postmortem examination showed rupture of the stomach. The two possible aetiological factors—barotrauma of ascent and cardiopulmonary resuscitation—are discussed.
Air bubbles were found in the pial, coronary, pericardial and femoral arteries, and in the jugular and coronary veins. Histological examination revealed hyperinflation of the lungs with rupture of interalveolar septa and parenchymal haemorrhage. The heart showed moderate atherosclerosis of coronary vessels with diffuse chronic ischaemic myocardial damage and left ventricular hypertrophy.

**DISCUSSION**

Rupture of the stomach during diving is, theoretically, a constant hazard to the diver. The rapid changes in pressure to which the diver is subjected underwater (1 atmosphere—760 mm Hg—1 bar every 10 m of depth change) result in rapid and extreme changes in the volume of intragastric gas (Boyle's Law, \( PV = \) Constant). Since the maximal volume of the adult stomach is approximately 5 litre (Cramer and Heimbach, 1982), extreme inflation may result in rupture. However, during ascent from depth, the expanding air usually escapes easily through either one or both gastric outlets, thus accounting for the extreme rarity of this problem.

In the patient presented, a combination of factors existed which may have resulted in both excessive air in the stomach and obstruction of its outlets. The patient was in poor physical condition and suffered from coronary atherosclerosis. In attempting to perform a hard physical task, he probably hyperventilated and swallowed much air and water. The pressure of water in the stomach may have blocked the pylorus. Undoubtedly, sympathetic tone was high and, coupled with the \( \beta \)-blockade produced by the oxprenolol may have tended to increase the tone of both gastric sphincters. He surfaced from 6 m in what, on the evidence of the pulmonary barotrauma, must have been a rapid, uncontrolled ascent. This ascent would have resulted in further increase (60%) in the volume of the already distended stomach (Boyle's Law), perhaps causing its rupture.

If ascending to the surface did not result in gastric rupture, the greatly distended stomach was probably ruptured during attempts at resuscitation. He was an obese, thick- and short-necked individual who was ventilated with difficulty by untrained individuals while being transported on a stretcher. He had aspirated sea water and his pulmonary compliance was low. Air entry into the stomach was favoured, causing further distension. During cardiac massage, intrapleural pressure was probably high, and would conceivably compress the oesophagus and block the exit of air from the stomach. Pressure could also have been transmitted to the stomach, finally causing it to rupture. Lacerations of the gastric mucosa are found in up to 12% of patients undergoing cardiopulmonary resuscitation (Anthony and Tattersfield, 1969), but complete perforation of the stomach wall is much more rare (Demos and Poticha, 1964; Darke and Bloomfield, 1975; Linch, McDonald and McNicol, 1979).

Other reported causes of gastric rupture include the ingestion of sodium bicarbonate (Lemmon and Paschal, 1941), oxygen administration via nasal catheter (Fenton, 1956), overeating after prolonged hypophagia as a result of anorexia nervosa (Evans, 1968) and blunt abdominal trauma (Siemans and Fulton, 1977).

Both of the possible causes of the ruptured stomach in this patient are partly preventable. Divers should be in good physical condition, should not attempt tasks likely to put them under undue stress, and should refrain from diving while receiving \( \beta \)-adrenoeceptor blocking medication. Resuscitation teams should use correct ventilation techniques, especially those which ensure adequate opening of the airways and the avoidance of excessive force during cardiac massage.

The diagnosis of rupture of the stomach is based on noting distension of the abdomen, and tympanism. Subcutaneous emphysema may be present. Aspiration via a nasogastric tube does not usually yield much air and fails to relieve the abdominal distension. A peritoneal tap will disclose free air and effect decompression, thus relieving the pressure on the diaphragm. Definitive treatment requires suturing the perforation at laparotomy.

Rupture of the stomach is a serious complication of compressed air diving, and of cardiopulmonary resuscitation. Since it is a treatable condition, it should be suspected whenever the above mentioned signs and symptoms appear.

**REFERENCES**


