Yonsei Medical Journal
Vol. 41, No. 4, pp. 533-535, 2000

Pneumatic Colonic Rupture Accompanied by Tension Pneumoperitoneum

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Abstract

Rupture of the colon caused by high pressure compressed air is a rare, unique and traumatic intra-abdominal injury. As the use of compressed air in industrial work has increased, so has the risk of associated pneumatic injuries from its improper use. Recently we experienced a case of pneumatic rupture of the sigmoid colon accompanied by tension pneumoperitoneum, which caused respiratory distress. The patient's respiration was very rapid with the rate of 44 breaths per minute. On arterial blood gas analysis, pH was 7.40, pO_2 68 mmHg, pCO_2 44 mmHg, and SaO_2 90%. Chest X-ray film showed marked pneumoperitoneum and an elevated diaphragm. The respiratory distress was severe and required immediate relief by emergency decompression peritoneocentesis before surgical intervention consisting of the serosal tear repair, colonic rupture colostomy and abdominal cavity irrigation. A follow up operation 2 months later for colostomy repair completed the patient's recovery.

Key Words: Pneumatic rupture, colon

INTRODUCTION

In the industrial era, the use of compressed air has become common in many workplaces, and thus injuries associated with the misuse of compressed air are on the rise. Among pneumatic injuries, colon injury by accidental insufflation with compressed air is one of the most serious injuries because the high pressure of compressed air can deliver an enormous amount of air into the rectum in a very short time. When severe pneumatic injuries of the colon occur, adequate and prompt medical intervention is critical for life-saving. Many injuries occur at workplaces like plants or ships during pranks among workers. Especially, the exposure of the anal region when bending could lead someone to eject compressed air toward the anal region as a practical joke. It is not well recognized by laymen that the high pressure of compressed air can overcome barriers such as clothes and anal sphincters, and cause fatal colon injury.

Received February 19, 2000
Accepted April 26, 2000
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CASE REPORT

A 33-year-old man presented to the emergency department with complaints of severe abdominal pain, distension and respiratory difficulty. About 1 hour before his arrival, while working on a ship, his mischievous coworker directed the nozzle of a compressed air hose toward his anal region over the clothes and ejected compressed air with the pressure of 50 psi. Suddenly, he felt an expanding sensation, then severe abdominal pain and distension with respiratory difficulty developed. At the time of arrival, the patient was conscious, but irritable and distressed. When his vital signs were checked, his pulse rate was 144 beats per minute and blood pressure was 130/80 mmHg. His respiration was rapid and shallow with the rate of 44 breaths per minute. On physical examination, the abdomen was markedly distended and rigid with tenderness, and percussion produced a tympanic sound. Rectal examination showed no external or internal wounds. His complete blood count and liver function test were within normal limits. On arterial blood gas analysis, pH was 7.40, pO_2 68 mmHg, pCO_2 44 mmHg, and SaO_2 90%. Chest X-ray film showed marked pneumoperitoneum and elevated diaphragm (Fig. 1). With his respiratory distress progressively worsening, emergency decom-

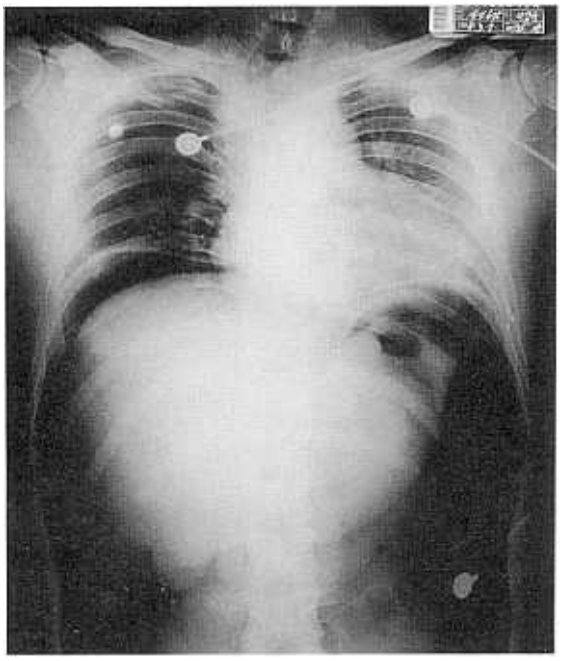

Fig. 1. Chest X-ray showing a large amount of intraperitoneal free air.

pression of abdominal distension was considered mandatory. After the insertion of a nasogastric tube, decompression peritoneocentesis was done with a 17-gauge needle at the counter-McBurney point. The peritoneal air gushed out immediately, then the abdomen became flat and the respiratory difficulty was relieved. After fluid resuscitation, an exploratory laparotomy was performed with a long midline incision. Exploration revealed moderate fecal spillage in the peritoneal cavity and an 8 cm-sized longitudinal perforation at the antimesenteric border of the sigmoid colon about 15 cm above the peritoneal reflection. A serosal tear, about 5 cm in length, was also noted below the perforation site. Further inspection of the peritoneal cavity did not reveal any other intra-abdominal injury. The serosal tear was repaired with sutures and the colonic rupture was treated by sigmoid loop colostomy, using the perforation site itself. The abdominal cavity was thoroughly irrigated and multiple drains were placed. The patient's postoperative course was unremarkable and he was discharged with a well-functioning colostomy. After 2 months, he was readmitted for colostomy repair and the operation was performed successfully. At the follow-up 2 months later, he was following a regular diet with good bowel movement, and he had gone back to work.

DISCUSSION

Pneumatic colon injury has been reported sporadically since the first report by Stone in 1904,[1] and reviewed in detail by Brown and Dwinelle in 1942,[2] and Raina and Machiedo in 1980.[3] Raina and Machiedo collected all 92 cases which had been reported up until that time and reviewed them. Several more cases have been reported since then.[4-9] An experimental study on the relationship between intestinal rupture and air pressure was performed by Burt in 1931.[10] Of the 4 layers of the intestinal wall, the mucosa is the strongest layer, and when pressure increases progressively, the muscle and serosa tear first, then the mucosa last. Pressure of 3.99 psi (lb/in^2) tears the muscle and serosal layer of the intestine, and 4.07 psi (210.42 mmHg) can rupture the whole intestinal wall, leading to perforation. In another animal experiment using pigs,[11] colon perforation occurred at the pressure of 2.32 psi (120 mmHg). The usual pressure of compressed air is 50–150 psi, 10- to 30-times greater than the pressure needed for intestinal perforation. Furthermore, the anatomical shape of the buttock and anus is like a funnel and allows the easy delivery of compressed air through the anus. Consequently, compressed air can pass the anal sphincter and even clothes, leading to colon injury.

Clinical manifestations vary, depending on the extent of intraluminal pressure and the presence of colonic injury, especially perforation. Colon perforation can occur singularly or multiply at any site of the colon,[2] but the most frequent site of perforation is the rectosigmoid region around the natural reflection site. High-pressure air having entered the rectum exerts enormous pressure on the reflection site, which may lead to perforation of the antimesenteric wall of the rectosigmoid.[12] Abdominal distension and pain develop abruptly, and if colon perforation also occurs, peritoneal irritation symptoms such as abdominal rigidity and tenderness are also presented. Frequently, symptoms of respiratory distress are seen because pneumoperitoneum restricts the diaphragmatic movement. In most severe cases, acute respiratory failure and circulatory shock can occur fatally. Zechel[13] differentiated the shock from pneumatic injury into two types. The primary shock is caused by the impact of compressed air and colonic rupture, and the secondary shock by tension pneumoperitoneum. Ten-

sion pneumoperitoneum means that the intraperitoneal air pressure is so strong as to exert tension on the circulatory and respiratory systems, which causes hypotension and respiratory distress. As in our case, acute respiratory distress sometimes necessitates emergency intervention for the relief of marked tension pneumoperitoneum. Paracentesis of the peritoneal cavity with a needle or trochar is a simple and useful method, and enough to reverse the respiratory distress.[9,13] After recovery from the initial shock, peritonitis due to fecal contamination of the peritoneal cavity should be checked for and treated immediately.

Diagnosis of pneumatic colon injury is usually easy because a history of exposure to compressed air and clinical manifestations are typical. On radiologic examination, a distended colon filled with air or a large amount of free air in the peritoneal cavity can be observed. When acute respiratory failure accompanies these symptoms, arterial gas analysis reveals hypoxia and respiratory alkalosis. High intraperitoneal air pressure can compress the inferior vena cava and cause circulatory collapse, and severe circulatory failure can even cause rhabdomyolysis.[7] Although most cases of pneumatic colon perforation are diagnosed on the initial visit, some cases of delayed colonic rupture have been occasionally reported.[3,14,15] Such cases showed no peritoneal signs or free intraperitoneal air on a simple X-ray at first, but after 3 to 5 days peritoneal signs developed suddenly. So it is important to detect delayed colon perforation during the initial admission period because a delay in diagnosis and surgical intervention could result in overwhelming peritoneal sepsis.[8]

The management of pneumatic colon injury has two aspects, tension pneumoperitoneum and colon injury. Tension pneumoperitoneum frequently leads to acute respiratory distress with or without circulatory collapse, which may have fatal consequences if emergency peritoneal paracentesis is not done. Colon perforation itself should be treated, according to general principles of treatment for colon perforation. After initial resuscitation, an emergency laparotomy should be performed. The contaminated peritoneal cavity with feces should be cleansed thoroughly and multiple drains should be placed. For wounds of a perforated colon, primary repair or segmental resection, with or without colostomy, should be performed, according to the extent of contamination. It should be remembered that a second operation might be necessary in case of delayed colon perforation. Modern prognosis is generally favorable if early surgical management is employed, although the mortality rate was high (80−100%) in early collective reviews, where conservative management was employed.[2,10]

ACKNOWLEDGEMENTS

We thank Dr. Wonsick Choe for his editorial assistance.

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