Aspiration Injury Due to Polyacrylamide

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Acute lung injury secondary to aspiration of polyacrylamide, a synthetic polymer used widely in industry, has not been previously described in man or animal. We report the case of a 26-year-old man who aspirated polyacrylamide gel while cleaning it out of a tank truck. Subsequently, severe airway obstruction and lung parenchymal damage developed, and the patient died. At autopsy, numerous polyacrylamide particles were found in the lungs, along with extensive bronchiolar and alveolar damage. (Chest 1992; 101:576-78)

Polyacrylamide is a synthetic polymer used widely in many types of liquid-solid separation procedures, water clarification, waste treatment, and mining.2,3 Despite its extensive use in industry, little or no information is available regarding the hazards posed by polyacrylamide to the environment or public health if aspirated or accidentally ingested. We report the case of a 26-year-old man who aspirated polyacrylamide gel while he was removing this substance from within a tank truck. This case is unique because there are no previous medical reports of aspiration of this substance in man or animal.

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Figure 1. Cross-sectional view of the patient's endotracheal tube. The lumen is almost completely obstructed by encrusted polyacrylamide gel.

CASE REPORT

A 26-year-old white man was brought to Hermann Hospital, Houston on January 16, 1989, after aspirating polyacrylamide gel. He had been cleaning the inside of a tank truck used to transport the polyacrylamide. For unexplained reasons, the chemical had been unloaded from the tank using pressurized nitrogen gas, rather than the usual pumping procedure utilizing air. Apparently, no warning was provided to indicate that the tank had been pressurized with nitrogen; therefore, the patient entered the tank without a breathing support apparatus and began to clean the sides and floor. Presumably, the patient became hypoxic, secondary to the low level of oxygen in the tank, and, within minutes, he fell inside the tank. Members of the fire department arrived at the scene 15 min later and found the patient face down in the liquid. They lifted the patient out of the tank and found him apneic and pulseless. They promptly initiated resuscitative measures and transferred him to the hospital.

On arrival at the emergency room, the patient was comatose, and his entire body was covered with a white, gelatinous material. His blood pressure was 222/129 mm Hg; pulse, 134 beats per minute; temperature, 34.8°C. Spontaneous respirations were absent. The rest of his physical examination was unremarkable. Arterial blood gas measurements were as follows: PaO2, 475 mm Hg (FIO2, 1.0); PaCO2, 36 mm Hg; pH, 7.15; and serum HCO3, 13 mmol/L. A chest radiograph was normal.

Considerable difficulty was encountered in delivering mechanical ventilation to the patient, and peak airway pressure exceeded 80 cm H2O. The arterial blood gas values deteriorated to the following levels: PaO2, 445 mm Hg (FIO2, 1.0); PaCO2, 93 mm Hg; pH, 6.95; and HCO3, 26 mmol/L. It was noted that the endotracheal tube was plugged with gelatinous material (Fig 1), and it was replaced with a new tube. Bronchoscopy revealed several plugs obstructing the main-stem bronchi; the plugs were mechanically extracted by forceps and suctioning. Bronchial lavage was not performed because a toxicologist informed us that polyacrylamide is a very hygroscopic compound, which solidifies when mixed with liquids. This information was confirmed by a simple in vitro test at the patient's bedside. Following bronchoscopy, peak airway pressure decreased to 60 cm H2O, and gas exchange improved, as evidenced by the following values: PaO2, 489 mm Hg (FIO2, 1.0); PaCO2, 53 mm Hg; pH, 7.24; and HCO3, 23 mmol/L.
lawyer Chemical, 1989), the polyacrylamide gel consisted of polyacrylamide liquid suspended in a hydrocarbon solvent. A gas chromatograph/mass spectrometer (GC/MS) system (Hewlett-Packard, Avondale, Pa) was employed to confirm the presence of these two substances in the gel and to determine whether they were present in the patient's lung tissue. Unfortunately, when the gel was subjected to GC/MS analysis, the polyacrylamide monomer did not register (probably reflecting its inert nature); when polyacrylamide was removed by centrifugation, and the suspending solvent was subjected to GC/MS analysis, the resulting pattern had the characteristics of a typical aliphatic hydrocarbon mixture which contained dodecane (C12H26) as a component. When the patient's lung tissue was analyzed with the GC/MS system, the same unique peak for dodecane was observed, whereas no such pattern was observed in a normal control lung sample (Fig 2).

DISCUSSION

Polyacrylamide is a synthetic polymer. Its versatility has led to substantial growth in its use and the development of many commercial applications. Despite its enormous use (in excess of 45,000 metric tons/yr), no studies have been undertaken to examine the results of possible lung damage following aspiration. The few toxicologic investigations available have examined only the toxic effects of oral intake in animals. This is the first reported case of toxic aspiration of polyacrylamide gel in man.

The patient was a previously healthy young man who aspirated a polyacrylamide gel while cleaning it from within a tank truck. We suspect that the patient became hypoxic shortly after entering the tank, fell to the floor, and aspirated the gel into his airways. The highly viscous nature of this substance caused severe airway obstruction. Vigorous endobronchial suctioning and forceps extractions, employed in an attempt to remove the polyacrylamide particles, were partly successful. Although tracheobronchial lavage with saline solution is commonly employed in the treatment of patients who aspirate toxic chemicals, we elected not to do so because polyacrylamide gel solidifies when mixed with saline. This case highlights the importance of being cautious when performing bronchopulmonary lavage in patients who aspirate toxic chemicals, and of checking to see whether the substance might react with saline before undertaking lavage.

The patient's clinical course and the histopathologic findings at autopsy demonstrate that in addition to causing airway obstruction, the polyacrylamide gel produced toxic damage to the lung parenchyma. We do not know which chemical component of the inhaled gel, aqueous polyacrylamide or its solvent, was responsible for the pulmonary injury; therefore, experimental studies in animals to further identify the injurious agent are in progress.

In summary, this man suffered fatal injury after aspirating a polyacrylamide gel. Although the immediate cause of death was hypoxic brain damage, aspiration of polyacrylamide gel produced pulmonary toxicity. This case further illustrates the importance of the display of warnings in the workplace to prevent industrial accidents. It also highlights the lack of medical knowledge regarding pulmonary toxicity of polyacrylamide and the need for experimental studies to examine the physiologic and pathologic consequences of its aspiration.

REFERENCES

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Unruptured Congenital Aneurysm of the Left Sinus of Valsalva Presenting as Acute Right Ventricular Failure


A patient with unruptured congenital aneurysm of the left coronary sinus of Valsalva presented with acute right-sided heart failure due to right ventricular outflow tract obstruction. The mechanism for such an acute presentation may have been a sudden increase in the size of the aneurysm. The surgical importance of this lesion is the combined aortocameral approach which is seldom required for correction of such aneurysms. (Chest 1992; 101:578-79)

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Increasingly frequent reports of unruptured aneurysms in recent years is due to easy availability of echocardiography. Isolated unruptured aneurysms of the sinus of Valsalva present with aortic regurgitation, right ventricular outflow obstruction causing congestive heart failure, complete heart block, coronary artery compression, resistant ventricular tachycardia, and left/right ventricular inflow obstruction. In all the reported cases of patients with right ventricular outflow tract obstruction, the aneurysm arose from the right coronary sinus and was caused by its close proximity to the right ventricular outflow tract. An isolated unruptured aneurysm of the left coronary sinus of Valsalva is rare. Of the five reported cases, three patients had left coronary artery compression, one had left atroventricular valve obstruction, and one remained asymptomatic for 19 years without surgery. To our knowledge, a left sinus of Valsalva aneurysm presenting as right ventricular outflow tract obstruction has not been reported in the literature so far. Moreover, acute presentation as seen in our patient is extremely unusual.

Case Report

A 30-year-old man presented with exertional dyspnea of two weeks' duration with acute worsening of symptoms 48 h prior to the hospital admission. Physical examination revealed the patient to be orthopenic with blood pressure of 106/74 mm Hg, pulse of 110 beats per minute, and respiratory rate of 36 per minute. The jugular venous pressure was elevated up to the angle of the mandible, with prominent "a" and "V" waves. Cardiovascular examination revealed evidence of mild cardiomegaly, prominent right ventricular heave, systolic thrill in the left third intercostal space, soft pulmonic component, and right ventricular S4 gallop. A grade 4/6 ejection systolic murmur was heard in the pulmonary area and a grade 2/6 pansystolic murmur was heard in the tricuspid area. The liver was tender and palpable 10 cm below the right costal margin.

Figure 1a (left). Aortic root and (b, right) right ventricular angiograms both in right anterior oblique projection showing unruptured aneurysm of the left sinus of Valsalva indenting the right ventricular outflow tract (arrowsheads) with evidence of grade 2 aortic regurgitation. RA = right atrium; RV = right ventricle; and MPA = main pulmonary artery.