

Severe barium sulphate aspiration: a report of two cases and review of the literature

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ABSTRACT

Aspiration of barium sulphate is a well-recognized complication, occurring accidentally during examinations of the upper gastrointestinal system using contrast media. Rarely, large amounts of barium sulphate are inadvertently aspirated into the lung. Certain conditions affecting the anatomical and functional integrity of the oropharynx and oesophagus suggest predisposing factors. Aspiration of barium sulphate is not expected to cause severe lung injury due to its relatively non-irritant matter. On the other hand, acute inflammation or even death attributed either to high or low density preparations of barium sulphate, have been reported.

We present two patients, both with a history of schizophrenia, who developed acute respiratory failure requiring mechanical ventilation, following aspiration of large amounts of barium, during an upper gastrointestinal radiographic contrast study. One patient died following massive aspiration which led to multiple organ dysfunction syndrome, while the other, although sub- acutely complicated by pneumonia, was successfully treated.

Beside presentation of cases, several aspects of investigation, differential diagnosis, treatment and prevention are discussed. Complications of barium sulphate aspiration depend upon the density and quantity of the aspirated solution, the extent of tracheobronchial distribution and the general physical condition of the patient. In severe cases, early treatment and close follow up with high-resolution computed tomography are mandatory to prevent progression towards fibrosis. Patients with psychiatric disorders, apart from other conditions predisposing to aspiration, should be dealt with particular caution, when performing the above-mentioned procedures.

Key words: barium, barium sulphate, aspiration pneumonia, lung CT, lung scintigraphy

Introduction

Barium sulphate is a relatively insoluble salt of barium used as a radiographic contrast medium. Barium swallow is the simplest, most common routine procedure in the examination of the oropharynx and esophagus (1). Only rarely are large amounts of barium sulphate accidentally aspirated into the lung during an upper-gastrointestinal radiographic contrast procedure. Here, we present two patients, both

with a history of schizophrenia, who developed acute respiratory failure requiring mechanical ventilation, following inadvertent aspiration of large amounts of barium during an upper gastrointestinal radiographic contrast study.

Case report

Patient 1

A 43-year old male patient with a long history of schizoid personality disorder, suffering from dysphagia, underwent a radiographic contrast study with barium sulphate. The patient aspirated a large amount of the radiographic

medium and became dyspneic and rapidly hypoxemic (PaO₂/FiO₂: 118), requiring mechanical ventilation. Chest X-rays showed alveolar deposition of barium sulphate in the form of dense punctate foci, distributed to both lower lung lobes, particularly in the left lung (fig.1). A bronchoscopy was carried out immediately after admission to the ICU, but failed to extract the barium from the tracheobronchial tree. An urgently performed lung CT scan showed a combination of alveolar and intralobular interstitial patterns of aspirated barium in both lungs, with the left lower lobe being mainly affected, thus confirming



Fig.1 Chest X-ray with dense foci of aspirated barium, distributed to both lower lung lobes but mainly to the left.

the radiographic findings (fig 2). Ill-defined centrilobular nodules and high-density conglomerations were also noted, located mostly in the basal and posterior segments of all lung lobes with the prominent lesions in the left lower lobe. A 'ground glass' pattern was also noted to follow the aforementioned lesions throughout the lungs.



Fig.2 Lung CT scan with a combination of alveolar and interstitial patterns of aspirated barium, located mostly at the basal and posterior segments of all lung lobes with the prominent lesions at the left lower lobe.

A few hours later, the patient developed fever and leucocytosis ($11700/mm^3$) so antibiotic treatment was initiated (2nd generation cephalosporin plus metronidazole). Shock was apparent 24 hours later requiring vasoactive/inotropic support after fluid resuscitation. A perfusion lung scintigraphy revealed patchy distribution of the radioisotope;

the irrigation distribution of the lungs was: left lung 34.9% (upper left lobe 77.3% lower left lobe 22.7%) and right lung 65.1% (fig. 3). Since the irrigation of the lower left lobe was only 8% of total lung irrigation, excision of the affected region was performed. Unfortunately, the following day, the patient developed multiple organ dysfunction syndrome (MODS) and died.



Fig.3 Posterior view of lung perfusion scintigraphy. The irrigation of the lower left lobe is almost absent (only 8% of the total lung irrigation).

Patient 2

A 37-year old male patient, with a history of chronic schizophrenia, presented with pneumonia and evolving respiratory failure that required ICU admission and mechanical ventilation. After studying the patient's medical record, we found out that he had aspirated barium sulphate during a radiographic contrast study for gastroesophageal reflux, three months earlier. He did not have any significant reaction after the



Fig. 4 Chest X-ray with some high-density foci of aspirated barium, at the lower lobes, mainly on the left side.

aspiration. Chest X-ray demonstrated high-density discrete foci of obviously insoluble barium, in the lower lobes but mainly on the left side.(fig.4) These findings were confirmed by a lung CT-scan that showed a relatively large pleural effusion with concomitant consolidation and atelectasis of the left lower lobe. Several small nodules occurring in clusters were seen, distributed in the left lobe bronchial tree and alveoli. Segmental consolidation was also noted in the right lower lobe. A few discrete nodules were also noted at the inner segment of the right lower lobe. These findings were suggestive of pneumonia, which developed following barium aspiration. During his 10-day ICU stay, the patient's condition was complicated by ventilator-associated pneumonia (VAP) due to *Acinetobacter baumannii* infection that was successfully treated with piperacillin/tazobactam plus gentamicin and chest drainage. The patient was discharged to the ward in good general condition.

Discussion

The overall incidence of aspiration pneumonia, in the hospital population, is assessed as approximately 8 in 1000, but as many as 40% of such aspiration cases remain asymptomatic (2). Aspiration of barium sulphate into the lungs is a well-recognized complication, occurring accidentally during upper gastrointestinal studies (3). The overall mortality rate associated with massive barium aspiration is approximately 30% and exceeds 50% in patients with initial shock or apnoea, secondary pneumonia, or adult respiratory distress syndrome.(4). The exact incidence is not known. In the literature it is reported either as rare (5,6) or frequent (7), depending on the severity of the reported cases.

Certain conditions affecting the anatomical and functional integrity of the oropharyngeal and esophageal segments suggest predisposing factors for the occurrence of aspiration (6, 7, 8, 9, 10). These might be the extremes of age (7,8,10) disordered swallowing, neuromuscular dysfunction, broncho-



Fig 5. Lung CT-scan showing a relatively large pleural effusion with consolidation and atelectasis of the left lower lobe. Note the small nodules occurring in clusters at the left lobe bronchial tree and alveoli. Segmental consolidation is also noted at the right lower lobe.

esophageal fistula (11), alcoholism (6), head and neck cancer and psychological illness. The last is commonly associated with functional gastrointestinal disorders and is important to consider during patient consultation (12).

The regions of the lung involved depend on the position of the patient during and after aspiration. The basal segments of the lower lobes are most commonly involved when the patient is in the erect position, as in our cases, the middle lobe if the patient inclines forward, as occurs during vomiting or coughing, and the posterior segments of the upper lobes or superior segments of the lower lobes in the recumbent position. (6,8). Aspiration of barium sulphate into the lungs is not expected to cause severe lung injury due to its relatively non-irritant nature. Although inert in nature, acute inflammation or even death attributed either to high or low density preparations of barium sulphate, have been reported (3,6,10). Whether mortality is a result of gastric contents aspiration concomitant to barium aspiration is a matter of debate (13). Certainly, the volume of aspirated material plays an important role in the progression of aspiration, as it did in our first case, even if there are reports of lack of signs of lung injury in terms of neutrophil sequestration and edema which is usually seen after acid aspiration. This is the reason why barium sulphate suspension has been used

even for bronchography in the past (14). On the other hand, experimental studies in animals suggest the presence of a severe pulmonary inflammatory reaction (15). Moreover, hypersensitivity reactions, caused by one of the many additives to commercial barium preparations, have been observed (16).

The typical radiographic pattern is that of striking opacities caused by the high atomic number of barium ($z=56$) (3,6,8). There is no single pattern, which is pathognomonic of the early or late sequelae of barium aspiration, apart from the high-density changes. Due to a slow progressive clearance of the barium particles, the pattern visible in X-ray or in lung CT may be time dependent (7). The barium particles, if not eliminated by coughing and the mucociliary apparatus, accumulate in alveolar spaces and become phagocytosed by alveolar macrophages. Particles may also pass directly across the alveolar epithelium into the alveolar or peribronchial interstitial tissue leading to fibrosis (7), as revealed by high-resolution computed tomography (HRCT) (8). Plain chest radiographs remain the method of choice in the acute phase (8), while lung HRCT is indicated only in severe cases and is useful in evaluating long-term prognosis. Scintigraphy may also be helpful in decision making- as was the case with our patient- although this has not been reported in the literature. Differential diagnosis, in cases where the history is unhelpful, may include alveolar microlithiasis with a very similar paving pattern in the dependent parts of the lower lobes, deposition of calcium within the lung due to hypercalcemia in patients with chronic renal failure and secondary hyperparathyroidism, pulmonary ossifications of various causes, hemosiderosis, amiodarone toxicity, silicosis and heavy metal pneumoconiosis (7,8).

Since no prospective controlled trials on the treatment of this rare type of complication are available, the treatment suggestions are based on common sense and clinical judgment. In cases of arterial hypoxemia and dyspnea after massive aspiration, bronchoscopy is

recommended to firstly, eliminate as much barium as possible, and to secondly obtain aspirates for microbiology testing. Bronchoalveolar lavage is not recommended because of the danger of dissemination of the contrast medium into the bronchoalveolar system (6). Antibiotic treatment with anaerobic coverage should be initiated in cases of a probable infection (6). Kinesitherapy with postural drainage has also been suggested.

Prevention should be focused on the early recognition of predisposing factors, pretreatment with antireflux medications, such as domperidone or omeprazole, and correct choice of contrast media. Unlike barium sulphate, iopodol (Hytrast[®]), normally used for bronchography, demonstrates no pulmonary harm (15). On the other hand, amidotrizoat (Gastrografin[®]), a non-absorbable, hypertonic water-soluble contrast media may induce pulmonary edema when introduced into the lungs, due to its hyperosmolarity. Lately, a newly introduced isoosmolar contrast medium, iodixanol (Visipaque[®]), formulated with sodium and calcium in a ratio equivalent to blood has been used successfully in our radiology department, especially in children or babies with congenital abnormalities. This medium, mainly designed for intrarterial and intravenous contrast studies, has been shown to be safe in studies of the upper gastrointestinal tract, in terms of aspiration hazards (17).

Conclusion

Complications of barium sulphate aspiration depend upon the density and quantity of the aspirated solution, the extent of tracheobronchial distribution and the general physical condition of the patient. In severe cases, early treatment and close follow up with HRCT are mandatory to prevent fibrosis progression. Apart from other factors predisposing to aspiration, patients with psychiatric disorders are also at an increased risk and should, therefore, be approached with particular caution when performing relevant procedures on these patients.

REFERENCES

1. Zaino C, Beneventano TC. Radiologic examination of the oropharynx and esophagus. New York: Springer; 1977, pp1-28.
2. Pikus L, Levine MS, Yang TX, Rubestin SE, Katzka DA, Laufer I, Geffer WB. Videofluoroscopic studies of swallowing dysfunction and the relative risk of pneumonia. *Am J Roentgenol* 2003;180:1613-16
3. Pracy JPM, Montgomery PQ, Reading N. Acute pneumonitis caused by low- density barium sulphate aspiration. *J Laryngol Otol* 1993;107:347-8
4. Franquet T, Gimenez A, Roson N, Torrubia S, Sabate JM, Perez C. Aspiration diseases: Findings, pitfalls, and differential diagnosis. *Radiographics* 2000;20:673-85
5. Chiu CY, Wong KS, Tsai MH. Massive aspiration of barium sulphate during an upper gastrointestinal examination in a child with dysphagia. *Int J Pediatr Otorhinolaryngol* 2005;69:541-4
6. Tamm I, Kortsik C. Severe barium sulphate aspiration into the lung: clinical presentation, prognosis and therapy. *Respiration* 1999;66:81-4
7. Venkatraman B, Rehman HA, Abdul-Wahab A. High resolution computed tomography appearances of late sequelae of barium aspiration in an asymptomatic young child. *Saudi Med J* 2005;26:665-7
8. Voloudaki A, Ergazakis N, Gourtsoyiannis N. Late changes in barium sulphate aspiration: HRCT features. *Eur Radiol* 2003;13:2226-9
9. Kaira K, Takise A, Goto T, Horie T, Mori M. Barium sulfate aspiration. *Lancet* 2004;364:2220
10. Fruchter O, Dragu R. A deadly examination. *N Engl J Med* 2003;348:1016
11. Rasley A, Logemann JA, Kahrilas PJ, Rademaker AW, Pauloski BR, Dodds WJ. Prevention of barium aspiration during videofluoroscopic swallowing studies: value of change in posture. *Am J Roentgenol* 1993;160:1005-9
12. Aalander T, Svaerdsudd K, Johansson SE, Argeus L. Psychological illness is commonly associated with functional gastrointestinal disorders and is important to consider during patient consultation: a population-based study. *BMC Med* 2005;3:8
13. Whiting J. Aspiration of barium. *N Engl J Med* 2003;348: 2582-3; author reply 2582-3
14. Nelson SW, Christoforidis AJ, Pratt PC. Further experience with barium sulphate as a bronchographic contrast medium. *Radiology* 1976;92:367-70
15. Ginai AZ, ten Kate FJ, ten Berg RG, Hoornstra K. Experimental evaluation of various available contrast agents for use in the upper gastrointestinal tract in case of suspected leakage. Effects on lungs. *Br J Radiol* 1984;57:895-901
16. Gray C, Sivaloganathan S, Simpkins KC. Aspiration of high-density barium contrast medium causing acute pulmonary inflammation – Report of two fatal cases in elderly women with disordered swallowing. *Clin Radiol* 1989;40:397-400
17. Davenport D, Cohen MD, Hanna MP, Bugaieski E, Heifetz SA. Studies of iodixanol in the rabbit lung and peritoneum. *Pediatr Radiol* 1999;29:724-30