Barium Sulfate Bronchography*  
Report of a Complication  
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Alveolarization of the barium sulfate and subsequent retention of barium sulfate for years was demonstrated in three patients in whom dilute suspension of barium sulfate in water was used for bronchography. Pathologic examination in one patient showed barium sulfate within macrophages in the alveolar spaces and walls and in the perivascular and peribronchial interstitium. Since the residual barium sulfate interferes with imaging procedures of the lungs, it represents an unwanted event in patients with pulmonary disease. High-resolution computed tomography is the preferred method of evaluating for bronchiectasis. If bronchogram is performed, it should be performed after bronchoscopy using oily propylidone (Dionosil).

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Most bronchography has been replaced by flexible bronchoscopy or computed tomography (CT). However, there are still indications for bronchography and it is sometimes performed at the conclusion of a flexible bronchoscopic procedure. Since high-viscosity contrast media are difficult to force through the narrow lumen of the flexible bronchoscope, barium sulfate without a suspending agent has been used in some cases. The suspending agent, carboxymethyl-cellulose, increases the viscosity of barium sulfate to roughly that of the conventional agent (S. M. Nelson, personal communication), oily propylidone (Dionosil), and thereby reduces the ease of injection through the bronchoscope. Although barium sulfate prepared with proper suspending agents is probably the safest of all bronchographic contrast media‡ because of its inertness and absence of associated allergic reactions or of proven chronic inflammatory effects in the lung, it does not have FDA approval and has been used mainly in patients with known iodine sensitivity.†

Three patients referred to this hospital after bronchography using dilute aqueous barium sulfate mixture (not suspended in carboxymethyl-cellulose) demonstrated long-term retention of barium sulfate in the lung. The absence of a suspending agent and resulting low viscosity allowed the barium sulfate to reach the peripheral airways and alveoli. Once beyond the ciliated mucosa, the material could not be effectively cleared, and it was retained in macrophages in the alveolar walls, alveolar spaces, and interstitium. Retention of barium sulfate in the lung interferes with subsequent imaging studies and therefore represents an unwanted event.

CASE REPORTS

CASE 1

A four-year-old girl was examined because of chronic recurrent pneumonitis, cough, and a persistent right middle lobe infiltrate that had developed in the first year of life and that had not cleared despite antibiotic therapy. She was referred for evaluation of possible right middle lobe syndrome. There was no history of foreign body or other aspiration.

Results of the physical examination were normal except for right hemithoracic retractions, decreased breath sounds over the right middle lobe, and slight wheezing over the right upper lung. Sweat chloride, urinalysis, immunologic workup, α1-antitrypsin level, and complete blood cell counts were normal. There was no family history of lung disease. The chest roentgenogram at the time of presentation showed right middle lobe collapse. Upper gastrointestinal tract roentgenographic series showed a small amount of distal esophageal reflux, but was otherwise unremarkable.

Bronchoscopy showed an inflamed right main bronchus and right middle lobe bronchus, and a moderate amount of whitish exudate, but no evidence of right middle lobe bronchial stenosis. Bronchography performed through the flexible bronchoscope using barium sulfate diluted in water showed mild cylindrical bronchiectasis (Fig 1A). The final diagnosis was right middle lobe syndrome. Over the next few months, the patient had two pulmonary infections treated with intravenous antibiotics. Chest roentgenogram showed retained barium in the right middle and lower lobes. Seven months after the bronchoscopy and bronchography, the patient underwent right middle lobectomy. The postoperative posteroanterior chest roentgenograms showed residual barium sulfate in the right lower lobe. Pathologic examination showed barium sulfate in alveolar macrophages (Fig 1B).

CASE 2

A 31-year-old woman was examined because of elevated serum immune complex levels. She had lost 9 kg and had suffered from tarry stools, oral ulcers, corneal ulcerations, and fatigue.

Two years earlier, the patient had been examined for reactive airways disease. She had had bronchoscopy followed by a bronchogram using barium sulfate diluted with water introduced through the bronchoscope. The bronchogram was not available for review. Her current chest roentgenogram showed residual pulmonary barium sulfate (Fig 2).

CASE 3

A six-year-old girl was examined because of asthma and persistent atelectasis of the right middle lobe. This patient had been extensively investigated previously for recurrent pneumonia. Rigid and flexible bronchoscopy had been performed, followed by bronchogram performed through the flexible bronchoscope using an aqueous barium sulfate mixture. The bronchogram did not demonstrate bronchiectasis. Chest roentgenograms immediately after bronchoscopy and bronchogram and 18 months later (Fig 3) showed residual barium sulfate.

The right middle lobe collapse was attributed to the moderately severe asthma and the recurrent pulmonary infections were attributed to an isolated IgG subclass 2 deficiency.

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DISCUSSION

The technique for bronchography has been previously described for adults using oil-based contrast (oily propylidone [Dionosil]) and the complications have been described. Barium sulfate suspension was introduced as a contrast medium for bronchographic use by Nelson et al. Their studies and the studies of others emphasize the need to use carboxymethyl-cellulose to provide proper viscosity that prevents alveolarization. Postural drainage and coughing after the procedure also help to prevent alveolarization and retention of barium sulfate.

Nelson et al. found barium sulfate to be a safe bronchographic contrast medium. There was little retention of barium sulfate when precautions were taken to prevent alveolarization and to remove excess barium sulfate after the study. However, it should be noted that barium sulfate suspensions have not been approved by the FDA, and should therefore be considered only when oily propylidone is contraindicated.

In the three patients whose cases were reported, the evidence indicated that a standard barium sulfate water suspension was further diluted with water for easy administration via the flexible bronchoscope. It is known that in bronchoalveolar lavage, the volume of returned fluid obtained immediately after endobronchial injection of the fluid is usually about 50 percent. The remaining fluid is thought to be absorbed across the alveolar membrane into the circulation. We hypothesize that if no attempt is made to aspirate the barium sulfate suspension following a barium sulfate bronchogram, most of the water will be absorbed across the alveolar membrane, leaving barium sulfate in the alveoli, where it may be retained for a long time. Although it is known that barium sulfate can be removed from the alveoli by alveolar macrophages (which pass through the alveolar epithelium into the alveolar wall and eventually into regional lymph nodes), only small amounts of barium sulfate can be removed by this mechanism. The retention of barium sulfate in our three patients is best explained by the alveolarization of large amounts of barium sulfate and incorporation of the barium into macrophages in the alveolar spaces and interstitium as shown by the pathologic findings in case 1 (Fig 1B).
six months before lung resection. They were unable to demonstrate any fibrotic pulmonary changes in these patients who had barium sulfate retention for up to six months after the bronchogram.

In the first patient, a right middle lobectomy was necessary because of recurrent infection. Because such recurrent infections antedated the bronchography, they could not be attributed to retained barium sulfate. The other two patients did not develop infection after the bronchogram.

The major complication of retained barium sulfate is interference with imaging procedures. On chest roentgenograms, pneumonia and other abnormalities can be obscured. Streak artifacts may be generated on CT scans and artifacts will also occur on nuclear scans of the lung, heart, or skeleton. These sequelae of retained pulmonary barium sulfate will create difficulty in the diagnostic evaluation of the conditions of patients whose pulmonary disease requires imaging studies to evaluate the status of their disease. With bronchoscopy and pulmonary high-resolution CT, there are few remaining indications for bronchograms, and since barium sulfate has not received FDA approval, oily propyl iodone is the contrast agent to be used. A standard red rubber catheter exchanged for the bronchoscope after bronchoscopy for the injection of oily propylidone is recommended if bronchogram is needed after bronchoscopy.

When barium sulfate bronchograms are performed, we strongly urge that the barium sulfate powder be suspended in a normal saline solution containing 2 to 3 percent carboxymethyl-cellulose and precautions be taken to prevent alveolarization as described by Nelson.1,3 Diluting the barium sulfate suspension should be avoided. Even though it makes administration easier, it increases the risk of alveolarization and long-term retention of barium sulfate in the lungs.

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