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Spillage of Cystic Pulmonary Masses into the Airway during Anesthesia

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Congenital pulmonary cystic lesions consist mainly of bronchogenic cysts, pulmonary sequestrations, and cystic adenomatoid malformations. Surgical management has been the standard of care for all these lesions. We report two cases of intraoperative spillage of fluid-filled congenital pulmonary cysts into the tracheobronchial tree, one occurring from a bronchogenic cyst, and the other from a cystic adenomatoid malformation.

Case 1

A 6-yr-old boy weighing 19 kg presented with a history of chronic cough. His chest radiograph revealed complete opacification of the right upper lobe, with downward bulging of the fissure (fig. 1A). A computed tomography (CT) scan of the chest (fig. 2) demonstrated a cystic right upper lobe mass containing an air fluid level, consistent with a bronchogenic cyst. His medical history was unremarkable. The physical examination was notable for rhonchi in the right-upper lobe. Laboratory data were normal. The patient was taken to the operating room for thoracotomy and excision of the cystic mass.

After premedication with intravenous midazolam, anesthesia was induced with thiopental and pancuronium. Gentle positive pressure ventilation by face mask was initiated. While awaiting onset of neuromuscular blockade, a large volume of fluid appeared in the oropharynx. Fifty milliliters of clear fluid was suctioned, and the trachea was intubated with a 5.0 cuffed endotracheal tube. Despite administration of 100% oxygen, the SaO_2 decreased to 90%. A chest radiograph (fig. 1B) revealed absence of the previously visualized right upper lobe consolidation. Borders of the bronchogenic cyst were now distinct. Based on this finding, a diagnosis of spillage of the cyst was made. After 20 min, a decision was made to proceed with surgical resection based on the return of the arterial oxygen saturation to 99% with an FiO_2 of 40% and on the clinical impression that the oropharyngeal fluid represented noninfected cystic fluid. A right thoracotomy and cystectomy was performed during combined general and thoracic epidural anesthesia. The patient was extubated at the conclusion of surgery and had an unremarkable postoperative course.

Case 2

A 1-month-old girl weighing 2.8 kg presented with coughing and tachypnea. A chest radiograph showed a cystic mass in the right perihilum displacing the right mainstem bronchus, which led to the preoperative diagnosis of a bronchogenic cyst. Physical examination was notable for rales in the right anterior lung field and decreased breath sounds at the right base. Laboratory data were unremarkable. All temperatures recorded before surgery were normal. The patient was taken to the operating room for bronchoscopy and thoracotomy to remove the cystic mass.

Anesthesia was induced with halothane and nitrous oxide. Intravenous access was obtained, and pancuronium was administered. Bronchoscopy was unrevealing. The trachea was then intubated with a 3.0 uncuffed endotracheal tube. A radial arterial line was placed, and the patient was turned to the lateral decubitus position. During rib retraction, the endotracheal tube became occluded with copious purulent material. The tube was suctioned, and eventually the thick nature of the secretions required endotracheal tube replacement. Persistent secretions led to a decrease in the patients arterial oxygen saturation, followed by bradycardia and hypotension. Intravenous epinephrine was administered to restore circulation. High ventilatory pressures and 100% oxygen were required. Right upper lobectomy was completed, and the patient was taken to the intensive care unit with the trachea still intubated.

A culture of the purulent material grew *Streptococcus pneumoniae*. Pulmonary infection and a bronchopleural fistula mandated prolonged ventilatory support, including management with a high frequency oscillatory ventilator. The final pathologic diagnosis was a type II cystic adenomatoid malformation. The patient was eventually discharged home in good condition.

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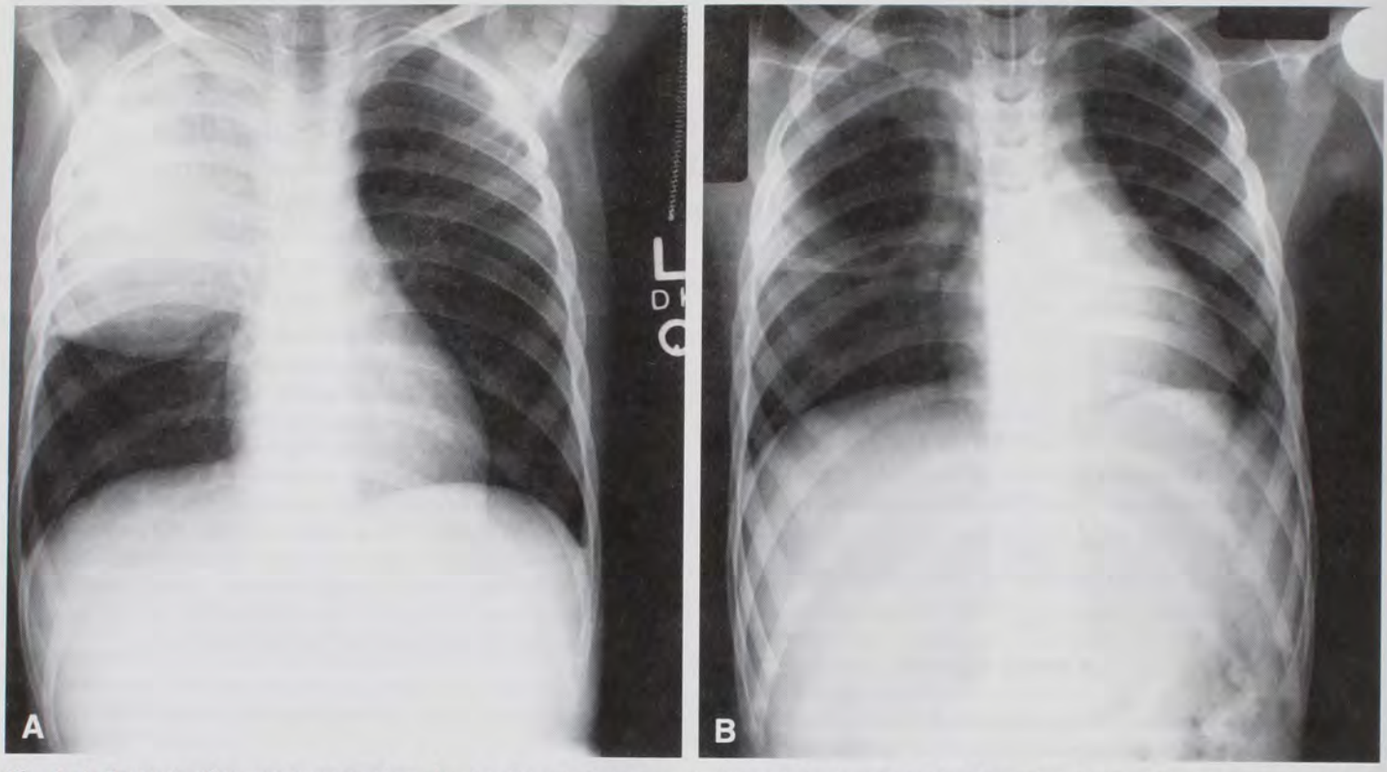

Fig. 1. A, Preoperative anteroposterior chest radiograph of case 1, demonstrating complete opacification of the right upper lobe as a result of the presence of a fluid-filled bronchogenic cyst. Downward bulging of the fissure is apparent. B, Intraoperative anteroposterior chest radiograph of the same patient taken after the appearance of oropharyngeal fluid, demonstrating absence of the right upper lobe cystic fluid visualized in the preoperative film.

Discussion

Bronchogenic cysts represent abnormal embryologic development of the primitive foregut, forming a cystic structure that may occur in numerous anatomic locations. Most often, the location is the mediastinum or the pulmonary parenchyma.[1-3] Cystic adenomatoid malformations represent overgrowth of terminal bronchioles, with suppression of alveolar growth, leading to cystic masses that communicate with the airway.[4] Bronchogenic cysts may be filled with air, fluid, or both, and only rarely communicate with the tracheobronchial tree. Air within the cyst indicates communication.[2] Bronchogenic cysts located in the pulmonary parenchyma are more likely than mediastinal cysts to communicate and to be a focus of infection.[5,6] Patients with bronchogenic cysts often present before the age of 5 years, usually with airway compression resulting in wheezing, chronic cough, or recurrent pneumonia. They also may have symptoms caused by pressure exerted on the esophagus or on major vascular structures.[1] Cystic adenomatoid malformations often (46%) present in the neonatal period with respiratory symptoms, but they may present later as recurrent pneumonia.[7] Bronchogenic cysts and cystic adenomatoid malformations may be incidentally diagnosed on chest radiograph, and both lesions may first present in adults.[4,5] Although bronchogenic cysts frequently lead to pulmonary infection, infection of the cyst itself is uncommon, occurring with an approximate prevalence of 4–5%.[2] Management of bronchogenic cysts and cystic adenomatoid malformations, as with nearly all cystic pulmonary lesions, involves open excision of the involved lobe. Excision of bronchogenic cysts by mediastinoscopic and thoracoscopic approaches has been performed.

Preoperative radiologic studies are useful for defining the cystic nature and the exact location of pulmonary masses. Bronchogenic cysts classically appear on plain chest radiographs as a round or oval mass located below the carina.[6] Location of a cystic mass in the middle mediastinum increases suspicion of a bronchogenic cyst. Congenital pulmonary cystic masses occurring in the parenchyma are more difficult to differentiate radio-

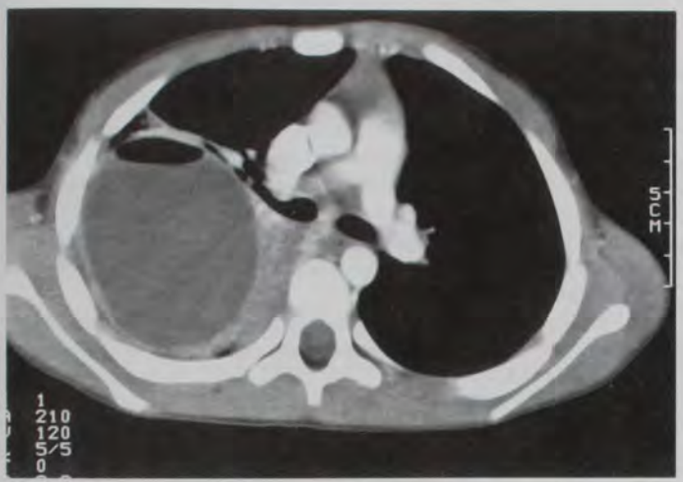

Fig. 2. Preoperative computed tomography scan of the chest of case 1, demonstrating a 5 x 7 x 7 cm cystic lesion in the right upper lobe. An air fluid level is present within the lesion, and there is a suggestion of a communication with the right upper lobe bronchus.

logically. Lesions occurring in the upper lobes, or right middle lobe, and in which bronchovascular markings are present, may represent congenital lobar emphysema rather than a true cyst. Cystic adenomatoid malformations have no lobar predilection.[4] Pulmonary sequestrations may be cystic and usually occur in the lower lobes. The ability to accurately diagnose a cystic mass from preoperative radiologic studies is limited. Although sensitivity of detecting bronchogenic cysts may be 67–100% when chest radiography and confirmatory CT scanning are used,[2,3] there appears to be no information on their positive predictive value. Other cystic lesions therefore should be considered possible, despite the preoperative diagnosis. Increased signal intensity of the cyst on CT and on magnetic resonance imaging (MRI) T1 images is consistent with proteinaceous nonserous cystic contents and should increase suspicion of infection. Also, a cyst with a thick contrast enhancing wall on CT scan is consistent with cyst infection. Nonetheless, the sensitivity of CT and MRI in diagnosing infected cystic contents is unclear. Tracheobronchial communication of a cystic mass is difficult to show in the absence of an air fluid level, even with high resolution CT scanning.[8] Because of their inability to definitively differentiate pulmonary cystic masses and to reliably determine the presence of infection or airway communication, preoperative radiologic studies are of limited value to the anesthesiologist planning the perioperative care of these patients.

Complications may occur during surgical excision of cystic pulmonary masses, including hemorrhage, tracheal wall tear, pneumothorax, and sinus bradycardia.[5] Our cases demonstrate the risk of spillage into the tracheobronchial tree at any time during the anesthetic. In our first case, positive pressure ventilation, and in our second case, rib retraction, appear to have precipitated cyst spillage. As expected, the pulmonary sequelae of intrabronchial spread of cystic fluid was considerably worse when the fluid was infected. When a pulmonary cyst is suspected of harboring infection, some authors would recommend delaying surgery until a course of antimicrobial therapy has been received.[9] However, because the inflammatory response to purulent cystic fluid may be mainly chemical and because the efficacy of antimicrobial treatment of infected pulmonary cysts is unknown, we suggest this decision be made on a case-by-case basis. One patient with a bronchogenic cyst infected with *Hemophilus influenza,* with an associated bronchopleural fistula and empyema, was treated with antibiotics before lobectomy, which resulted in improved medical condition at the time of surgery.[10] When infection of a pulmonary cyst is suspected, we recommend lung separation and avoidance of positive pressure ventilation until the lungs have been separated. Pediatric lung separation may be achieved with selective bronchial intubation or with bronchial blockade using Foley or Fogarty catheters.[9] Because there are no double lumen endotracheal tubes for infants and children, lung isolation is more difficult and probably is more prone to complication than in adults. For this reason and because spillage is unusual, we do not recommend lung separation for infants and children when a cyst is thought to be infection-free. Avoiding positive pressure ventilation until the chest is open may be prudent even when a cyst is not infected. This would serve to avoid overdistention of a communicating cyst, an undiagnosed lobar emphysema, or a cystic adenomatoid malformation.[9]

These two case reports document the intrabronchial spillage of congenital pulmonary cyst contents during anesthesia. Awareness of the possibility of intrabronchial spillage and knowledge of the possible occurrence of severe respiratory sequelae after intrabronchial spread of infected cystic fluid will help guide anesthesiologists during preoperative planning and intraoperative treatment of patients with infected and noninfected cysts.

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Acute Bronchospasm Associated with Polymethylmethacrylate Cement

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Polymethylmethacrylate bone cement is widely used in prosthetic joint implantation surgery and repair of bony defects. Well-recognized complications are most frequently seen during prosthetic joint implantation. We describe a patient who developed acute bronchospasm on application of polymethylmethacrylate during cranioplasty.

Case Report

A 71-yr-old, 65-kg, woman was to undergo cranioplasty to repair a 4 × 2 cm bony defect of the left temporal fossa left by clipping of internal carotid and ophthalmic artery aneurysms 9 months previously. She suffered no neurologic sequelae from the surgery. Her medical history was otherwise significant only for hypertension controlled with captopril. She reported an allergy to penicillin. She used no tobacco or alcohol. Physical examination was unremarkable.

Just before induction of anesthesia, vancomycin and gentamicin were given without incident. The American Society of Anesthesiologists' standard monitors were used, along with airway pressure and volume monitors. Anesthesia was induced with thiopental and fentanyl, and muscle relaxation was attained with vecuronium. Proper placement of an 8.0-mm inner diameter cuffed oral endotracheal tube was confirmed by auscultation of bilateral, equal breath sounds, and positive end-tidal CO_2. Anesthesia was maintained with isoflurane (0.2%–1.5% end-tidal concentration) in 66% N_2O and 33% O_2 (adult circle circuit; total fresh gas flow 1.5–2 l/min). Mechanical ventilation by a Drager AV-2 ventilator (North American Drager, Telford, PA) was adjusted to maintain end-tidal CO_2 between 30 and 36 mmHg. Patient was in supine position, with head slightly turned to the right.

The patient's hemodynamic and respiratory parameters remained stable for the first 2 h of the procedure, during which the skull defect was exposed, with minimal blood loss. One minute after application of semi-solid polymethylmethacrylate on a steel-wire mesh spanning the bony defect, pulse oximetry reading (SaO_2) decreased from 99% to 89% (fig. 1B); heart rate increased from 62 to 85 beats/min, and blood pressure decreased from 110/65 to 80/50 mmHg (fig. 1A). Simultaneously, airway pressures abruptly increased from 32/22 cmH_2O (peak/plateau) to 40/32 cmH_2O (fig. 1C). The capnograph exhibited an upsloping plateau, and the end-tidal CO_2 decreased from 36 to 28 mmHg. Anterior chest auscultation confirmed presence of bilateral, equal breath sounds. In addition, diffuse high-pitch expiratory wheezes were heard. The blood pressure returned to baseline within 10 min after ephedrine, 5 mg, was given intravenously. Inspired oxygen concentration was increased to 100%, and positive end-expiratory pressure (PEEP) of 5 cmH_2O was added. With these maneuvers, SaO_2 improved from 89% to 92% over 5 min, but wheez-

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