

Robotic Bronchogenic Cysts Surgeries: A Case Report and Literature Review

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Abstract

Bronchogenic mediastinal cysts are congenital lesions originating from the primitive ventral foregut that are often located in the middle or posterior mediastinum. Surgical resection of bronchogenic cysts is the recommended treatment of choice and is both a diagnostic and therapeutic measure. In this paper, we report a case of mediastinal bronchogenic cyst that was operated on at our institute using the Da Vinci Xi robotic system as well as a literature review about this disease. Reviewing the literature about the robotic resection of these lesions shows that it is considered a safe technique with advantages for patients.

Keywords

Bronchogenic Cyst, Robotic Surgery, Mediastinum

1. Introduction

Bronchogenic cysts (BCs) are benign congenital mediastinal or lung parenchyma lesions that account for about 10% - 15% of all primary mediastinal tumors. BCs typically result from the abnormal budding of the primitive tracheobronchial tube which happens at any time during airway development. If the abnormal budding occurs early in gestation, cysts will be formed in the center along the tracheobronchial tube, and most commonly in the middle or posterior mediastinum, and they rarely communicate with the trachea or the bronchi. However, if it happens later in gestation, then cysts will be found in the lung parenchyma with patent communication to the bronchial tree.

In addition, the precise timing of abnormal budding affects where the cyst will ultimately form; if the abnormality happens early in gestation, the tracheobronchial trees or mediastinum, including the right paratracheal area and tracheal carina, are mainly sites for cyst formation. Later in development, abnormal budding causes peripheral cysts to form within the lung parenchyma, most commonly in the lower lobes, with no preference for side [1] [2].

Histologically, BCs are filled with thick mucoid material, encased in bronchial hyaline cartilage, smooth muscle, elastic tissue, bronchial mucus glands, and nerve trunks. Moreover, these cysts' lining consists of ciliated pseudostratified columnar epithelium [3] [4].

In neonates, symptoms occur because of adjacent structures compression by the mass [5]. In adult patients, the clinical presentation varies from being asymptomatic to more significant presentation such as pneumothorax, respiratory infection, pain, dysphagia, or superior vena cava syndrome. Radiologically, CT imaging shows smooth-edged, sometimes lobulated cysts with variable density, and magnetic resonance imaging (MRI) may be used to confirm their cystic nature if required. Bronchogenic cysts appear as spherical masses on CT scans, characterized by either water or soft-tissue attenuation. When these cysts present with water attenuation, differentiating them from other mediastinal conditions, such as lymphadenopathy or neoplasia, is simple. However, if they present with soft-tissue attenuation, differentiating them from solid lesions is more complicated [6] [7]. Moreover, endoscopic bronchial ultrasound (EBUS) is used for the diagnosis and treatment of BC, although it has an elevated risk of developing infection due to bacterial contamination during the procedure [8]-[11].

Surgical excision is considered the gold standard for treating symptomatic bronchogenic cysts [12]-[14]. However, in neonates, it might be delayed allowing for weight gain. In symptomatic adults, surgical resection should be considered after the patient is stabilized [15] [16]. Aspiration may provide temporary relief for compressive symptoms, but it carries a considerable risk of infection and is associated with a tendency for short-term recurrence [8]-[10]. Thus, to minimize recurrence, complete cyst wall removal is crucial [17] [18]. Lobectomy in the case of intrapulmonary BCs, is the gold standard approach [19].

Furthermore, minimally invasive techniques such as video-assisted thoracoscopic surgery (VATS) and robotic-assisted thoracoscopic surgery (RATS) have become feasible methods for resection due to the adaptation of robotic platform for minimally invasive thoracic surgery and are frequently used for cysts in the mediastinum or lung parenchyma. These techniques allow for effective removal with a shorter recovery period and lower morbidity in addition to the advantage of the three-dimensional view of robotics in having greater visualization and precision especially for difficult angles [14] [20] [21].

In this study, a case of a subcarinal BC was documented, which highlights the importance of surgical procedures in the management of such masses and reveals the clinical benefits of RATS for thoracic lesion resection.

2. Case Presentation

A 23-year-old lady with a background of subclinical hypothyroidism was presented to the thoracic surgery outpatient clinic as a case of stabbing chest pain which was radiating to the back. On physical examination, the patient has no tenderness on the lateral side of the back, no tenderness on the left or right chest wall, no clinical signs of inflammation, and no swelling. The patient's initial plan was to schedule a chest CT.

Chest CT (**Figure 1**) was done and it showed a subcarinal, well-defined, oval-shaped lesion, measuring 3.8×3 cm in transverse and AP diameters, with minimal peripheral calcification, seen as inseparable from the esophagus. Additionally, the relation to pericardium cannot be completely evaluated due to the lack of IV contrast. The mass most likely represents a bronchogenic cyst, but further evaluation with a chest MRI was recommended.

Chest MRI (**Figure 2**) was done and it showed a subcarinal well-defined lesion, measuring $2.7 \times 3.7 \times 3.6$ cm in AP, transverse, and craniocaudal dimensions, with no notable change in size, and again shows mild splaying of the carina. However, no invasion of the adjacent structures, and it seems to be separate from the underlying esophagus. The lesion demonstrates high T2 signal intensity, however, the intermediate signal intensity noted on T1 images could be related to the presence of pertinacious/bloody contents. There was no drop of signal on the out-of-phase images to suggest a microscopic fat component, no solid component, or appreciable intrinsic enhancement on the post-gadolinium images. The lesion shows no diffusion restriction on the apparent diffusion coefficient (ADC) map. The MRI showed a demonstration of the subcarinal cystic structures likely representing a bronchogenic cyst.

Upper GI Fluoroscopy was done (**Figure 3**) to make sure it was not communicating with the esophagus, and it showed that the contrast smoothly passed through the esophagus into the stomach with no holdup or reflux of contrast, no hernia, and no stricture or stenosis.

The patient was operated on. The plan was to perform a right-sided robotic

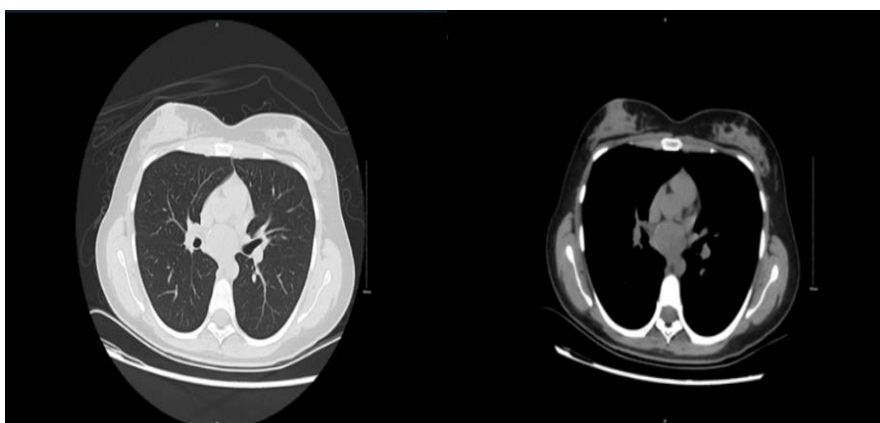


Figure 1. CT scan demonstrates a subcarinal, well-defined, oval-shaped lesion.

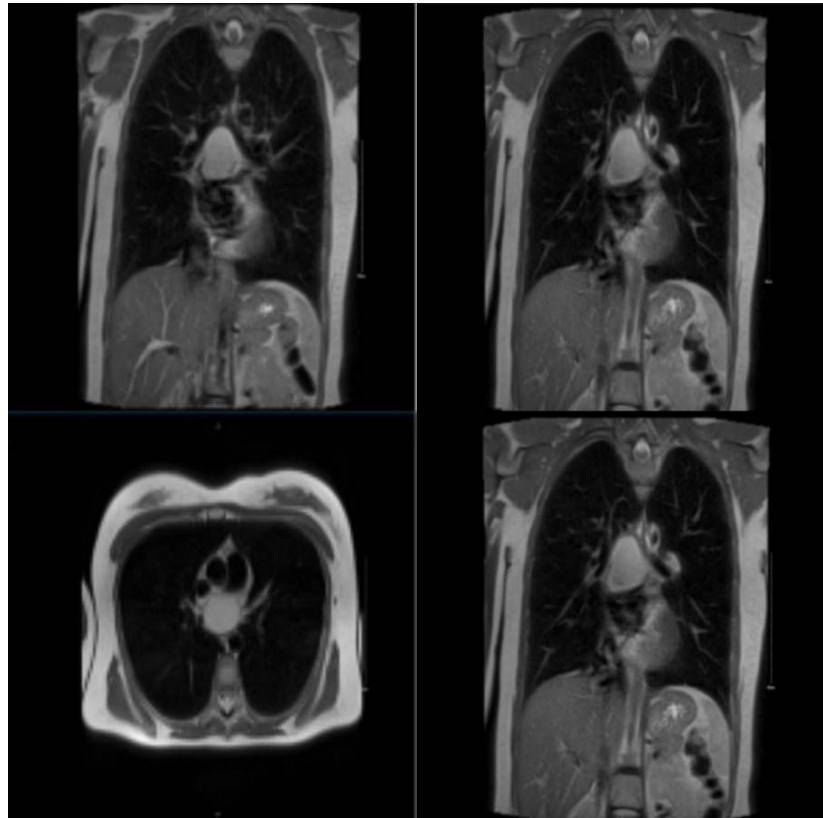


Figure 2. Chest MRI demonstrates the lesion without invasion of the adjacent structures.

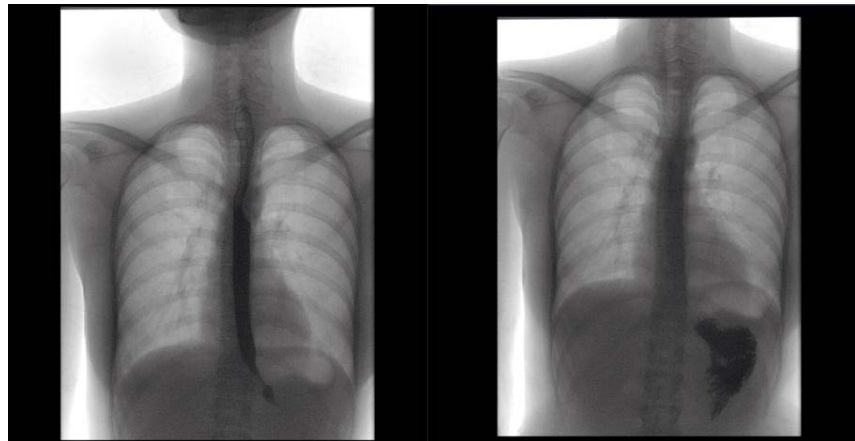


Figure 3. Swallow study of the patient with contrast passing smoothly through the esophagus into the stomach.

bronchogenic cyst resection. General anesthesia was administered through a left-sided double-lumen endotracheal tube which was inserted to secure one-lung ventilation during the operation and full monitoring capacity was initiated. Under sterile conditions, the patient was positioned in the left lateral decubitus position with the right side up. Port locations were selected as follows. The first incision was made in the 7th intercostal space posterior axillary line. Through this incision, the robotic camera was inserted to inspect the area, and the lung had fallen nicely.

A thorough inspection of the posterior mediastinum allowed for cyst identification. Two other ports were added posteriorly around 9 cm apart for each at the same level and one additional port was added anteriorly for retraction around 9 cm as well from the camera. The right hand was used for Maryland with bipolar energy and the left with a Cadiere forceps that is soft. A swab (cigar) was used for safety and to swab any blood. The lung was retracted medially to expose the posterior hilum. We started by dissecting the posterior mediastinal pleura starting from the inferior pulmonary ligament level till we reached the cyst that was obvious. It seemed that the cyst was adhered to the pericardium as well as the airway. At the level of the cyst, we started by dividing the pleura overlying the cyst and try to find a plane outside the cyst and dissect it out. We were carefully coming around the cyst and doing some gentle spreading and bipolar cautery. care should be taken not to do thermal injury to the airway or any surrounding structure. The aim was to preserve the cyst as long as we can as that will help find the cyst easily compared with when its compressed. A small unintentional rupture in the cyst occurred and a thick whitish gelatinous material came out. Decompressing the cyst is mentioned in such operations to decompress the cyst that helps in better grasping and removing the cyst in piecemeal. We immediately used a sucker to suck the sac content, decompress it and make sure it is not spilled in the chest cavity. We washed the cyst to minimize contamination of the operating field. We observed the inside membranous part of the cyst cavity, and it was clearly clean. We carefully dissected the cyst from surrounding structures including the airway, esophagus, and pericardium. The goal was to stay right on the cystic structure that helps us maintain the correct plane. The entire cyst was removed and placed in retrieval bag and sent for pathology. Irrigation of the chest was done to make sure we cleaned the chest cavity. A 28 Fr chest tube was inserted, and lung reinflation was done fully. All ports were closed. At the end of the procedure, the patient was extubated and shifted to the recovery room for observation without any complications or problems.

The specimen that was sent to the pathology lab revealed a fibrous cyst wall lined by respiratory-type epithelium and containing cartilage, calcification, and mucinous gland consistent with a bronchogenic cyst with no identified malignancy. Moreover, one reactive lymph node was identified.

The postoperative course was uneventful for the patient. Her chest X-ray before (**Figure 4**) and after chest tube removal was satisfactory (**Figure 5**) and she was discharged on the 4th post-operative day after doing very well in post-operative hospitalization with no complaints and very well pain control. The chest tube was removed on the 3rd day after surgery. She was seen in the outpatient clinic after a week. Follow up one, three, and six months after surgery were particularly good and she was doing well in all these visits. Chest X-rays on follow (**Figure 6**) were all satisfactory as well. There were no obvious consolidations or pleural effusions seen. She was recovering very well.



Figure 4. Post-operative day 1 chest x-ray.

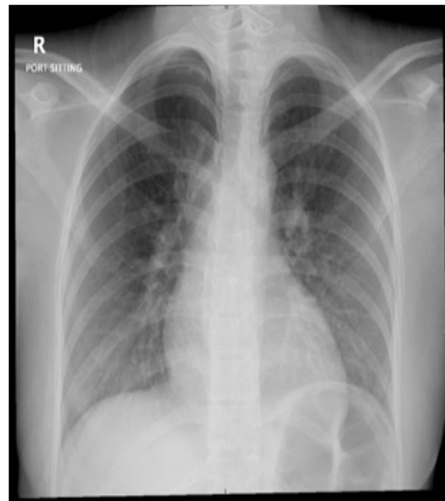


Figure 5. Post-operative day 4 chest x-ray.



Figure 6. One-week post-operative chest x-ray.

3. Discussion

Bronchogenic cysts are benign lesions that result from abnormal budding of the primitive tracheobronchial tube [1] [2]. Its prevalence is approximately 1 out of every 42,000 and 1 out of every 68,000 admissions in two hospital series [22]. These lesions are encased in either ciliated pseudostratified columnar epithelium or airway component, which includes bronchial hyaline cartilage, smooth muscle, elastic tissue, bronchial mucus glands, and rarely nerve trunks. Moreover, they also may contain clear fluid, mucus, and rarely air or hemorrhagic secretions [3] [4]. Bronchogenic cyst formation may occur at any stage of airway development. The site of faulty budding affects where these cysts are found. Cysts usually grow centrally if this defect occurs during early gestation and more peripherally if it forms later in pregnancy [1] [2]. Even though they can occur in other sites such as the pericardium, the pleura, the neck, the diaphragm, and the retroperitoneum, they mainly develop in the middle mediastinum [23].

In this case, we presented a 23-year-old female diagnosed with a subcarinal bronchogenic cyst. The patient presented with left-sided stabbing chest pain that radiates to the back. Initial investigations with a CT scan revealed a subcarinal, well-defined, oval-shaped lesion, measuring 3.8×3 cm in transverse and AP diameters, with minimal peripheral calcification. After right-sided robotic surgery with bronchogenic cyst resection, the patient tolerated the surgery very well with no complications.

Patients presenting with BCs are primarily asymptomatic, however, symptoms if present vary with age. For example, in pediatric patients, compressive symptoms may be life-threatening [5]. In adults, fistulized cysts can cause sputum production, cough, and hemoptysis, while non-fistulized cysts mainly cause chest pain, similar to this case report [23].

Bronchogenic cyst diagnosis is mainly done by imaging. Chest radiography is usually used at first, and the findings depend on the location. In pulmonary cysts, they appear sharply defined, solitary, round, or oval opacities, mainly in the lower lobe. They also can present as a homogeneous water density, as an air-filled cyst, or with an air-fluid level. Furthermore, mediastinal BCs appear as spherical or ovoid masses that are homogeneous, smooth, solitary, and typically located in the middle mediastinum. CT is the preferred method of investigation, and bronchogenic cysts' CT densities range from normal water densities to high densities associated with blood, elevated calcium, anthracotic pigment, or elevated fluid protein. When it comes to defining the cyst and defining anatomic relations, magnetic resonance imaging is superior to CT scanning. Depending on the cyst contents, the intrinsic signal strength on T1-weighted imaging ranges from low to high. High signal intensity is seen in T2-weighted images. Often, there is no enhancement following a contrast injection [6] [7].

Surgical resection is the preferred treatment for mediastinal bronchogenic cysts due to patients' being at a higher risk of developing symptoms, infections, or, in rare cases, malignant transformation [24]-[26]. To our knowledge, the first

resection of a mediastinal bronchogenic cyst using a robotic approach was reported by Yoshino *et al.* in January 2001 and published in 2002. They resected a bronchogenic cyst which is 2.0 cm in size and located at the left posterior mediastinum [27]. Mediastinal bronchogenic cysts are mostly adhesive to adjacent vital structures such as the trachea, aorta, and main bronchi, consequently making a complete resection difficult via conventional thoracoscopy. In the case of dense adhesions, thoracotomy should be always kept in mind. The three-dimensional visualization, remarkable instrument maneuverability, and more accurate dissection of robotic systems may overcome this complexity and avoid incomplete mediastinal bronchogenic cyst resection. The articulating instruments may be significantly helpful for mediastinal mass dissection within the vital tissues in the thoracic cavity [28].

A study was conducted on the cyst's rupture intraoperatively and showed similar findings to this case report. In both cases, the rupture required cyst contents aspiration to manage the situation effectively, followed by the careful removal of the remaining cyst to prevent further complications. This underlines the importance of being prepared for such events during surgery, as they can significantly affect the surgical procedure and overall patient outcomes [29].

RATS is considered more effective than traditional open procedures, showing benefits such as enhanced precision and reduced time of recovery. In terms of patient outcomes, it compares with video-assisted thoracoscopic surgery, making it a compelling option for minimally invasive treatment of mediastinal masses [30]. A study was conducted by Hong *et al.* compared the advantages, disadvantages, and results of VATS and RATS. The RATS group has numerous benefits including automatic filtering of tremors, three-dimensional visualization, 10× magnification image, and wrist rotation with 7 degrees of freedom, but lack of force feedback is considered a disadvantage of RATS during the procedure. The total procedure time for RATS is shorter due to a clearer intraoperative view and easier maneuvering in tight spaces. In addition, the operation time of RATS can be significantly reduced with the cooperation and skills of the operator and the robotic team. Moreover, patient recovery is faster, normal tissue is protected, and trauma is smaller in RATS. The VATS group has surgical safety that is similar to RATS but with a two-dimensional visualization, difficult knotting, and insufficient handling ability in small spaces. Furthermore, VATS has no significant difference in the rate of transferring to an open chest and postoperative complication rate compared with RATS [31].

Studies on bronchogenic cysts with RATS are limited by small samples, and some surgeons may avoid it due to limited training or the lack of published literature. A randomized controlled trial is recommended to compare RATS with other approaches to fully explain its benefits and promising results.

4. Conclusion

Bronchogenic cysts are benign congenital masses that are found commonly in the

mediastinum or lung parenchyma. BCs are usually discovered incidentally, but they can sometimes cause significant complications. Recent studies considered RATS for mediastinal bronchogenic cysts as a minimally invasive, safe, and effective technique, particularly for accessing hard-to-reach areas [29]. In this case report, the patient successfully underwent RATS with no complications, further confirming the efficacy and safety of this procedure.

Ethical Considerations

The patient agreed to participate in this research and consent was taken to publish the clinical data in the journal.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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