Original Article

Comparative outcomes of video-assisted thoracoscopic surgery versus open surgery for bronchogenic cysts in adults: a retrospective cohort study

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Background: Open thoracotomy has been the traditional surgical approach for patients with bronchogenic cysts (BCs). This study aimed to evaluate the safety and efficacy of video-assisted thoracoscopic surgery (VATS) compared to open surgery for the treatment of BCs in adults.

Methods: This single-institution, retrospective cohort study included 117 consecutive adult patients who underwent VATS (group A) or open surgery (group B) for BC resection between February 2019 and January 2023. Data regarding clinical history, operation duration, length of hospital stay, 30-day mortality, and recurrence during follow-up were collected and analyzed.

Results: Of the total cohort, 103 (88.0%) patients underwent VATS, while 14 (12.0%) patients underwent open surgery. Patients' age in group B were much older than group A (P=0.014), and no significant differences in other demographic and baseline clinical characteristics were observed between the groups. The VATS group had shorter median operation duration (96 *vs.* 149.5 min, P<0.001) and shorter mean length of hospital stay (5.0±5.5 *vs.* 8.6±4.0 days, P<0.001). One death occurred in the open surgery group. During a median follow-up of 34 (interquartile range, 20.8–42.5) months, no instances of BC recurrence were observed in either group.

Conclusions: Compared to open surgery, VATS is also a safe and efficacious approach for treating BCs in adults. What's more, VATS offered shorter operative times and hospital stays. Considering the minimally invasive, VATS may be a better choice in most patients with bronchial cysts.

Keywords: Bronchogenic cyst (BC); video-assisted thoracoscopic surgery (VATS); open surgery; thoracotomy

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Introduction

A bronchogenic cyst (BC) is a rare congenital cystic malformation of the respiratory tract (1), arising from abnormal budding of the primitive foregut during early embryonic development (2). While the precise incidence is unknown, BCs may be more prevalent than currently estimated. These cysts occur more frequently in children than adults and are typically localized within the mediastinum or lung parenchyma (3), with rare occurrences in the pericardium or esophageal wall (4,5). Ectopic BCs can also be found intra-abdominally or, in exceedingly rare instances, in the head and neck region (6-8).

Most BCs are asymptomatic but may provoke symptoms if infected or sufficiently enlarged to compress adjacent organs (9). Although typically benign, malignant transformation of BCs is possible (10). Therefore, surgical resection is an effective method to alleviate associated symptoms and reduce the potential risk of malignant transformation and to prevent complications arising from the cyst itself. Previous case reports have documented endoscopic resection of BCs (11,12). However, only a few of comprehensive cohort studies evaluating thoracoscopic surgical techniques for BCs resection have been conducted (13,14).

Herein, we present a cohort study aimed at assessing the safety, efficacy, and potential advantages of thoracoscopic BC resection compared to open surgery. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-602/rc).

Highlight box

Key findings

- Video-assisted thoracoscopic surgery (VATS) is a safe, and efficacious approach for resecting mediastinal or pulmonary bronchogenic cysts (BCs) ≤4 cm in adults.

What is known and what is new?

- Traditionally open thoracotomy has been the primary surgical approach for managing BCs. However, the advent of VATS has revolutionized thoracic surgery by offering a less invasive alternative. Despite this advancement, the literature on BCs has been limited, comprising primarily case reports, with a paucity of cohort studies assessing the efficacy of VATS for BC resection.
- To address this gap, we conducted a retrospective cohort study evaluating the safety and potential advantages of thoracoscopic resection compared to open surgery.

What is the implication, and what should change now?

- Our findings demonstrate that VATS is associated with a short hospital stay for cysts ≤4 cm. Consequently, we advocate for the widespread adoption of VATS as a safe and preferable option for managing BCs in adults, particularly those ≤4 cm in size.

Methods

Study design and patient selection

We conducted a retrospective, comparative cohort study of consecutive adult patients who underwent video-assisted thoracoscopic surgery (VATS) or open thoracotomy for BC resection. From February 2019 to January 2023, 117 individuals underwent surgical resection of BCs at the First Affiliated Hospital of Bengbu Medical University, Bengbu, China.The sample size was determined based on the incidence of cases within our catchment area during the study period. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Ethics Committee of the First Affiliated Hospital of Bengbu Medical University (No. BYYFY-2019KY39). The requirement for patient consent was waived since this study was retrospective and observational.

A thoracic surgeon manually reviewed the patients' medical records, with the diagnosis of BC confirmed via imaging studies and pathologic examination. On preoperative computed tomography (CT) scans, BCs appeared as homogeneous cystic masses with smooth and thin walls. Approximately 50% of the cases exhibited homogeneous water density (–10 to 10 Hounsfield units). If the cyst density was high, however, it could not be distinguished from soft tissue masses. On magnetic resonance imaging (MRI), cysts filled with water or serous fluid showed low signal intensity on T1-weighted images, while cyst contents with protein exhibited high signal intensity. Regardless of protein presence, the signal intensity of BCs on T2-weighted images was homogeneously hyperintense (similar to that of cerebrospinal fluid). BCs with inflammation or hemorrhage displayed heterogeneous signal intensity, with varying T1- and T2-weighted signal patterns. Mediastinal BCs often compressed adjacent airways and blood vessels, while intrapulmonary BCs compressed and displaced adjacent lung tissue. Postoperative pathological examination was necessary for all patients to establish the final diagnosis. The main pathological findings revealed that the BC wall was lined with respiratory epithelium, cartilage, smooth muscle, and mucous glands.

The procedures were performed by multiple surgeons, resulting in variations in treatment approaches across the cohort. The decision for VATS versus open surgery was based on BC location and size, as well as surgeon's technical expertise. VATS was generally favored for smaller mediastinal or pulmonary BCs, while the following BCs were selected for open surgery: pulmonary lesions located near the hilum and with unclear boundaries with vascular tissue; posterior mediastinal cysts that were large and in close proximity to the esophageal wall, tracheal membrane, and pulmonary hilar vessels; anterior mediastinal lesions located above the aortic arch, irregularly shaped, and embedded between vascular spaces. All patients were discussed within the department. For patients deemed challenging for thoracoscopic surgery during discussions, the chief surgeons believed VATS could be largely performed; thus, VATS was attempted first, with instruments for open surgery on standby. In this group of patients, no conversion from VATS to open surgery occurred.

Outcomes and covariates

The primary outcome of interest was the time between diagnosis and death. Information about survival and deaths was obtained through telephone interviews or outpatient chart review, with the cut-off date for data collection set on December 31, 2023. No patients were lost to follow-up. Electronic medical records were reviewed to retrieve data on patient characteristics (sex, age, body mass index, body surface area, comorbidities, smoking history, alcohol consumption), operative variables (size and location of BCs, presence of adhesions, operation duration), total drainage volume, length of hospital stay, and 30-day mortality. For ruptured BCs during surgery, cyst size was determined using preoperative CT or MRI. Documentation of BC adhesion to surrounding tissues was based on operation records. Operation duration was extracted from anesthesia records. Total drainage volume referred to the cumulative fluid drained before chest tube removal. All the operations were successfully completed, and there was no conversion to open thoracotomy in the VATS group. No bleeding or other serious complications occurred during the operation. There was no recurrence in any of the patients.

Operative techniques

In the open surgery group, a thoracotomy through the fifth intercostal space was performed. An anterolateral incision was employed for BCs in the anterior mediastinum, while those located in the posterior mediastinum were approached thorough a posterolateral incision. Patients in the VATS group, underwent incisions in the fourth intercostal space. For anterior mediastinal BCs, the incision was made between the anterior axillary line and the midaxillary line. Patients with BCs located in the lung or posterior mediastinum received an incision between the midaxillary line and the posterior axillary line. Most patients underwent uniportal VATS, with some requiring placement of an additional port.

For the subxiphoid approach, either a single 3–5 cm port incision with a sternal retractor or a three-port incision with intraoperative carbon dioxide insufflation was employed. Regardless of the approach, both blunt and sharp dissection techniques were used during the operation. An ultrasonic scalpel and a monopolar electrocautery were often used in combination. Lobectomy was performed for patients with large pulmonary BCs or, concomitant lung diseases (2 cases with adenocarcinoma, 1 case with squamous cell carcinoma). In certain instances, complete BC resection posed technical challenges due to the cyst's large size, critical location, or dense adhesions to surrounding vital organs. In such cases (8 cases), a portion of the BC wall was intentionally left *in situ* and thoroughly lavaged with povidone-iodine solution to reduce the risk of recurrence while avoiding inadvertent injury to unresectable adjacent structures.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation, and categorical variables as absolute values and percentages. Differences between the groups were assessed using the χ^2 test for categorical variables and Student's *t*-test for continuous variables. Fisher's exact test was employed for categorical variables with cell frequencies <5. Statistical analysis was performed using the software environment for statistical computing R version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Table 1 summarizes the demographic and clinical characteristics of the included patients, as well as surgical outcomes. The cohort comprised 52 (44.4%) males and 65 (55.56%) females, with a mean age of 49.06±14.10 years. The open surgery group had larger median BC size [5 cm; interquartile range (IQR), 4–6 cm] than the VATS group (3 cm; IQR, 2–4 cm; P<0.001). The median operation

Table 1 Patients' characteristics

Variable	Overall (n=117)	Thoracoscope surgery (n=103)	Open surgery (n=14)	P value
Age (years)	49.06±14.10	47.93±13.69	57.71±14.59	0.014*
Gender, male	52 (44.44)	45 (43.69)	7 (50.0)	0.66
BSA (m^2)	2.34±0.20	2.32±0.21	2.39±0.16	0.32
BMI (kg/m^2)	24.89±3.47	24.95±3.18	25.71±2.57	0.28
History of smoking	16 (13.68)	14 (13.59)	2 (14.29)	>0.99
History of alcohol	20 (17.09)	15 (14.56)	5 (35.71)	0.11
History of COPD	1 (0.85)	1 (0.97)	0	>0.99
History of hypertension	35 (29.91)	31 (30.09)	4 (28.57)	>0.99
History of diabetes mellitus	10 (8.55)	10 (9.71)	0	0.48
Location of bronchogenic cysts				
Mediastinum	95 (81.20)	88 (85.44)	7 (50.0)	0.005*
Lung parenchyma	22 (18.80)	15 (14.56)	7 (50.0)	0.005*
The greatest dimension (cm)	3 [2–4.8]	3 [2–4]	5 [4–6]	<0.001*
Tight adhesion	29 (24.79)	23 (22.33)	6 (42.86)	0.18
Loose adhesion	88 (75.21)	80 (77.67)	8 (57.14)	0.18
Operation duration (min)	98 [73–118]	96 [71–113]	149.5 [110.25–169.0]	<0.001*
Total drainage volume (mL)	300 [142.5–548.75]	210 [0–560]	557.5 [442.5–137.75]	0.002*
Length of hospital stay (days)	9 [7–12.5]	8 [7–11]	7.5 [6–10.25]	<0.001*
Mortality in 30 days	1 (0.85)	0	1 (7.14)	–
Follow-up duration (days)	926 [519.5–1,203]	932 [576–1,283.25]	1,079 [805–1,234.25]	0.15
Recurrence	0	0	0	–

Data are presented as n (%), mean ± SD or median [IQR]. *, P<0.05. BSA, body surface area; BMI, body mass index; COPD, chronic obstructive pulmonary disease; SD, standard deviation; IQR, interquartile range.

duration was longer in the open surgery group compared to the VATS group [149.5 (IQR, 110.25–169.0) *vs.* 96 (IQR, 71–113) min; P<0.001]. There was significant difference in total drainage volume between the groups (P=0.002). The mean length of hospital stay was shorter for VATS patients compared to open surgery patients (5.0±5.5 *vs.* 8.6±4.0 days; P<0.001). In the open surgery group, one patient died due to cardiogenic shock. She was a 72-year-old female admitted to the cardiac surgery department for combined valvular heart disease and an anterior mediastinal cyst. After undergoing mitral valve replacement, tricuspid valve repair, and resection of the anterior mediastinal cyst, which was diagnosed as a BC, the patient succumbed to cardiac insufficiency during the hospitalization period. The median follow-up duration after hospital discharge was 926 (IQR, 519.5–1,203) days, with a maximum of 57.6 months, without any BC recurrence observed in either group. *Figure 1* illustrates BCs in the lung and mediastinum.

Representative VATS for BC resection is shown in *Video 1*. During the operation, a 4-cm incision was made from the right midaxillary line to the posterior axillary line in the 4th intercostal space, revealing partial pleuropulmonary adhesions. The BC was located in the posterior mediastinum, with the upper edge adjacent to the azygos vein, the carina in the anterior superior region, the pericardium in the anterior inferior region, the pulmonary vessels and esophagus on the left edge, the right main bronchus and right lung on the right edge, the spine on the posterior edge, and the lower edge at the level of the right

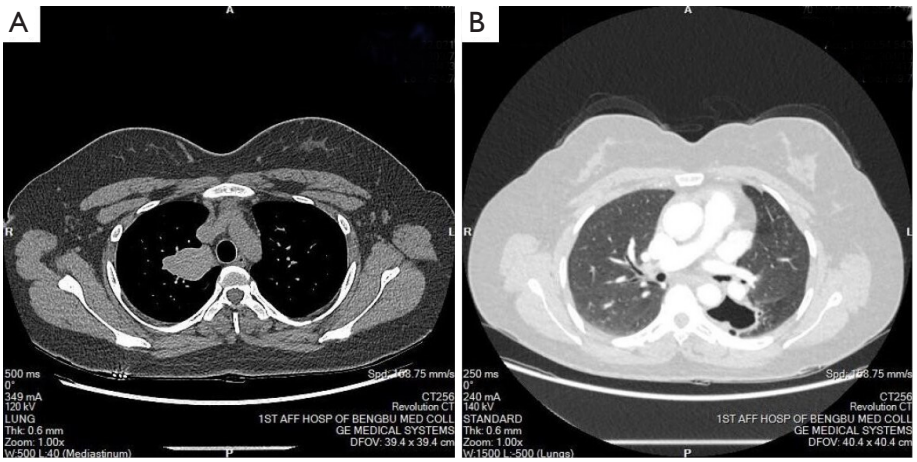
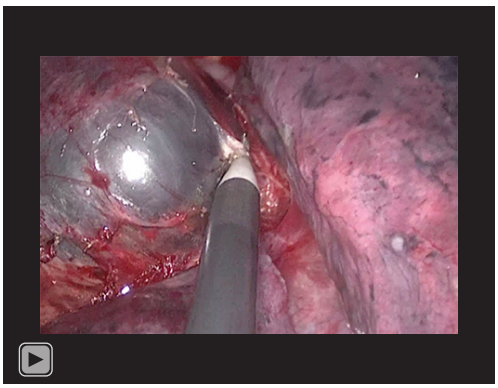


Figure 1 Bronchogenic cysts located in the mediastinum (A), and lung parenchyma (B).



Video 1 Representative VATS for BC resection. The video obtains informed consent from the patient involved. VATS, video-assisted thoracoscopic surgery; BC, bronchogenic cyst.

inferior pulmonary vein.

The following steps outline the key surgical techniques employed for BC resection in this case:

(I) Alternating blunt and sharp dissection maneuvers facilitated separation of the BC from the right lung to which it was tightly adhered.

(II) When adequate space existed between the trachea and BC, care was taken to avoid damaging the tracheal membranous portion. An electric hook was primarily utilized to dissect the outer BC membrane from the mediastinal pleura.

(III) Prior to dissecting the BC base or dorsal surgical field, the BC was opened to drain the fluid contents, creating a clear surgical field for safer manipulation.

(IV) The subcarinal lymph nodes, tightly adhered to the BC, were simultaneously removed to allow complete resection of the cyst wall.

(V) Maintaining BC integrity during the separation process was prioritized to avoid leaving behind portions of the BC wall, as the posterior wall can be compromised during the operation.

(VI) Upon opening the posterior mediastinal pleura and delineating the anterior esophageal edge, careful dissection was performed to separate the posterior BC wall from the esophagus, thereby preventing esophageal injury. Blunt dissection was initially employed to develop the plane at the superior margin, followed by sharp dissection for complete separation. A giant BC was successfully excised *en bloc* (*Figure 2*).

Discussion

In this retrospective cohort study, we aimed to better understand the characteristics of BCs and evaluate the safety and efficacy of VATS. Our findings demonstrate that VATS is a useful and safe option for the resection of mediastinal or pulmonary BCs in adult patients.

BCs are usually asymptomatic and incidentally discovered in adults. As they increase in size, however, they can cause upper airway obstruction, respiratory distress, dysphagia, infection, and possible abscess formation. The symptoms depend on the size and location of the BC (15). Accurate diagnosis is crucial due to the rarity of the disease.

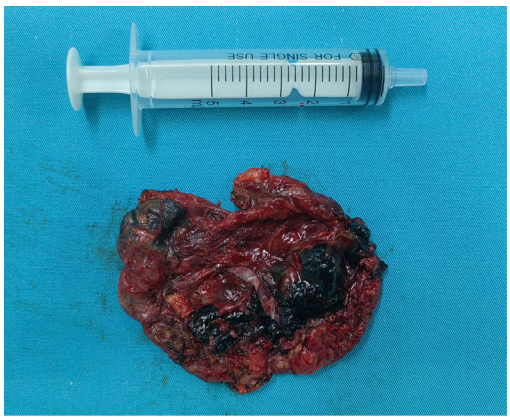


Figure 2 Bronchogenic cyst resected through VATS. VATS, video-assisted thoracoscopic surgery.

Basic diagnostic investigations include CT and MRI. On CT, BCs typically appear as well-demarcated soft tissue or water attenuation masses. MRI offers higher resolution than CT and is optimal for detecting vascular structures on the BC wall and identifying adhesions with adjacent organs (16). In our study, most patients underwent contrast-enhanced CT, while those with poor renal function were diagnosed via MRI.

Infected BCs may lead to severe mediastinitis or lung abscesses (17,18), while those located at specific sites can cause severe compression symptoms (19). Surgical BC resection is an effective method to minimize the risk of complications. Nevertheless, there is no established consensus for managing asymptomatic patients. Some researchers recommend surgical resection upon discovery, regardless of clinical symptoms (20). The primary surgical goal is total BC resection due to the risk of recurrence or malignant transformation. However, the tightly adherent nature of BCs can increase the risk of intraoperative complications and preclude total resection. In such cases, cautious partial resection rather than an aggressive approach may be prudent.

VATS is less invasive than traditional open surgery and has recently become a safe approach due to advances in magnified visualization and thoracoscopic instrumentation. In a multicenter retrospective study by Fievet *et al.*, VATS for BC resection was performed in 88 patients, with seven requiring conversions to thoracotomy. The authors concluded that VATS is easier and safer than open surgery for small and uncomplicated BCs (21). In our study, VATS was performed on 103 patients, none of whom required conversion to thoracotomy. We believe that VATS is an effective treatment for most BCs in the thoracic cavity given careful preoperative evaluation and appropriate operative techniques.

In a study by Guo *et al.* (13), the VATS approach was superior to posterolateral thoracotomy, offering shorter operative times, shorter drainage duration, shorter postoperative hospital stays, less intraoperative blood loss, and reduced pleural drainage during the first three postoperative days. In our study, we found that the VATS group had less drainage and significantly shorter hospital stays compared to the open surgery group. This may be attributed to the relatively larger wound in open surgery, resulting in increased exudation in the postoperative period. Additionally, the more severe pain associated with open surgery can impair breathing to some extent, affecting fluid absorption in the pleural space and ultimately leading to increased drainage in the open group. The increased drainage volume and need for pain management could have contributed to the prolonged hospital stays observed in the open surgery group.

The study cohort included patients with BCs underwent operations in VATS and open surgery. In VATS group of patients, no conversion occurred. Some authors have shown that the size and the location of cysts were not important considerations in selecting the surgical method (14). Additionally, we chose a subxiphoid approach (single-port or three-port) for patients with BCs located near the left innominate vein.

A study has noted the possibility of BC recurrence (22). Therefore, regardless of surgical approach, our aim is to ensure complete BC resection. In particular, for BCs with dense adhesions to surrounding unresectable structures, complete resection may lead to serious complications, thereby necessitating the retention of part of the BC wall. For large BCs that adhere to the esophagus and tracheal membranous portion, internal decompression should precede BC resection to minimize the risk of injury to adjacent organs BCs that are not completely resected can be treated with povidone iodine solution to reduce the possibility of postoperative recurrence. All patients with incomplete BC resection in our cohort underwent this treatment, without any recurrences occurring during the follow-up period.

Limitations

Limitations of the present study include its single-

center, retrospective design, which may lead to selection and classification bias. Furthermore, the sample size was relatively small due to the rarity of BCs. Moreover, the follow-up duration was relatively short, and thus, recurrences beyond this period are possible. Therefore, we recommend future larger studies with longer follow-up periods to better understand the factors affecting the prognosis of BCs.

Conclusions

For mediastinal or pulmonary BCs, VATS was associated with shorter operative times and reduced postoperative hospital lengths of stay compared to open surgical approach. Nonetheless, open surgery remains a viable alternative for managing BCs, particularly those of larger dimensions. Collectively, our findings support the safety and efficacy of VATS as a minimally invasive surgical modality suitable for select cases of BC resection.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-602/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-602/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-602/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Ethics Committee of the First Affiliated Hospital of Bengbu Medical University (No. BYYFY-2019KY39). The requirement for patient consent was waived since this study was retrospective and observational.

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