



# Efficacy and safety of video-assisted thoracoscopic surgery and thoracotomy in the treatment of pulmonary hydatid disease in the Tibetan Plateau: a retrospective study

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**Background:** Although video-assisted thoracoscopic surgery (VATS) plays an increasingly significant part in treating thoracic disease, the role of thoracotomy is not replaced in cystic echinococcosis. The aim of this study was to demonstrate the application of VATS and traditional thoracotomy in the treatment of pulmonary hydatid disease in Shigatse of the Tibet Plateau and to compare the clinical safety and efficacy of these two surgical approaches.

**Methods:** A total of 53 patients with pulmonary hydatid who received thoracoscopic cystectomy with needle aspiration from January 2015 to December 2020 were enrolled in the study, and 126 patients who received thoracotomy during the same period were matched as the control group. The clinical characteristics, operative time, incidence of perioperative complications, length of stay, and hospitalization cost of the VATS and thoracotomy groups were analyzed to compare the safety and efficacy. Patients were followed up through telephone and outpatient service. In order to balance potential confounding baseline factors, propensity-score matching (PSM) was applied to establish a 1:1 VATS to thoracotomy group ratio.

**Results:** There were statistically significant differences between the VATS group and the thoracotomy group in operative time, blood loss, drainage volume, and postoperative hospital stay ( $P < 0.05$ ), with the VATS group being superior to the thoracotomy group. There were no significant differences in postoperative complications, adverse imaging outcomes, or recurrence rates between the 2 groups. In terms of complications, there was no significant difference in the incidence of postoperative air leakage, atelectasis, or other common complications between the 2 groups, while the frequency of postoperative fever and incision infection in the thoracotomy group was significantly higher than that in the VATS group ( $P < 0.05$ ). Moreover, the postoperative recurrence rate between the 2 groups showed no significant difference after a 3-year follow-up.

**Conclusions:** Compared to traditional thoracotomy, VATS had acceptable efficacy and safety and it could further accelerate postoperative recovery and reduce the cost in the treatment of pulmonary hydatid disease in the Tibetan Plateau. Thus, VATS should be promoted more widely to other Tibetan regions.

**Keywords:** Echinococcosis; pulmonary hydatid disease; video-assisted thoracoscopic surgery (VATS); cystectomy with needle aspiration; Tibetan Plateau

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## Introduction

Cystic echinococcosis is a zoonotic parasitic disease with a global distribution but is more common in countries and regions with a highly developed husbandry sector. Of the afflicted areas, China has the highest incidence of echinococcosis (1). The disease burden of echinococcosis in China was estimated to be 322,400 disability-adjusted life years (DALYs) and 293,400 years lost to disability (YLD) in 2018, while in 2017, the years of life lost (YLL) was estimated to be 28,800 (2). According to a national survey in China on echinococcosis infection conducted from 2012 to 2016, echinococcosis was endemic in 368 out of 413 counties surveyed, and the overall detection rate was 0.46% in over 364 endemic counties from 9 provinces and autonomous regions (3). In 2012, the average prevalence in 4 counties in the Tibet Autonomous Region was 4.23%, which was much higher than the average prevalence in China (0.24%) (4). Due to the remoteness and challenges in transportation in Tibet, patients in Tibet usually experience more severe symptoms and have larger hydatid cysts (5,6). Moreover, the hypoxia and low air pressure in high-altitude areas significantly influence the function of multiple systems in patients, which necessitates the use of unique surgical methods and precautions relative to low altitude areas (4,5).

The detection and diagnosis of pulmonary cystic echinococcosis have been improved with the widespread use of computed tomography (CT) (7,8). The role of surgery is paramount in the treatment of this disease, for it is the only way to achieve a radical cure (9). Since the complete evacuation of the cyst and removal of the endocyst are essential in the radical resection, thoracotomy is recognized as the standard surgical method due to its ability to provide a better operating space for avoiding contamination and spillage (10). With the development of minimally invasive surgery, video-assisted thoracoscopic surgery (VATS) has been more widely applied in treating benign and malignant pulmonary diseases (11,12). Although the VAST provided a more minimal invasion, the indirect view and operation could raise the risk of breaking the hydatid cyst and leading to severe complications. Therefore, the treatment of pulmonary cystic echinococcosis with VATS in Tibetan regions is still limited.

The Shanghai-Tibet Medical Assistance Team is an annual program aimed at providing technical support and improvement in the medical services of Tibetan regions. As the members of the team of 2021, we deployed a multidisciplinary group and conducted this study to

determine the safety and efficacy of VATS in treating pulmonary cystic echinococcosis in the Tibetan city of Shigatse. We present the following article in accordance with the STROBE reporting checklist (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-714/rc>).

## Methods

### *Studied population*

The retrospective study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by institutional ethics committee of Shigatse People's Hospital (No. 2022RKZRMYYLL021). Informed consent was taken from all the patients included. From January 2015 to December 2020, 53 patients with pulmonary hydatid disease who underwent thoracoscopic cystectomy with needle aspiration in the Shigatse People's Hospital were enrolled, and 126 patients who underwent cystectomy with needle aspiration through thoracotomy in the same period were included as controls. The age of the study group ranged from 6 to 69 years old, with an average age of 34.21 [standard deviation (SD) 3.48] years. There were 30 males and 23 females. The size of hydatid cyst ranged from 2 to 12 cm, with an average of 4.48 (SD 2.35) cm, all single. There were 20 cases of left lung hydatid and 33 cases of right lung hydatid, and no rupture or hydatid cyst of other organs. The age and sex of 53 patients who had been followed up for 12–60 months were matched. There was no significant difference in general data between the 2 groups.

### *Surgical method*

The principle of the surgical approach of both the study group and the control group involved the removal of the lesion and preservation of the pulmonary function as much as possible. With double-lumen endotracheal intubation and one-lung ventilation, cystectomy with needle aspiration under thoracoscopy was performed as follows. The area surrounding the hydatid cyst was protected with a 10% hypertonic saline gauze pad in an “embankment shape”. The highest point of the gray-white area on the lung surface was punctured and decompressed with a 3-way needle and injected with 10% hypertonic saline. The whole capsule was filled and soaked for 5–10 min. The internal capsule of the hydatid cyst was completely removed, and the excess gray-white capsule wall was cut off. The remnant cavity was

**Table 1** Clinical characteristics before and after matching

Characteristics	Before matching			After matching		
	VATS (n=53)	Thoracotomy (n=126)	P value	VATS (n=53)	Thoracotomy (n=53)	P value
Age (years), mean $\pm$ SD	34.21 $\pm$ 3.48	41.53 $\pm$ 5.53	<0.001	34.21 $\pm$ 3.48	36.24 $\pm$ 3.81	0.189
Gender, n			0.783			1.000
Male	30	70		30	30	
Female	23	56		23	23	
Cyst size (cm), mean $\pm$ SD	4.48 $\pm$ 2.35	6.36 $\pm$ 3.64	<0.001	4.48 $\pm$ 2.35	4.61 $\pm$ 2.57	0.563
Location, n			0.514			1.000
Left lung	20	52		20	20	
Right lung	33	74		33	33	

SD, standard deviation; VATS, video-assisted thoracic surgery.

closed by a discontinuous and tight suture along the travel of bronchi in vertical direction. After the operation, the thoracic cavity was rinsed with a large amount of normal saline.

In the thoracotomy group, different incisions were selected according to the site of the hydatid cyst by CT imaging before operation. After general anesthesia, endotracheal intubation, and one-lung ventilation, the patient was positioned on the healthy lateral side. After the thoracic cavity was entered for exploration, it was isolated and filled with a 10% hypertonic saline gauze pad. Following this, the highest point of the gray lesion area was punctured and decompressed with a 3-way needle, and hypertonic saline was injected for 5–10 min after the internal capsule was pumped clean. The pulmonary tissue was removed to form the residual cavity into the shape of a bowl. After the residual cavity was tightly sutured, it was rinsed with a large amount of sterile saline and chest drainage was placed.

### Observational measures

The operative time, blood loss, drainage volume, postoperative length of hospital stay, postoperative complication rate, etc., between the thoracoscopic and thoracotomy groups and among the subgroups of different thoracoscopic approaches were compared. Postoperative imaging and recurrence were compared to evaluate the prognosis. The 30-day postoperative complications were observed by reoperation for stopping bleeding, admission to intensive care unit (ICU), bronchopleural fistula, empyema,

atelectasis, and incision infection. Patients were followed up through the telephone and outpatient service every 6 months after the operation, CT images were evaluated to determine whether there was encapsulated effusion, atelectasis, or a cavity at the original lesion. The presence of any 1 of the above 3 factors would constitute a “poor imaging outcome” and expressed as a percentage.

### Statistical analysis

Propensity matching was carried out to reduce any sample selection bias introduced through R software (version 3.4.4; software package “matchit”). All data are expressed as mean  $\pm$  SD. The *t*-test was used for comparisons between the 2 groups, while one-way analysis of variance (ANOVA) and pairwise comparison were used for comparisons between multiple groups. A two-side P value <0.05 indicated a statistically significant difference. Statistical analyses were conducted using SPSS 22.0 software package (IBM Corp., Armonk, NY, USA).

## Results

### Comparison of perioperative outcomes between the 2 groups

There was no significant difference in age, sex, maximum diameter of hydatid cyst, or site of hydatid cyst between the VATS group and thoracotomy group after matching (Table 1).

There were significant statistical differences in operation time, intraoperative blood loss, postoperative drainage volume, and postoperative length of hospital stay between the VATS group and thoracotomy group. These results

**Table 2** Comparison of perioperative outcomes between the 2 groups

Variables	Thoracoscopic group (n=53)	Thoracotomy group (n=53)	P value
Operation time (min), mean ± SD	74.81±11.28	90.28±10.62	<0.001
Intraoperative blood loss (mL), mean ± SD	52.47±21.87	123.21±19.87	<0.001
Postoperative drainage volume (mL), mean ± SD	235.91±55.35	396.65±82.37	<0.001
Postoperative length of hospital stay (days), mean ± SD	5.97±1.21	9.52±2.89	<0.001
Postoperative complications, n (%)	6 (11.3)	7 (13.2)	0.759
Reoperation, n (%)	0 (0)	0 (0)	1.000
Readmission to the ICU, n (%)	1 (1.9)	1 (1.9)	1.000
Bronchopleural fistula, n (%)	2 (3.8)	3 (5.7)	1.000
Atelectasis, n (%)	6 (11.3)	5 (9.4)	1.000
Incision infection, n (%)	4 (7.5)	4 (7.5)	1.000

SD, standard deviation.

**Table 3** Comparison of imaging and recurrence after operation between the 2 groups

Variables	VATS (n=53), n (%)	Thoracotomy (n=53), n (%)	P value
Poor imaging outcome	9 (17.0)	10 (18.9)	0.827
Recurrence rate	1 (1.9)	1 (1.9)	1.000

VATS, video-assisted thoracic surgery.

revealed that VATS had advantages in rapid postoperative recovery over thoracotomy. There was no significant difference in the postoperative complication rate between the 2 groups ( $P=0.759$ ; *Table 2*).

#### **Comparison of postoperative imaging and recurrence between the 2 groups**

During the follow-up period of 12–60 months, there was no significant difference in the recurrence rate, and there was no significant difference in poor imaging outcomes ( $P=0.827$ ; *Table 3*).

### **Discussion**

Echinococcosis is a global epidemic zoonotic disease resulting from human infection by *Echinococcus* larvae (13,14). The pastoral area of the Tibet Plateau is one of the areas with high incidence of hydatid disease in China. Due to the vast area and sparse population, receiving medical treatment is problematic, which results in patients experiencing severe symptoms at the time of

onset. Furthermore, with growing economic development and population mobility, urban areas also sustain a high infection rate about 3%, endangering the health of the Tibetan people and hindering the development of animal husbandry (4). Shigatse City has a high average altitude and a low oxygen content, which has a great impact on the feasibility and effect of pulmonary surgery. We carried out a variety of treatment methods for pulmonary hydatid disease, explored minimally invasive treatment techniques in high altitude hypoxic and low-pressure areas, and completed optimization and evaluation.

Surgery is an exact and effective treatment for pulmonary hydatid disease. The principle of surgery is to completely remove the cyst, prevent extravasation of cyst fluid, avoid allergic reaction and dissemination, and preserve normal pulmonary tissue to the greatest extent. According to the literature, the surgical approaches for pulmonary hydatid disease include complete internal capsule extraction, internal capsule puncture extraction, complete internal and external capsule resection, segmental pulmonary resection, lobectomy, pneumonectomy, and thoracoscopic pulmonary hydatid surgery (15,16). We summarized the curative

effects of internal capsule puncture extraction and complete internal and external capsule resection by thoracotomy in Shigatse. Complete removal of the internal and external cysts leads to many complications, and the operation conditions are limited by many factors. These factors include the hydatid cyst being close to the hilum, the central hydatid cyst located near the pulmonary fissure, a huge hydatid cyst, cyst infection, the thickening of the external capsule, or pronounced fibrosis, as these could introduce considerable difficulty in completing resection and thus increase risks of bronchial or vascular injury. Therefore, in our clinical practice, the surgical approach of complete excision of internal and external cysts has been abandoned for hydatid cysts >3 cm in size and located centrally, while wedge excision is performed for hydatid cysts  $\leq 3$  cm and located in the outer one-third of the pulmonary field.

Many believe that, in most cases, thoracoscopic surgery is a safe alternative to pulmonary hydatid disease (17). Our study suggests that there is a significant difference in the operation time between thoracotomy and VATS operations. The overall time of thoracoscopic surgery is about 16 minutes shorter than that of thoracotomy. The operation of pulmonary hydatid disease consists mainly of internal capsule extraction, with thoracoscopic chest entry and closure being relatively fast; nonetheless, several techniques and time are required to suture the residual cavity of external capsule under thoracoscopy. Moreover, the hydatid often involves infection and adhesion, which takes time to isolate and expose. Compared with previously used approaches, the specific method of internal capsule removal in this study was more optimal. In previous process we only sutured the external capsule bronchial fistula and placed it in a bowl shape for drainage. Different from the previous method, a 3-0 absorbable suture was used to suture the branch air duct fistula, and the external capsule was sutured in a full layer along the bronchial direction to close the residual cavity tightly both for the study group and control group in this study. The blood loss, drainage volume, and postoperative length of hospital stay in the VATS group were significantly lower than those of the thoracotomy group. There was no significant difference between the 2 groups in recurrence or poor imaging outcomes 3 months after surgery, further indicating that the efficacy of thoracoscopic surgery is comparable to that of thoracotomy.

The treatment of pulmonary hydatid disease is different from that of other lung diseases in that the surgical principle involves completely removing the hydatid sac while preserving the functional pulmonary tissue as much

as possible. In our clinical practice, we use wedge complete resection for patients with hydatid cyst diameter  $\leq 3$  cm and located in the outer one-third of the lung field; for patients with a cyst between 3 and 10 cm in diameter, internal capsule puncture and extraction are used; for patients with a hydatid cyst greater than 10 cm, associated with infection or located in the center of the lung, or with focal lobe dysfunction, lower lobectomy is applied, with most of these patients undergoing these procedures under thoracoscopy. We also found that patients who undergo video-assisted thoracoscopic wedge complete resection experience better outcomes than those who undergo video-assisted thoracoscopic internal capsule resection or lobectomy in regard to operation time, blood loss, postoperative drainage volume, and postoperative length of hospital stay. Therefore, for eligible patients with pulmonary hydatid disease, video-assisted thoracoscopic wedge resection can provide greater benefits than can other approaches. In patients undergoing lobectomy, hydatid cysts are often huge and complicated with infection and rupture, and the resected lobe is often nonfunctional and has been occupied by giant hydatid cysts. The variation of anatomical structure makes thoracoscopic surgery difficult. Targeted thoracoscopic surgery according to the situation of different patients can achieve the purpose and principle of individualized and precise treatment, and VATS could also expand the field of treatment in pulmonary hydatid disease.

Multiple pulmonary hydatid disease is a major difficulty in thoracic echinococcosis, with surgery still being the main treatment for this disease. According to the Chinese expert consensus in 2015, patients with multiple pulmonary hydatids on both sides should be operated on by stages based on the principle of “more severe first” (16). If the patient’s physical condition permits, a one-stage operation can be performed by median sternotomy. The surgical approach is determined according to the size, number, location, concurrent infection, and pleural adhesion of cysts. Zhang *et al.* (18) reported more than 30 cases of multiple pulmonary hydatid cysts and proposed that internal capsule puncture should be preferred when there are giant cysts, deep lung cysts, or ruptured infected hydatid cysts, while internal capsule extraction should be considered when the cysts are superficial, 5–10 cm in diameter, or not ruptured. However, segmentectomy or even lobectomy may be considered if there is a high number of cysts in one segment or lobe. Li *et al.* and Cao *et al.* (19,20) respectively reported thoracoscopic surgery for pulmonary hydatid disease, in which patients with multiple pulmonary hydatid

cysts recovered well. Therefore, the decision of surgical procedure for patients with multiple pulmonary hydatid disease needs to be based on the specific situation. In general, thoracoscopic surgery for pulmonary hydatid disease requires strict indications. Solitary cyst and no pleural adhesion are the basic indications. However, large cysts and multiple cysts should also be considered carefully (18).

It should be noted that the application of thoracoscopic surgery in the treatment of pulmonary hydatid disease in the Tibetan Plateau was carried out with the assistance of a multidisciplinary model. High altitude hypoxia has a significant impact on patients' respiratory, cardiovascular, and coagulation function. Surgeries, especially those involving the lung, can easily induce perioperative hypoxemia, even result in respiratory failure. Our experience of thoracoscopic surgery in low-altitude areas cannot be directly and completely applied to high-altitude thoracoscopic surgery, which needs to be carefully adjusted and optimized according to the characteristics of the plateau. Thoracoscopic surgery in Plateau Tibetan areas especially needs good coordination with the anesthetic process, postoperative monitoring, treatment of respiratory and cardiac complications, and professional nursing. Even with these present, due to the tension, adhesion, thickened outer capsule, and extrusion of a pulmonary hydatid, thoracoscopic puncture and removal of the inner capsule of the pulmonary hydatid still require caution, especially in the treatment of children with pulmonary hydatids. In our study, 3 children with pulmonary hydatids underwent thoracoscopic surgery, which was more difficult to perform than the operation in adult patients. Moreover, for older adult patients being operated on at high altitudes, the requirements for anesthesia and adequate oxygen supply are higher, and close monitoring during the operation must be timely for proper removal of the fluid infiltrating into the trachea. Postoperative care should be strengthened, attention should be paid to the body positioning, vital signs and drainage should be monitored, and regular respiratory care should be implemented in the dry highland climate. Patients with poor pulmonary function who cannot tolerate one-lung ventilation should not be operated on.

There are several limitations in our study. First, the research was performed retrospectively, thus the selection bias, which might have influenced the outcomes, could not be avoided. Second, the patients were enrolled in a single center and the sample size of two groups were relatively small. We believe that thoracoscopy cannot completely replace thoracotomy in the Tibetan Plateau.

Early screening, early diagnosis, early treatment and the improvement of surgical instruments can further expand the field of thoracoscopy in the treatment of pulmonary hydatid disease. Following multicenter randomized clinical trials are expected to further compare these two minimally invasive approaches.

In conclusion, we found the thoracoscopic minimally invasive treatment of plateau pulmonary hydatid disease in the Tibetan Plateau city of Shigatse to be safe and feasible. We should thus optimize and expand the field of thoracoscopy, more precisely individualize the treatment of pulmonary hydatid disease with the assistance of multiple disciplines, and still maintain open surgery as an indispensable approach in treating this disease.

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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-22-714/rc>

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*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-714/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 institutional ethics committee of Shigatse People's Hospital (No. 2022RKZRMYYLL021). Informed consent was taken from all the patients included.

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