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Video-Assisted Thoracoscopic Surgery (VATS) in the Treatment of Pulmonary Bulla

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Abstract

Introduction: Video-assisted thoracoscopic surgery (VATS) has been widely applied for the treatment of intrathoracic diseases, including bullous lung disease. VATS has been evaluated to replace thoracotomy for various lung resection surgeries. This study aims to determine the efficacy, safety, and outcome VATS for bullectomy.

Method: This retrospective study was performed from January 2021 to December 2022 in the department of Thoracic Surgery at National Institute of Diseases of the Chest & Hospital, Dhaka and Green Life Hospital, Dhaka. We reviewed all the patients who underwent bullectomy through VATS within this period. The demographic and operative variables were collected. The safety and efficacy of the procedure in terms of postoperative complications and change in lung function after bullectomy was analysed.

Result: Forty patients underwent elective VATS bullectomy due either to giant bulla or pneumothorax. Among them, 36 were male with mean age 47.4 years (range 20-65 years). There was significant improvement in lung function following bullectomy. Approximately one third patients (32.5%) developed postoperative complications, majority having air leak. There was no postoperative mortality within 30 days.

Conclusion: VATS resection is a safe and effective treatment for bullous lung disease with significant improvement in symptoms and lung function following surgery.

Keywords: Pulmonary bullae; Video-assisted thoracoscopic surgery; Bullectomy; VATS

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Introduction:

The bullous disease of the lung has often been a therapeutic challenge due to its complex pathophysiology and varied presentations. A bulla is defined as an expansion of the alveolar space with a diameter of more than 1 cm due to emphysematous destruction and a wall thickness of less than 1 mm.[1] Compared to the surrounding lung parenchyma, the bulla has no recoil tendency creating a pressure effect on the surrounding lung parenchyma. One or more bullae can enlarge so that they can fill more than one-third of the hemithorax, which is called a giant bulla.[2] Surgical resection of bullous emphysema is indicated for patients with symptoms related to the compression of giant bulla or related complications, including infection, pneumothorax, rupture, or bleeding.[1,3]

Bullectomy is the standard operation for bullous lung disease, which is essentially a non-anatomical wedge resection of the bullous lung tissue.[4] The surgical

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approach was traditionally via an open thoracotomy—including a standard posterolateral, anterolateral, or axillary approach.[5] Today, video-assisted thoracic/thoracoscopic surgery (VATS), a minimally invasive procedure, has become the approach of choice for bullectomy in many centers.[6]

VATS is a minimally invasive procedure with a minor morbidity and mortality compared to open surgery. In this study, we reviewed our experiences with surgical treatment for pulmonary bulla by thoracoscopic approach in terms of clinical outcome.

Methods:

This retrospective study was conducted from January 2021 to December 2022 in the department of Thoracic Surgery at the National Institute of Diseases of the Chest & Hospital and Green Life Hospital, Dhaka. We reviewed all the patients who underwent bullectomy through VATS either due to giant bulla or any related complications due to bulla. Patients with secondary spontaneous pneumothorax diagnosed with bullous diseases were included in the study. Patients who underwent bullectomy either by uniportal or biportal, or triportal VATS were included. Patients underwent lobectomy for bulla were excluded from the study. All clinical data including demographic information, clinical presentation, medical history, computed tomography (CT) images, postoperative complications, length of hospital stay, and pulmonary function.

Postoperative complications were defined as any deviation from the typical outcome during hospitalization and within 30 days after surgery. Postoperative death was defined as the death of a patient within 30 days after surgery. A prolonged air leak was defined as an air leak of more than or equal to seven days after surgery. prolong IT drainage was indicated as increased fluid drainage in the intrathoracic drainage tube for more than seven days postoperatively.[7]

Categorical variables were described as frequency and percentage, and continuous variables were described as the mean ± standard deviation or median (interquartile range [IQR]). Statistical analyses were conducted using SPSS (statistical package for social sciences) version 24.0.

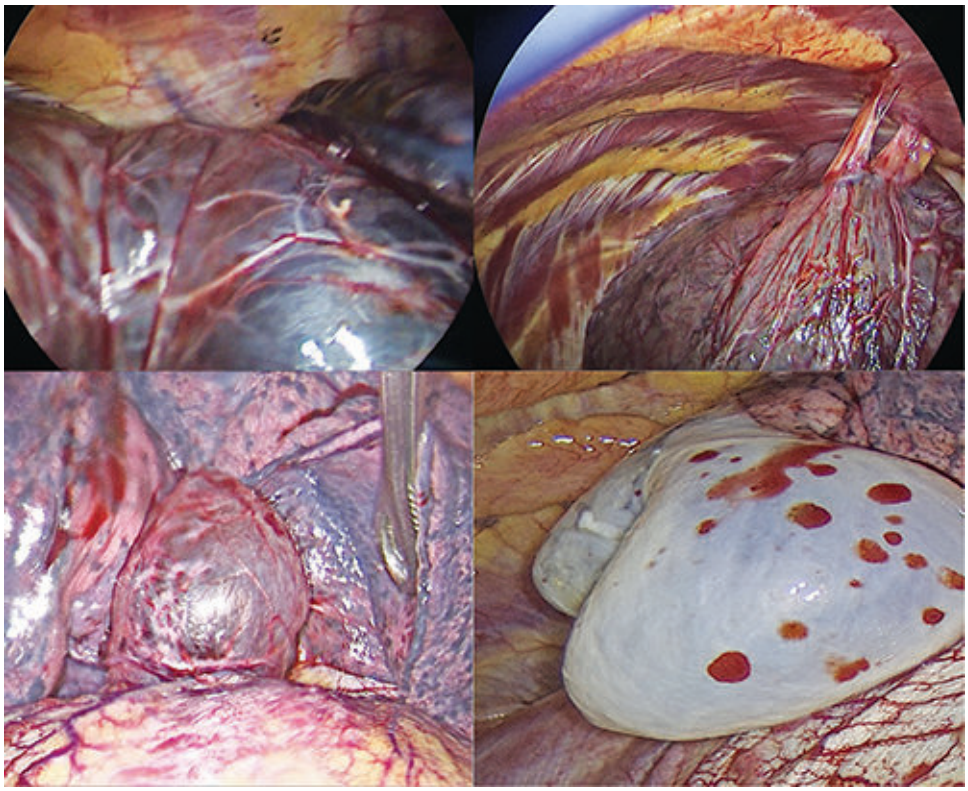
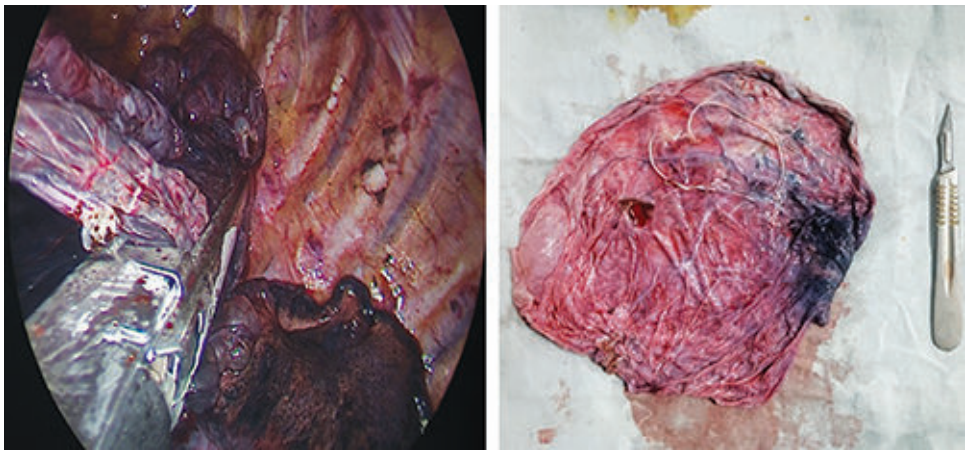


Fig.-1: *Thoracoscopic view of bulla*



A B

Fig.-2: *A. Stapling technique of bullectomy, B. Resected specimen of giant bulla.*

Operative technique

All operations were performed with the patient under general anesthesia and double-lumen endotracheal intubation and placed in the contralateral lateral decubitus position while leaving the operated side upwards and the lung unventilated. VATS bullectomy was undertaken through one to three keyhole/ small incisions without rib spreading. The use of 'rib spreading' was prohibited as this is the crucial intra-operative maneuver that disrupts tissues and causes pain (and is used in open surgery). Instead of a rib spreader, we used a plastic wound protector; the procedure was performed with videoscopic visualization without any direct vision. The procedure included examination of the chest cavity, adhesiolysis of the adhesions, rupture of the bulla, and excision of bulla with part of viable lung tissue at the base with the help of endo GIA stapler of various sizes. Figure 1 demonstrates a telescopic view of intact and ruptured bulla of different sizes. Whereas figure 2 shows the technique of endo GIA stapler placement and resected specimen of the bulla. Any residual air leak was checked after bullectomy by water submerge test. Pleurodesis with mechanical abrasion or partial parietal pleurectomy was performed in all cases. Incisions were closed, leaving one to two wide-bore chest drain tubes in situ.

Result

A total forty patients who underwent elective VATS bullectomy due either to giant bulla or complications were evaluated. Among them, 36 were male and 4 were female. The mean age was 47.4 years (range 20-65 years). Majority of the patients were above 40 years. Other characteristics of the patients are shown in Table 1. In our analysis, 24 patients (60%) were smokers, whereas 22 patients (55%) had chronic obstructive pulmonary disease. Other comorbidities were diabetes mellitus (DM) and hypertension (HTN). Dyspnoea was the most common symptom (the dyspnoea grade was classified according to the Hugh Jones grading.[8] Six patients had grade I dyspnoea, eighteen had grade II dyspnoea, and eight had grade III dyspnoea.

Thirty-one patients (77.5%) had bulla within the right lung, whereas 7 (17.5%) had bulla within the left lung, and two cases (5%) had bilateral bulla. Most bullae were located in the upper lobe (75%). VATS was performed on 24 patients due to symptomatic giant bulla and 16 patients due to accompanied pneumothorax. Only one patient needed conversion to open thoracotomy due to extensive adhesions. In 42.5% of patients, there was multiple bullae. Most of the patients underwent uniportal VATS (57.5%). Whereas 12 patients underwent biportal VATS, and two patients underwent triportal VATS. The mean operation time was 193.85 minutes (SD 55.22 minutes). Two patients had excessive intraoperative bleeding, and the average blood transfusion was 139.50ml (SD 147.49ml). Table 2 shows the mean of total use of pethidine and pain scores at 24 hours, 72 hours, and seven days after surgery. The average length of chest drain was 5.70 days (range 3-14 days), and the mean postoperative hospital stay was 7.95 days (SD 2.60).

Table-I

Characteristics of the patients with giant bulla (n=40)

Variables	Mean±SD or, Percentage
Age (years)	47.40±11.67
Gender	
Male	36 (90%)
Female	4 (10%)
Height cm	163.45±6.67
BMI (kg/m^2)	
Underweight	6 (15%)
Normal	34(85%)
Overweight	0
Smoking	
Yes	24 (60%)
No	16 (40%)
COPD	
Yes	22 (55%)
No	18 (45%)
Hypertension	
Yes	4 (10%)
No	36 (90%)
Diabetes	
Yes	4 (10%)
No	36 (90%)
Dyspnea grade	
Grade 0	8 (20%)
Grade 1	6 (15%)
Grade 2	18 (45%)
Grade 3	8 (20%)
Grade 4	0 (0.0)
Side distribution	
Right	31 (77.5%)
Left	7 (17.5%)
Bilaterality	2 (5%)
Lobar distribution	
Upper	30 (75%)
Middle	3 (7.5%)
Lower	7 (17.5%)
Indication of Surgery	
Pneumothorax	16 (40%)
Giant bulla	24 (60%)

Table-II

Operative variables

Variables	Mean±SD or, Percentage, Range
Operation time (minutes)	193.85±55.22
Surgical Approach	
Uniportal	23 (57.5%)
Biportal	12 (37.5%)
Triportal	2 (5%)
Average blood transfusion (ml)	139.50±147.79
Presence of multiple bulla	17 (42.5%)
Pleural adhesions	23 (57.5%)
Peroperative bleeding	2 (5%)
Total use of pethidine	
At 24 hours (mg)	171.25±54.24
At 72 hours (mg)	325.00±72.18
Pain score (numeric scale)	
At 24 hours	3.95±0.49
At 72 hours	2.50±0.50
At 7 days	1.55±0.59
Length of IT drainage (days)	5.70±2.93 (3-14)
Postoperative hospital stay (days)	7.95±2.60 (5-15)

Postoperative complications occurred in 13 patients (32.5%). (Table 3) The air leak was the most common postoperative complication. Four cases (15%) had air leaks less than seven days, and 7 cases (20%) had prolonged air leaks (> 7 days). Among them, one patient needed a second operation for an air leak. There was no postoperative bleeding, but two patients had prolonged IT drainage (>7 days). Our operated patients had no postoperative ICU stay and 30 days postoperative mortality.

Table-III

Postoperative complications

Complications	Number (%)
Air leak	
< 7 days	4(15%)
>7 days	7 (20%)
Surgical emphysema	0 (0%)
Postoperative bleeding	0 (0%)
Prolong IT collection	2 (2.5%)
Total	13 (32.5%)
Mortality	0%

Table-IV

Changes in lung function

Variables	Preoperative	Postoperative	Change	P value*
FVC	1.74±0.54	2.04±0.53	0.29±0.15	<0.001
FVC % pred	48.10±9.53	58.45±9.43	10.35±4.38	<0.001
FEV1	1.44±0.43	1.64±0.40	0.20±0.12	<0.001
FEV1% pred	45.95±8.73	55.10±6.22	9.15±4.06	<0.001

% pred = % predictedFVC = forced vital capacity; FEV1 = Forced Expiratory volume in first second*The *P* values are calculated by paired *t*-test.

Preoperative and postoperative complete lung functions after 30 days were measured in 30 patients (75%). The mean improvement of FVC was 0.29±0.15L (preoperative = 1.74±0.53, postoperative = 2.04±0.53), which is statistically significant (p<0.001). Predicted FEV1 also improved from 45.95% to 55.10% postoperatively (p<0.001). The related data are shown in Table IV.

Discussion

There is general agreement that with proper selection of patients with bullous emphysema it is possible to improve lung function and consequently, the quality of life.[5,9,10] Surgical resection is contraindicated in patients with large bullae accompanied by hypercapnia or diffuse emphysema.[4] A wide variety of surgical procedures has been applied for the treatment of emphysematous bullae. Before the era of the stapler, patients with bulla were treated by ligation and excision or by 'capitonage'.[11] Later, the introduction of the linear stapler permitted the resection of giant bullae more straightforward and safe. The recent 'rediscovery' of thoracoscopy, involving advanced video technology, widened its application to thoracic clinical problems. One of them is the treatment of patients with a bulla with the video-assisted thoracic surgical (VATS) technique, which is less invasive than the usual thoracotomy. VATS has been a preferred approach to treating pulmonary bulla because it is far less invasive or painful and equally effective compared with open surgery.[3,12,13] VATS has been increasingly used in our country in thoracic cases for the last few years. This is the first study from Bangladesh evaluating the feasibility of VATS in the resection of the pulmonary bulla.

In this study, we shared our experiences of VATS bullectomy and tried to analyze the outcome. We performed 40 VATS bullectomies in patients who presented to us as symptomatic giant bulla or with complications like pneumothorax. This study shows that VATS bullectomy is feasible in our current setup with an acceptable postoperative complications rate (32.5%). In our study group, there was no postoperative mortality. The most common postoperative complication was air leak for over seven days (20%). Other postoperative complications were small air leak and prolonged chest drain. There may be some selection bias as high-risk patients were not chosen for VATS bullectomy. This finding is comparable to other observations. According to Gunnarsson et al., postoperative air leakage was the most prevalent postoperative complication in three-quarters of patients who underwent resection for pulmonary bulla.[14] A retrospective study also showed that among 44 patients who underwent VATS bullectomy, 28 experienced postoperative complications, of which the most common were air leaks.[15] Another study showed 39.3% (11 patients among 28 patients) had postoperative complications after VATS bullectomy, including pneumonia , persistent air leakage, respiratory failure and bleeding).[16] One patient in cohort needed a second operation for a persistent air leak with surgical emphysema.

In our study, 87.5% patients with dyspnea improved after recovery from surgery. In addition, lung function tests performed 30 days after surgery showed that the mean FEV_1 increased from 1.44 L preoperatively to 1.64 L postoperatively ($P < 0.001$). There were improvements in forced vital capacity (FVC) and FEV_1/FVC postoperatively. Our findings suggest that VATS is effective in treating pulmonary bulla and its complications. These findings are consistent with the findings of earlier studies.[15,16] Zhu et al also

demonstrated that VATS bullectomy significantly improved symptoms and lung function in most cases in their series.[15]

The mean use of postoperative pethidine was 169.25 mg in 24 hours and 325mg in 72 hours. The postoperative pain measurement at 24, 72 hours, and 7 days hours after bullectomy, which was recorded by numerical pain scale, showed a seemingly low pain score. We believe VATS bullectomy requires fewer analgesics postoperatively, leading to a lower pain score.

This study has certain limitations, one of which is the fact that it is a retrospective, and the number of patients included in the study is small. We plan to conduct a prospective comparative study to analyze the efficacy and safety of VATS compared to traditional bullectomy.

Our study basically highlighted the effectiveness and safety of Video-Assisted Thoracoscopic Surgery for the treatment of bullectomy. It can lead to improvement in symptoms and lung function with an acceptable complication rate.

Conclusion:

Surgery is often needed for lung bulla, and our experience has provided evidence that Video-Assisted Thoracoscopic Surgery (VATS) is an effective and safe method for bullectomy, which leads to significant improvement in postoperative lung function. This result will encourage the regular use of VATS for bullectomy as an operative procedure of choice to for the resection of the pulmonary bulla.

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Conflict of interest:

No conflict of interest.

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Ethical Issue

Approval was taken from National Institute of Diseases of the Chest & Hospital, Dhaka Bangladesh. Written informed consent was obtained from all individual participants.

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