Original article

Title: The objective and subjective outcome of bullectomy in patients of bullous lung disease: A prospective study.

Abstract:

Background: This study aimed to evaluate the outcome of bullectomy in patients with bullous lung by comparative analysis of their preoperative and postoperative pulmonary function parameters and subjective dyspnea score.

Materials and Methods: The study included 42 cases of bullous lung disease, who underwent open or video-assisted thoracoscopic surgery (VATS) bullectomy at our hospital from November 2019 till January 2022. All patients were subjected to set protocol which included preoperative comprehensive history and physical examination, chest X-ray, lung CT, and pulmonary function tests. Postoperative evaluation included 3 monthly follow-up for three visits, with clinical assessment for subjective dyspnea score and pulmonary function tests (PFTs). Preoperative and postoperative comparisons of parameters were made using the student's paired t-test to calculate the statistical significance.

Results: Primary bullous lung disease was the most common underlying lung pathology in our population, followed by COPD. Spontaneous pneumothorax was the most common presenting feature, and the most patients presented in their fourth decade of life with a history of smoking.

All cases underwent VATS/open bullectomy. Most patients were discharged on the 4th postoperative day. Statistically, significant improvement was seen in mean FEV_1 (forced expiratory volume in 1st second), FVC (forced vital capacity), and FEV_1/FVC. FEV_1 appeared to be the most reliable indicator of postoperative progress. The subjective dyspnea score improved in a statistically meaningful way. Diffuse parenchymal disease patients had a higher rate of complications. Our research found no evidence of mortality.

Conclusion: We conclude that surgery remains the standard treatment for bullous lung disease. Most of the patients who got benefitted are those having localized disease with remaining normal parenchyma. Statistically significant improvement in subjective and objective parameters is seen in all cases. Those with the diffuse emphysematous disease need careful selection given their high complication rate.

Key words: Bullous lung disease, bullectomy, PFT, Subjective dyspnea score

INTRODUCTION

Bullous lung disease is a common non-infectious pathology encountered in the lungs. Surgery remains the mainstay treatment in most cases who present to a clinician with dyspnea or pneumothorax. However, those who have a concomitant diffuse emphysematous or non-emphysematous lung pathology should be evaluated on an individual basis. Targeting even a small increase in pulmonary function in such patients might be of major benefit [(1)]. A computed tomography scan (CT-scan) can reliably outline bullae that are not visible on a plain chest X-ray [(2)]. Besides, a CT can reliably give a diagnosis of the bulla(e) with its dimensions and effects on adjacent lung tissue and identify a potentially operable well-defined bulla from inoperable bulla situated in a generalized emphysematous lung [(3)]. Bullous lung disease leads to replacement and compression of normal parenchyma by the space-

occupying non-functional bulla(e). Therefore, the main outcome parameters are the PFT indices including FEV_1, FVC, and their ratio (FEV_1/FVC) after surgery [(4)]. Bullectomy or resection of the entire bulla(e), either through a standard open thoracotomy or a video-assisted thoracoscopic surgery (VATS) is the most common surgical technique used for treatment[(1)]. In selected cases of severe emphysema with air trapping, bronchoscopic placement of endobronchial valve device(s) has emerged as novel and effective way to achieve lung volume reduction, thereby contributing to improved lung functions, exercise capacity and quality of life. The key selection criteria for endobronchial lung volume reduction (ELVR) are hyperinflation with a residual volume >175% of predicted, forced expiratory volume <50% of predicted, and a 6-min walking distance >100 m.[(5)] In this procedure, implantation of a one-way valve in bronchi leads to egress of trapped air, while preventing air to move in; thereby leading to deflation of hyper-inflated lung lobe(s) and consequently better respiratory performance of remaining normal lung.[(6)]
This study aimed at evaluating and analysing the post-operative outcome of bullectomy surgery by statistically comparing pre-operative and post-operative subjective dyspnea score and pulmonary function indices.

MATERIALS AND METHODS

The study was done in the Department of Cardiovascular and Thoracic Surgery (CVTS), Super-speciality hospital, in Srinagar, India, from November 2019 to January 2022. The inclusion criteria were as follows:

1. Well defined CT evidence of bulla(e) occupying at least one third or more of hemithorax
2. Presence of symptoms or complications known to be attributable to bullae, like dyspnea, pneumothorax, or recurrent respiratory infections.

The following were the criteria for exclusion:

1. Presence of other pathology in the lung for which surgery is being performed primarily, and bullectomy is only an add-on procedure.
2. Presence of bilateral diffuse emphysematous lung disease, other significant comorbidities, which outweighed the benefits of surgery

A total of 48 cases of the bullous lung were encountered, out of which 6 cases were excluded, and the remaining 42 cases were included in this study. All of the patients were assessed and handled according to the procedure, and they were all followed up on. The patients were evaluated with:

1. History taking
2. General physical examination
3. Systemic examination
4. Baseline investigations
5. CT scan of the chest
6. Pulmonary function test
7. Informed consent was taken
8. Postoperative stay in the hospital till discharge, with the removal of intercostal tube drain done once Chest X-ray reveals full expansion of lung, no collection, and no air leak.
9. Appropriate follow-up plan at 3 monthly intervals for three visits. PFT was done at 3 months follow up, while dyspnea score was assessed on subsequent visits.

For comparing the postoperative parameters, including subjective dyspnea score based on Medical Research Council (MRC) guidelines[(7)] and PFT indices (FEV_1, FVC, FEV_1/FVC) with the preoperative ones, the student's paired t-test was applied to analyse the statistical significance. The MRC subjective dyspnea score is a reliable and simple questionnaire for quantifying dyspnea in clinical practice.[(8)] It ranges from 1 to 5, based on five statements about subjective breathlessness perceived by the patients: grade 1, "I only get breathless with

strenuous exercise"; grade 2, "I get short of breath when hurrying on the level or up a slight hill"; grade 3, "I walk slower than people of the same age on the level because of breathlessness or have to stop for breath when walking at my own pace on the level"; grade 4, "I stop for breath after walking 100 yards or after a few minutes on the level"; grade 5, " I am too breathless to leave the house".[9] The same questionnaire was used to assess and categorize our cases to particular subjective dyspnea score.

RESULTS

The mean overall age was 45.07 ± 13.12 years (range 19 to 62 years); including 30 males and 12 females. Spontaneous pneumothorax was the most prevalent presenting ailment. (30 out of 42 patients, 71 %). Dyspnea (without spontaneous pneumothorax) was present in 12 cases. Primary bullous lung disease was the most common underlying lung pathology (24 out of 42 cases, 57.14 %), followed by COPD in the remaining cases. Overall, 9 cases had associated diffuse parenchymal lung disease in the form of emphysema (7 cases) and interstitial lung disease (2 cases). The preponderance of primary bullous lung disease was found at a younger age (mean age of 32 years). Those with underlying COPD developed the disease at an older age (mean age of 57.53 years). The commonest site of bullae was in apical segments (13 cases) of upper lobes, followed by anterior (4 cases) and superior (2 cases). Three cases had multiple areas involved. 34 cases (81%) were subjected to bullectomy exclusively, while-as the remaining 8 cases need some degree of decortication. Mean drainage in the first 24 hours was 154 ml haemorrhagic, and drains were removed on post-operative day 4 on average. Out of 42, 5 cases had prolonged grade 1 air leak for over 2 weeks which settled on its own. Post-operative empyema was seen in 2 cases among those with prolonged air leaks which was managed with intercostal tube drainage and appropriate culture sensitive antibiotic therapy. There was no mortality.

The PFT values and subjective dyspnea score both improved statistically significantly (Table 1). The most accurate predictor of postoperative progress is FEV1 (correlation = 0.713). Patients with underlying diffuse lung disease had lower baseline values and post-operative outcomes than those without the condition (Table 2).

Table 1: shows mean value with standard deviation in different parameters in pre-op and post-op period. FEV_1: forced expiratory volume in 1st second, FVC: forced vital capacity

Parameters	**Pre-op**	**Post-op**	
		3 months	9 months
FEV_1 (Litres)	1.52 ± 0.48 L	2.17 ± 0.45 L *	
FVC (Litres)	2.52 ± 0.76 L	3.07 ± 0.55 L *	
FEV_1/FVC (%)	62.56 ± 13.88 %	70.47 ± 10.18 %*	
Subjective dyspnea score	2.09 ± 0.49		1.46 ± 0.81*

*p value <0.05 is statistically significant

DISCUSSION

The incidence of bullous lung disease was around 21 cases per year in our study, which is higher than generally reported from other studies . Palla et al.[10], reported an average of 12.87 cases per year in one of the largest prospective studies on the subject, which included a cohort of 193 cases operated with bullectomy. A previous study reported from our region has documented the same incidence as ours, and the author attributes it to a high prevalence of COPD and tuberculosis in the region.[11] In contrast to primary bullous lung disease in our study, Boushy et al.[7], Adeyemo et al.[2], and Palla et al.[10] reported COPD as the dominant underlying lung pathology for bullae. While we report spontaneous pneumothorax as the commonest presentation in those with primary bullous lung disease, and progressive dyspnea in those with underlying COPD, Potgieter et al,[12] and Adeyemo et al.[2] reported progressively incapacitating dyspnea as the commonest complaint at presentation, in their respective studies, with spontaneous pneumothorax affecting a small proportion of patients.

The mean preoperative FEV_1, FVC, and FEV_1/FVC in our study were 1.52 ± 0.48 L, 2.52 ± 0.76 L and 62.56 ± 13.88 % respectively. Out of this, among those patients who had the diffuse disease (9 cases), the mean preoperative FEV_1, FVC, and FEV_1/FVC was 1.31 ± 0.42 L, 2.33 ± 0.61 L, and 52.5 ± 10.8 % respectively. The same parameters among those with isolated bulla(e) (33 patients) were 1.82 ± 0.52 L, 2.52 ± 0.45 L and 74.02 ± 14.4 %, respectively.

Table 2: Observation in two groups: those with and without underlying diffuse disease. FEV_1: forced expiratory volume in 1st second, FVC: forced vital capacity

PFT indices	**Patients with diffuse lung disease (n=9)**		**Patients without diffuse lung disease (n=33)**	
	Pre-op	Post-op at 3 months	Pre-op	Post-op at 3 months
FEV_1 (Litres)	1.31±0.42L	1.76±0.52*	1.82±0.52L	2.72±0.35*
FVC (Litres)	2.33±0.61L	3.02±0.51*	2.52±0.45L	3.37±0.61*
FEV_1/FVC (%)	52.5±10.8%	59.9±10.08	74.02±14.4%	81.9±12.01*

*p value <0.05 is statistically significant

During post-operative follow up, same PFT indices showed an overall improvement. At 3 months, the mean FEV_1, FVC and FEV_1/FVC was 2.17 ± 0.45 L, 3.07 ± 0.55 L and 70.47 ± 10.18 %, respectively. On statistical comparison, the improvement in these values was statistically significant. A strong correlation was found for FEV_1 values. Pearson et al.[13] in his study reported mean FEV_1, FVC and FEV_1/FVC values at 3-6 months postoperatively as 1.77 ± 0.33 L, 2.84 ± 0.37L and 62.3%, respectively. He also reported the improvement to be statistically significant with the strongest correlation for FEV_1 values. Similar observation and statistical significance was reported by Palla et al.[10] in the FEV_1, FVC and FEV_1/FVC indices at 3-6 months postoperatively. Lone YA, et al[11] also reported a similar improvement in post-operative period from his study cohort of 54 patients.

In our study, the subjective dyspnea score showed a statistically significant improvement from 2.09 ± 0.49 to 1.46 ± 0.81, which showed a significant inverse correlation with the change in FEV_1. Similar observation were made by Lone YA et al[11], who reported a significant improvement in dyspnea score from a preoperative value of 2.25 ± 0.59 to 1.36 ± 0.9 and showed an inverse correlation with the change in FEV_1. The author further shows that 19 patients in his study having underlying diffuse disease showed improvement from preoperative value of 2.45 ± 0.62 to 1.66 ± 0.72; and other 25 patients without underlying diffuse disease had positive change from preoperative value of 2.05 ± 0.5 to 1.05 ± 0.61. Palla et al.[10] reported improvement from 1.8 ± 0.9 to 1.4 ± 0.8 with a significant inverse correlation with the FEV_1 trend. These studies depict results which are fairly consistent with ours and substantiate our observations.

Many studies have reported some mortality from their cohort. We had fortunately no mortality, and we attribute it to low sample size as compared to other studies, and possibly to a more fastidious selection of cases. The mortality rate reported by Gunstensen et al[14] was 9.5%. This rate was reported by Fitzgerald et al[15] as 2.1% and by Potgeiter et al, as 9.5%.[12] Antonio Palla et al[10] who had a large sample size reported zero mortality after 3-6 months, 7.3% after 1 year, 4.9% after 2 years with an overall mortality rate of 12.2% after 5 years (5 of 41 patients).

CONCLUSION: It is concluded that surgery for bullous lung disease remains a standard treatment to prevent the worsening dyspnea and development of potentially life-threatening pneumothorax in patients. We have substantiated the already established findings that bullectomy leads to significant improvement in subjective dyspnea score and PFT indices including FEV_1, FVC and FEV_1/FVC. Patients with underlying diffuse lung disease should be carefully chosen for surgery, as there is also definite advantage of surgery in subset of cases.

Ethical Approval:

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Consent

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

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