ORIGINAL RESEARCH

Impact of lung volume reduction surgery on quality of life in patients with advanced COPD

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Received: 14 August, 2022 Accepted: 18 September, 2022

ABSTRACT

Aim: To evaluate the impact of lung volume reduction surgery (LVRS) on quality of life, physical function, and lung function in patients with advanced chronic obstructive pulmonary disease (COPD). **Materials and Methods:** This prospective cohort study enrolled 110 patients with advanced COPD (FEV1 < 45% predicted), significant hyperinflation, and frequent exacerbations despite optimal medical therapy. Exclusion criteria included significant comorbid conditions or previous pulmonary interventions. Participants underwent LVRS, conducted by a specialized thoracic surgery team. Quality of life was assessed using the St. George's Respiratory Questionnaire (SGRQ), physical function with the 6-Minute Walk Test (6MWT), and lung function with spirometry and body plethysmography. Assessments were conducted preoperatively and at three and six months post-surgery. **Results:** Baseline SGRQ scores averaged 69.34, improving to 56.81 at three months and 54.34 at six months post-LVRS ($p<0.01$), indicating significant quality-of-life improvement. Physical function, as measured by 6MWT, increased from a baseline distance of 320.45 meters to 382.56 meters at six months ($p<0.01$). Pulmonary function tests showed significant enhancements, with FEV1 rising from 39.12% predicted at baseline to 48.12% at six months ($p<0.01$). Complications were manageable, with 7.27% experiencing pneumonia, 10.91% prolonged air leaks, and 16.36% requiring supplemental oxygen. **Conclusion:** LVRS significantly improves quality of life, exercise capacity, and lung function in carefully selected patients with advanced COPD. While complications exist, appropriate patient selection and postoperative management can maximize therapeutic benefits, making LVRS an effective intervention for enhancing outcomes in severe COPD.

Keywords: COPD, lung volume reduction surgery, quality of life, physical function, pulmonary function

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive, debilitating respiratory condition that affects millions worldwide. Advanced COPD, marked by severe airflow limitation, lung hyperinflation, and reduced exercise capacity, significantly impairs patients' quality of life, restricts their physical activities, and often leads to frequent hospitalizations. In many patients, despite optimized pharmacological therapy, COPD progression results in chronic breathlessness, reduced lung function, and an overall decline in functional status, making it challenging for patients to manage day-to-day activities. This impact on daily living highlights the need for alternative treatments to alleviate symptoms and improve quality of life in individuals with advanced COPD.[1]

One surgical approach to managing advanced COPD is lung volume reduction surgery (LVRS). LVRS aims to improve respiratory function and quality of life by removing diseased, non-functional lung tissue, which reduces lung hyperinflation. By excising damaged portions of the lung, LVRS creates more space for healthier lung tissue to expand, enhances diaphragmatic function, and reduces the work of breathing. This is particularly beneficial in COPD patients with emphysema, where damaged alveoli lose elasticity and trap air, leading to hyperinflation. LVRS has the potential to reduce this hyperinflation, relieve

breathlessness, and subsequently enhance exercise tolerance and quality of life.[2]

The hypothesis that LVRS can improve quality of life and functional outcomes for COPD patients has been supported by studies over the last two decades. For instance, the National Emphysema Treatment Trial (NETT), a large randomized controlled trial, showed that selected patients with upper-lobe-predominant emphysema and low exercise capacity could achieve significant improvements in survival, lung function, and quality of life after LVRS. These findings provided strong evidence for LVRS as an option in carefully selected COPD patients, particularly those who are most likely to benefit based on emphysema distribution and baseline physical capacity. However, despite its promising outcomes, LVRS remains underutilized due to associated risks, costs, and the need for rigorous patient selection.[3]

Quality of life is a critical outcome in COPD management, as the disease often leads to chronic symptoms that diminish mental and physical well-being. Standard assessments of quality of life in COPD patients include validated tools such as the St. George's Respiratory Questionnaire (SGRQ) and the 6-Minute Walk Test (6MWT), both of which are commonly used in studies evaluating the impact of LVRS. The SGRQ assesses the patient's perception of symptoms, daily activity limitations, and psychosocial impacts, providing a holistic measure of COPD burden. The 6MWT, on the other hand, provides an objective measure of physical function and exercise tolerance, reflecting patients' capability to perform physical tasks that impact quality of life. Improvements in these measures after LVRS could indicate a meaningful enhancement in the patients' daily life, self-sufficiency, and overall satisfaction with their physical health.[4]

However, the impact of LVRS on quality of life varies across studies, with some indicating significant benefits and others showing limited or short-lived improvements. Factors influencing these variable outcomes include differences in patient selection criteria, comorbidities, emphysema distribution, and severity of hyperinflation. For example, patients with upper-lobe-predominant emphysema and lower baseline exercise capacity tend to experience more pronounced improvements in quality of life and physical function post-LVRS compared to those with different emphysema distributions or higher baseline activity levels. Understanding these factors is essential to optimize patient selection and to identify individuals who are most likely to benefit from the procedure.[5]

While LVRS offers promise for quality-of-life improvements, the procedure is not without risks. Complications such as air leaks, respiratory infections, and a prolonged recovery period are commonly observed, necessitating careful postoperative management and follow-up. Additionally, LVRS is typically considered only for patients who have failed to achieve adequate symptom control with medical therapy, as it is an invasive procedure with significant perioperative risks. Advances in less invasive techniques, such as bronchoscopic lung volume reduction (BLVR), are also being explored as potential alternatives to LVRS, especially for patients at high risk of surgical complications. However, the long-term effectiveness and durability of BLVR compared to LVRS remain subjects of ongoing research.[6,7]

LVRS represents a viable therapeutic option for selected patients with advanced COPD, particularly those with specific emphysema patterns and severe hyperinflation. By potentially improving quality of life, exercise tolerance, and lung function, LVRS can play a transformative role in the management of COPD. Nevertheless, given the variability in outcomes and potential for adverse events, further research is needed to refine patient selection, enhance postoperative care, and compare the long-term efficacy of LVRS with newer, less invasive alternatives. As the understanding of LVRS continues to evolve, its integration into COPD treatment protocols holds the potential to significantly enhance the lives of patients burdened by this challenging disease.

MATERIALS AND METHODS

This study employed a prospective cohort design to assess the impact of lung volume reduction surgery (LVRS) on quality of life in patients with advanced chronic obstructive pulmonary disease (COPD). The study was conducted at a tertiary care hospital over a period of twelve months, following ethical approval from the institution's review board. All participants provided informed consent prior to enrollment.

Methodology

A total of 110 patients with a confirmed diagnosis of advanced COPD were recruited for this study. Inclusion criteria included patients aged 40–80 years with severe COPD (FEV1 < 45% predicted), significant hyperinflation, and a history of frequent exacerbations despite optimized medical therapy. Exclusion criteria included patients with comorbid conditions that could limit life expectancy, a history of other significant pulmonary conditions, and those who were unfit for surgery based on cardiopulmonary assessment.The 110 participants were enrolled in the LVRS program, with follow-up assessments scheduled at three and six months post-surgery.

All patients underwent LVRS, a surgical procedure aiming to improve lung mechanics and respiratory muscle function by removing diseased, non-functioning lung tissue, thereby reducing hyperinflation. The procedure was performed by a specialized thoracic surgery team under general anesthesia. A standardized technique was used, and the extent of lung volume reduction was tailored to

each patient's lung anatomy and disease distribution based on preoperative imaging and functional testing.

Quality of life was evaluated using the St. George's Respiratory Questionnaire (SGRQ), a validated tool specifically designed for patients with respiratory diseases. The SGRQ assesses symptoms, activity limitations, and overall impact of COPD on daily life. Scores range from 0 to 100, with higher scores indicating a lower quality of life. Baseline SGRQ scores were collected preoperatively, with follow-up scores recorded at three and six months post-LVRS.

In addition to the SGRQ, patients' physical functioning was assessed using the 6-Minute Walk Test (6MWT), measuring the distance walked in six minutes as an indicator of functional capacity. Baseline and follow-up 6MWT distances were recorded at the same intervals as SGRQ scores.

Pulmonary function was assessed preoperatively and at each follow-up using spirometry to measure forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Lung hyperinflation was evaluated by measuring total lung capacity (TLC) and residual volume (RV) using body plethysmography. These measures provided an objective assessment of LVRS's impact on lung function in conjunction with patient-reported quality of life.

Demographic data, smoking history, comorbidities, and baseline pulmonary function values were collected for each participant. Data on postoperative complications, including pneumonia, prolonged air leaks, and need for supplemental oxygen, were recorded to assess the safety of LVRS in this patient population.

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0. Continuous variables, such as SGRQ scores, 6MWT distance, and pulmonary function parameters, were analyzed using paired t-tests to compare preoperative and postoperative values at three and six months. Categorical variables, including the incidence of postoperative complications, were analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics (Table 1)

The demographic data shows a mean age of 63.45 years (SD ± 8.32) among participants in this study. Gender distribution includes 56.36% males (n=62) and 43.64% females (n=48). Most participants (77.27%, n=85) reported a history of smoking, a common characteristic among individuals with COPD. The mean BMI was 26.54 kg/m² (SD ± 4.31), indicating that the sample included a range of weight categories. The baseline FEV1, a measure of lung function, was relatively low (mean 39.12% predicted, SD ± 6.78), consistent with advanced COPD. Additionally, 42.73% of the participants (n=47) had hypertension, a prevalent comorbidity in COPD patients. In terms of physical activity, a larger proportion of participants (58.18%, n=64) reported low activity levels, while 41.82% (n=46) had moderate activity levels, reflecting limitations in physical functioning associated with severe COPD.

Quality of Life (SGRQ) Scores (Table 2)

Quality of life, as measured by the St. George's Respiratory Questionnaire (SGRQ), showed notable improvement after LVRS. Baseline SGRQ scores indicated significant symptoms, activity limitations, and impacts on daily life, with a total score of 69.34 (SD ± 10.21). At 3 months post-LVRS, the total SGRQ score improved to 56.81 (SD ± 10.02), with further reduction to 54.34 (SD ± 9.78) at 6 months, both indicating enhanced quality of life ($p<0.01$). The scores across all domains (Symptoms, Activity, and Impact) similarly showed significant improvements at both follow-up intervals. These findings suggest that LVRS had a positive and lasting effect on various aspects of quality of life, with the most substantial improvements observed in the Symptoms domain.

Physical Function (6-Minute Walk Test) (Table 3)

The physical function of patients, measured by the 6-Minute Walk Test (6MWT), showed considerable improvement after LVRS. Baseline distances averaged 320.45 meters (SD ± 52.34). At 3 months post-surgery, the average walking distance increased to 375.23 meters (SD ± 50.12), reflecting a 17.10% improvement. By 6 months, patients achieved an average distance of 382.56 meters (SD ± 48.67), marking a 19.40% improvement from baseline ($p<0.01$). This enhancement in walking distance indicates that LVRS not only improved lung function but also enhanced patients' physical endurance and overall exercise capacity.

Pulmonary Function Test Results (Table 4)

Pulmonary function tests revealed significant improvements following LVRS. Baseline FEV1 was 39.12% predicted (SD ± 6.78) and increased to 47.34% (SD ± 7.45) at 3 months and 48.12% (SD ± 7.02) at 6 months post-surgery ($p<0.01$). FVC also showed an upward trend, from 52.23% predicted (SD ± 8.54) at baseline to 58.67% (SD ± 8.32) at 3 months and 59.12% (SD ± 8.01) at 6 months ($p<0.01$). Total lung capacity (TLC), a measure of lung hyperinflation, decreased from 132.45% predicted (SD ± 10.23) at baseline to 118.34% (SD ± 9.89) at 3 months and 115.23% (SD ± 10.45) at 6 months ($p<0.01$). Similarly, residual volume (RV) decreased from 145.67% predicted (SD ± 12.45) to 130.78% (SD ± 11.23) at 3 months and 127.56% (SD ± 10.89) at 6 months ($p<0.01$). These findings indicate that LVRS effectively reduced hyperinflation, improved airflow, and enhanced respiratory mechanics over time.

Postoperative Complications (Table 5)

Postoperative complications following LVRS were relatively low. Pneumonia occurred in 7.27% of patients (n=8), and 10.91% (n=12) experienced prolonged air leaks lasting more than 7 days.

Additionally, 16.36% (n=18) required supplemental oxygen post-surgery, reflecting the severity of baseline respiratory impairment. The hospital readmission rate within 30 days was 4.55% (n=5), and there was one case of mortality (0.91%). These findings indicate that while LVRS is associated with some risks, the overall complication rates were manageable and in line with expectations for this high-risk patient population.

Table 1: Demographic Characteristics

Characteristic	Number	Percentage (%)
Age		
Age (years, mean ± SD)	63.45 ± 8.32	
Gender		
Male	62	56.36
Female	48	43.64
Smoking History		
Yes	85	77.27
No	25	22.73
BMI		
BMI (kg/m², mean ± SD)	26.54 ± 4.31	
FEV1		
FEV1 (% predicted, mean ± SD)	39.12 ± 6.78	
Comorbidities		
Hypertension	47	42.73
Physical Activity Level		
Low	64	58.18
Moderate	46	41.82

Table 2: Quality of Life (SGRQ) Scores Preoperatively and Postoperatively

Timepoint	Symptoms (mean ± SD)	Activity (mean ± SD)	Impact (mean ± SD)	Total SGRQ Score (mean ± SD)
Baseline	65.23 ± 12.45	72.36 ± 10.59	70.45 ± 11.32	69.34 ± 10.21
3 Months Post-LVRS	52.67 ± 11.12	59.45 ± 9.98	56.32 ± 10.56	56.81 ± 10.02
6 Months Post-LVRS	50.23 ± 10.89	57.12 ± 9.57	53.67 ± 10.14	54.34 ± 9.78
p-value	<0.01	<0.01	<0.01	<0.01

Table 3: Physical Function (6-Minute Walk Test)

Timepoint	Distance (meters, mean ± SD)	Improvement (%)
Baseline	320.45 ± 52.34	-
3 Months Post-LVRS	375.23 ± 50.12	17.10
6 Months Post-LVRS	382.56 ± 48.67	19.40
p-value	<0.01	-

Table 4: Pulmonary Function Test Results

Parameter	Baseline (mean ± SD)	3 Months Post-LVRS (mean ± SD)	6 Months Post-LVRS (mean ± SD)	p-value
FEV1 (% predicted)	39.12 ± 6.78	47.34 ± 7.45	48.12 ± 7.02	<0.01
FVC (% predicted)	52.23 ± 8.54	58.67 ± 8.32	59.12 ± 8.01	<0.01
TLC (% predicted)	132.45 ± 10.23	118.34 ± 9.89	115.23 ± 10.45	<0.01
RV (% predicted)	145.67 ± 12.45	130.78 ± 11.23	127.56 ± 10.89	<0.01

Table 5: Postoperative Complications

Complication Type	Frequency (n=110)	Percentage (%)
Pneumonia	8	7.27
Prolonged Air Leak (>7 days)	12	10.91
Need for Supplemental Oxygen	18	16.36
Hospital Readmission (within 30 days)	5	4.55
Mortality	1	0.91

DISCUSSION

This study examines the impact of lung volume reduction surgery (LVRS) on quality of life, physical function, and pulmonary function in patients with advanced chronic obstructive pulmonary disease (COPD).The demographic profile of the study participants was consistent with those in similar studies of advanced COPD, such as the one by Sciurba et al. (2018), where the mean age was 64.3 years and approximately 55% of participants were male.[8] In our study, participants had a mean age of 63.45 years, with a similar gender distribution (56.36% male). The high prevalence of smoking history (77.27%) and comorbidities such as hypertension (42.73%) reflect the characteristics typical of advanced COPD patients, suggesting that the study population accurately represents the broader COPD patient demographic. The baseline FEV1 in our sample was 39.12% predicted, slightly lower than in Martinez et al. (2017), who reported a mean FEV1 of 42.5%, which may indicate a slightly more severe COPD population in this study.[9]The improvement in quality of life, indicated by a reduction in SGRQ scores, is one of the most significant findings. At baseline, patients had a total SGRQ score of 69.34, indicating substantial symptoms and functional impairment. By 6 months post-LVRS, this score had reduced to 54.34, reflecting an improvement of over 20% from baseline. Similar studies, such as that by Gompelmann et al. (2019), also found substantial improvements in SGRQ scores post-LVRS, with a mean reduction of 18% in the first 6 months.[10] This improvement is clinically meaningful, as even a 4-point change in SGRQ score is considered significant for COPD patients. The SGRQ scores in this study highlight that LVRS provides lasting benefits in quality of life, primarily by alleviating respiratory symptoms and improving physical activity levels.The enhancement in physical function, as measured by the 6-Minute Walk Test (6MWT), is consistent with findings from earlier studies on LVRS outcomes. In this study, the average baseline 6MWT distance of 320.45 meters increased to 382.56 meters at 6 months, indicating a 19.40% improvement. These results align with Hopkinson et al. (2017), who reported a 15% improvement in 6MWT distances at 6 months post-LVRS in patients with similar baseline levels.[11]This improvement reflects enhanced exercise tolerance, likely due to the reduction in hyperinflation and improved respiratory muscle function, enabling patients to engage in daily activities with less exertion. The increase in walking distance, coupled with improved SGRQ scores, suggests that LVRS positively affects both functional independence and quality of life.The pulmonary function improvements observed post-LVRS further support the procedure's effectiveness. FEV1 increased from 39.12% predicted at baseline to 48.12% at 6 months, a finding consistent with Miller et al. (2020), who reported an 8-10% increase in FEV1 following LVRS.[12] FVC also showed significant improvement, while reductions in TLC and RV indicate decreased hyperinflation, an essential outcome of LVRS. Gompelmann et al. (2019) observed similar reductions in TLC (about 12%) and RV (approximately 15%) over 6 months, confirming that LVRS reduces lung hyperinflation and improves respiratory mechanics. The decrease in RV from 145.67% to 127.56% at 6 months in this study aligns with these findings and highlights the sustained benefits of LVRS in enhancing lung capacity and efficiency.[10] This reduction in hyperinflation can reduce the work of breathing and make physical activities less taxing, explaining the improvements in exercise tolerance observed in the 6MWT.The complication rates in this study are comparable to those reported in previous research. The incidence of pneumonia (7.27%) and prolonged air leaks (10.91%) is consistent with data from Oey et al. (2018), who reported pneumonia rates of around 8% and air leaks in 12% of LVRS patients.[13] Additionally, the need for supplemental oxygen in 16.36% of patients post-surgery reflects the baseline severity of COPD in this cohort but is within expected ranges for high-risk patients undergoing LVRS. The 30-day readmission rate of 4.55% and the mortality rate of 0.91% align with rates found in studies by Criner et al. (2019), who reported 30-day readmission rates of 5% and mortality rates of 1% following LVRS. These findings suggest that while LVRS carries inherent risks, these risks are manageable and relatively low compared to the substantial functional and quality-of-life benefits observed post-surgery.[14]

CONCLUSION

In conclusion, lung volume reduction surgery (LVRS) offers significant quality-of-life benefits for carefully selected patients with advanced COPD, particularly those with severe hyperinflation and upper-lobe-predominant emphysema. The improvements in lung function, exercise tolerance, and reduction in symptoms post-surgery highlight LVRS as an effective intervention for enhancing patient outcomes beyond pharmacological therapy. While LVRS is associated with some risks, appropriate patient selection and postoperative care can help mitigate these complications. Continued research and refinement of selection criteria are essential to maximize the therapeutic potential of LVRS, providing a meaningful improvement in the lives of patients with severe COPD.

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