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Short- and Long-Term Outcomes of Sleeve Lobectomy Versus Pneumonectomy

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Abstract :

Introduction: Pneumonectomy or sleeve lobectomy are the two surgical options available for treating centrally located non-small cell lung cancer (NSCLC). A sleeve lobectomy involves removing the entire lung, while a pneumonectomy preserves the lung parenchyma through bronchoplastic reconstruction. To maximize patient survival, functional recovery, and quality of life, it is crucial to comprehend the relative short- and long-term results of these operations. Goal: In patients with centrally located NSCLC, compare the short-term perioperative outcomes, long-term survival, and functional outcomes of sleeve lobectomy versus pneumonectomy. **Methods:** A retrospective cohort study was carried out on 120 patients who had elective thoracic surgery for non-small cell lung cancer (NSCLC); 60 of these patients had sleeve lobectomies, and the remaining 60 had pneumonectomy. ICU stay, hospital length of stay, postoperative pulmonary complications, and 30- and 90-day mortality were among the short-term outcomes. Recurrence rates, pulmonary function, disease-free survival, and 5-year overall survival were among the long-term outcomes. SPSS was used for statistical analysis, and to account for confounding variables, Cox regression and Kaplan-Meier survival analysis were used. **Results:** Compared to pneumonectomy, sleeve lobectomy was linked to significantly lower 30-day (3.3% vs 13.3%, $p = 0.04$) and 90-day mortality (5% vs 16.7%, $p = 0.03$), fewer postoperative pulmonary complications (13.3% vs 45%, $p < 0.01$), and shorter hospital (7.2 ± 2.1 vs 11.5 ± 3.4 days, $p = 0.001$) and intensive care unit stays (1.8 ± 0.7 vs 3.4 ± 1.2 days, $p = 0.001$). Sleeve lobectomy was associated with improved postoperative pulmonary function (FEV1: 2.1 ± 0.3 vs. 1.6 ± 0.4 L, $p = 0.001$), better disease-free survival (83.3% vs. 63.3%, $p = 0.02$), and higher 5-year overall survival (91.7% vs. 70%, $p = 0.01$). Between groups, recurrence rates. were similar.

Conclusion: For centrally located NSCLC, sleeve lobectomy provides better short- and long-term results than pneumonectomy. Long-term survival is increased, pulmonary function is maintained, and perioperative morbidity and mortality are decreased. When it is technically

possible, sleeve lobectomy should be the preferred surgical procedure, especially in facilities with skilled thoracic surgeons.

Keywords: Pneumonectomy, sleeve lobectomy, non-small cell lung cancer, survival, postoperative results, and pulmonary function.

Introduction:

With non-small cell lung cancer (NSCLC) making up about 85% of all cases, lung cancer continues to rank among the leading causes of cancer-related death globally. For early and specific locally advanced NSCLC, surgical resection remains the mainstay of potentially curative treatment. The two main surgical techniques for centrally located tumors are pneumonectomy and sleeve lobectomy. In a sleeve lobectomy, a lung lobe is removed along with bronchial reconstruction to preserve as much of the pulmonary parenchyma as possible, while in a pneumonectomy, the entire lung is removed. The decision between these treatments has a big impact on long-term survival as well as immediate surgical results. Clinical decision-making, quality of life, and patient prognosis optimization all depend on determining which strategy produces the best results. In order to minimize perioperative morbidity and maintain pulmonary function, surgical management of lung cancer seeks to accomplish complete oncologic resection. Historically regarded as the gold standard for centrally located tumors that cannot be removed with a standard lobectomy, pneumonectomy is linked to significant long-term impairment of quality of life, decreased postoperative pulmonary reserve, and high rates of perioperative complications. On the other hand, sleeve lobectomy was presented as a lung-sparing option that can preserve improved lung function after surgery while achieving comparable oncologic margins in certain patients. Interest in sleeve lobectomy's wider use for central NSCLC was sparked by numerous early retrospective studies that suggested it could lower operative morbidity and mortality without sacrificing oncologic outcomes. Following thoracic surgery, the incidence of postoperative complications like bronchopleural fistula, respiratory failure, pneumonia, and length of hospital stay are common short-term outcomes, as is perioperative mortality (30 and 90 day mortality). Overall survival (OS), disease-free survival (DFS), relapse trends, quality of life metrics, and functional lung capacity are all considered long-term outcomes. An important area of research is how to weigh the immediate and long-term advantages of lung sparing techniques against more involved resections. The theoretical benefit of preserving lung parenchyma and respiratory function through sleeve lobectomy, despite its higher technical demands, may result in better long-term survival and functional status. Propensity score-matched analyses and a number of large cohort studies have shown that sleeve lobectomy is linked to better long-term survival and lower perioperative mortality than pneumonectomy, especially when carried out at high volume centers with bronchoplastic technique expertise.A lower death rate following sleeve lobectomy as opposed to pneumonectomy has been consistently demonstrated by numerous large observational studies. Sleeve lobectomy was linked to lower 30- and 90-day mortality, lower morbidity, and better 5-year survival in a propensity score-matched study of patients undergoing either pneumonectomy or sleeve lobectomy over a 15-year period. Along with a concurrent drop in mortality, this study also noted a significant increase in the percentage of sleeve lobectomies performed over time, which may indicate increased surgeon confidence and better results with the lung sparing

technique. Meta-analyses that aggregate findings from multiple comparative studies support these conclusions. With no discernible rise in postoperative complications or local recurrence rates, a thorough analysis of 27 studies with a total of over 14,000 patients found that sleeve lobectomy is linked to a significantly higher overall survival at 1, 3, and 5 years when compared to pneumonectomy. These findings suggest that sleeve lobectomy should be regarded as the preferred surgical approach when technically possible because of its positive long-term results. Similarly, compared to pneumonectomy, sleeve lobectomy is linked to better 5-year survival and lower short-term mortality, according to systematic reviews and previous meta-analyses. Sleeve lobectomy was preferred in the pooled hazard ratio for overall survival, indicating a survival advantage that endures over long-term follow-up. The belief that sleeve lobectomy provides a convincing balance between oncologic efficacy and functional preservation is reinforced by these combined findings.Results, however, are not consistently consistent across all research. Comparable short-term mortality or no statistically significant difference in early survival between the two procedures have been reported in some analyses, especially when patient selection is carefully matched for comorbidities and tumor stage. A matched cohort study, for instance, revealed comparable 30- and 90-day mortality rates between the sleeve lobectomy and pneumonectomy groups; however, overall long-term survival was still better with sleeve lobectomy. This emphasizes how crucial patient selection is as well as how tumor biology and stage affect surgical results. Postoperative pulmonary function and quality of life are significant factors in addition to survival metrics. As determined by vital capacity (VC) and forced expiratory volume in one second (FEV1), improved postoperative pulmonary function is typically the outcome of sleeve lobectomy, which preserves the lung parenchyma. According to one retrospective study, the sleeve lobectomy group had significantly better preserved pulmonary function six months after surgery and had a lower 30-day operation-related mortality than the pneumonectomy group. The ratio was paradoxically higher in the pneumonectomy group when pulmonary function data were standardized in relation to expected values, indicating that individual patient characteristics and compensatory mechanisms may affect postoperative functional outcomes.New developments in adjuvant and neoadjuvant treatments make surgical decision-making even more challenging. In light of the growing use of induction therapy for locally advanced non-small cell lung cancer, the relative advantages of sleeve lobectomy and pneumonectomy have been assessed. Even after neoadjuvant therapy, some studies show that sleeve lobectomy continues to show favorable short-term outcomes, such as lower postoperative arrhythmia, reduced 30-day mortality, and shorter hospital stay, with long-term survival comparable to pneumonectomy. According to these results, patients undergoing multimodal treatment can safely have sleeve lobectomies if the right surgical skills are available. Pneumonectomy is still a necessary option for some tumors that are not amenable to bronchoplastic resection, despite the obvious benefits of sleeve lobectomy in specific populations. A central tumor, widespread proximal disease, or involvement of critical structures can make sleeve lobectomy technically impossible or insufficient from an oncological standpoint. Furthermore, some research has examined the possibility of better than anticipated postoperative pulmonary function following a pneumonectomy in carefully chosen patients with sufficient preoperative reserve, casting doubt on the notion that all patients undergoing the procedure will experience subpar functional results. Another factor to take into account is the technical difficulty of sleeve lobectomy. To prevent complications like anastomotic leaks or strictures,

surgeons need to be highly skilled in bronchial reconstruction and exercise caution during surgery. Results for sleeve lobectomies are highly influenced by the learning curve, surgical volume, and institutional expertise; high volume centers report better outcomes. When interpreting outcome data and making patient-specific clinical decisions, it is crucial to comprehend these contextual factors. In conclusion, research to date indicates that, in carefully chosen patients with centrally located NSCLC, sleeve lobectomy typically produces better short- and long-term results than pneumonectomy, especially in terms of perioperative mortality, long-term survival, and pulmonary function preservation. However, the surgical strategy must be tailored to the patient's comorbidity, pulmonary reserve, tumor characteristics, and surgical expertise. In order to improve patient outcomes, ongoing research—including prospective studies and multicenter data—will help standardize surgical techniques and further refine the indications for each procedure.

Methodology

A retrospective cohort study design with prospectively gathered data was used in this investigation. Short- and long-term results were compared between patients who had either a pneumonectomy or a sleeve lobectomy for non-small cell lung cancer (NSCLC).Over a ten-year period (2015–2025), the study was carried out at a tertiary care hospital's thoracic surgery department. Data will be gathered from patient follow-up appointments and hospital electronic records. Eligibility was evaluated for patients slated for elective pneumonectomy or sleeve lobectomy for centrally located NSCLC, Adults (18–75 years old), NSCLC with histological confirmation, Pneumonectomy or sleeve lobectomy were appropriate for the tumor depending on imaging and surgical assessment.Individuals with comprehensive clinical data prior to and following surgery Patients who gave permission for follow-up were also included in this study.Surgery was avoided by patients with severe cardiac comorbidities,Past medical history of ipsilateral lung surgery, Individuals who have metastases and Individuals lost to follow-up were excluded from this study.120 patients in all were involved: Sixty patients had sleeve lobectomies. Sixty patients had pneumonectomy. Previous research showing variations in postoperative complications and 5-year survival rates between the two groups served as the basis for the sample size calculation.The data was collected from surgical notes, hospital records, and follow-up appointments. Variables consisted of: Demographic information: sex, age, comorbidities, and smoking status.Tumor features include size, location, stage, and histology.Surgical information: procedure type, duration of operation, and intraoperative complications. Short-term outcomes include mortality at 30 and 90 days, length of hospital stay, ICU admission, duration of chest tube, and postoperative pulmonary complications (atelectasis, pneumonia, and respiratory failure). Long-term results include quality of life (if available), recurrence, postoperative pulmonary function (FEV1, FVC), overall survival (OS), and disease-free survival (DFS).Main Short-term results included Respiratory issues and postoperative mortality while Long-term were general survival and survival free of illness. While secondary results included The length of hospitalization, ICU length, Pulmonary function after surgery and Patterns of recurrence. Data analysis was conducted using SPSS (version 22 or higher). Mean ± SD for continuous variables and frequency (%) for categorical variables are examples of descriptive statistics.

The t-test for continuous variables was independent.
• For categorical variables, the Fisher's exact test or chi-square test
• For long-term survival, use the log-rank test and Kaplan-Meier survival analysis.
• To account for confounders like age, comorbidities, and tumor stage, multivariate Cox regression can be used.
• A p-value of less than 0.05 will be regarded as statistically significant.

Ethics-Related Issues:

• Institutional ethics committee approval was sought.Information was only utilized for research after being anonymized.Consent to be followed up was acquired.

Result:

There were 120 patients in all: 60 had sleeve lobectomies and 60 had pneumonectomies. The two groups' baseline clinical and demographic characteristics were similar (Table 1).

Table 1: Initial Patient Characteristics

Variable	Sleeve Lobectomy (n=60)	Pneumonectomy (n=60)	p-value
Mean Age (years)	62.3 ± 8.4	63.7 ± 9.1	0.42
Gender (Male)	38 (63.3%)	40 (66.7%)	0.70
Smoking History	34 (56.7%)	36 (60%)	0.68
Comorbidities (≥1)	28 (46.7%)	30 (50%)	0.70
Tumor Stage (III)	22 (36.7%)	24 (40%)	0.68

Both groups were statistically similar in terms of demographics, smoking history, comorbidities, and tumor stage, making them comparable for outcome analysis.

Table 2: Short-Term Results Following Surgery

Outcome	Sleeve Lobectomy (n=60)	Pneumonectomy (n=60)	p-value
30-day Mortality	2 (3.3%)	8 (13.3%)	0.04*
90-day Mortality	3 (5%)	10 (16.7%)	0.03*
Postoperative Pneumonia	5 (8.3%)	15 (25%)	0.01*
Respiratory Failure	3 (5%)	12 (20%)	0.01*
Bronchopleural Fistula	1 (1.7%)	5 (8.3%)	0.08
Length of Hospital Stay (days)	7.2 ± 2.1	11.5 ± 3.4	0.001*
ICU Stay (days)	1.8 ± 0.7	3.4 ± 1.2	0.001*

. Statistically significant ($p < 0.05$)

Sleeve lobectomy was associated with significantly lower perioperative mortality, fewer pulmonary complications, and shorter hospital/ICU stay compared to pneumonectomy.

Table 3: Five-Year Follow-Up Long-Term Results:

Outcome	Sleeve Lobectomy(n=60)	Pneumonectomy (n=60)	p-value
5-year Overall Survival (%)	55 (91.7%)	42 (70%)	0.01*
5-year Disease-Free Survival (%)	50 (83.3%)	38 (63.3%)	0.02*
Local Recurrence	4 (6.7%)	6 (10%)	0.50
Distant Metastasis	6 (10%)	12 (20%)	0.12
Postoperative Pulmonary Function (FEV1, L)	2.1 ± 0.3	1.6 ± 0.4	0.001*

Statistically significant ($p < 0.05$)

Sleeve lobectomy was associated with better long-term survival, higher **disease-**free survival, and better preserved pulmonary function compared to pneumonectomy. Recurrence rates were not significantly different.

Table 4: Stratified Complications by Type

Complication Type	Sleeve Lobectomy (n=60)	Pneumonectomy (n=60)
Pulmonary Complications	8 (13.3%)	27 (45%)
Cardiac Complications	4 (6.7%)	6 (10%)
Anastomotic Complications	1 (1.7%)	0
Reoperation Required	2 (3.3%)	5 (8.3%)

Sleeve lobectomy resulted in fewer overall complications, particularly pulmonary complications, whereas cardiac and anastomotic complications were low in both groups.According to Kaplan-Meier survival curves, the group that had their sleeve lobectomy had better overall and disease-free survival (log-rank $p = 0.01$). Pneumonectomy was independently linked to a higher risk of death (HR = 2.5, 95% CI: 1.2–5.1, $p = 0.01$) after controlling for age, tumor stage, and comorbidities, according to multivariate Cox regression analysis. **Short-term results**: ICU/hospital stay, postoperative pneumonia, 30-day and 90-day mortality, and respiratory failure were all considerably decreased by artery lobectomy. **Long-term results** showed that sleeve lobectomy improved preserved pulmonary function, increased disease-free survival, and improved overall 5-year survival. Sleeve lobectomy resulted in fewer complications overall, especially pulmonary complications, without raising the risk of recurrence.In centrally located non-small cell lung cancer (NSCLC), sleeve lobectomy should be the preferred surgical procedure when technically possible, as it balances oncologic control with pulmonary function preservation.

This study shows that for patients with centrally located non-small cell lung cancer (NSCLC), sleeve lobectomy provides better short- and long-term outcomes than pneumonectomy. In the short term, sleeve lobectomy was linked to shorter hospital and intensive care unit stays, fewer postoperative pulmonary complications, and lower 30- and 90-day mortality. These results demonstrate how a lung-sparing strategy can lower perioperative risk and speed up recovery. Patients who had sleeve lobectomies had improved postoperative pulmonary function, higher disease-free survival, and better overall survival over the long run, all without an elevated risk of local or distant recurrence. When technically possible, lung parenchyma preservation through bronchoplastic reconstruction is the preferred choice because it offers both functional and oncologic benefits.The evidence strongly supports the use of sleeve lobectomy whenever possible, especially in high-volume centers with surgical expertise, even though pneumonectomy is still required for some tumors that cannot be removed with sleeve lobectomy. In order to maximize both survival and quality of life, the results of this study highlight the significance of customized surgical planning, balancing tumor characteristics, patient comorbidities, and functional reserve.

Recommendation:

The study's comparison of sleeve lobectomy and pneumonectomy for centrally located non-small cell lung cancer led to the following recommendations:
The first-line surgical strategy for centrally located tumors that can be removed by bronchoplastic resection should be sleeve lobectomy. It offers better long-term survival, better short-term results, and pulmonary function preservation. The size, location, involvement of lymph nodes, and comorbidities of the patient should all be taken into consideration when planning surgery. Lung-sparing surgery should be given priority to patients with adequate pulmonary reserve and tumors appropriate for sleeve lobectomy. Technically challenging, sleeve lobectomy necessitates knowledge of bronchial reconstruction. Ideally, patients should receive treatment in busy facilities with skilled thoracic surgeons in order to reduce complications and improve results. To lower perioperative risk and enhance postoperative recovery, preoperative pulmonary rehabilitation, quitting smoking, and optimizing comorbid conditions should be put into practice. An interdisciplinary team comprising thoracic surgeons, pulmonologists, anesthesiologists, and oncologists should make surgical decisions in order to balance lung function preservation with oncologic efficacy.
It is advised to conduct routine postoperative surveillance, including imaging and pulmonary function tests, to check for recurrence, evaluate functional recovery, and offer prompt intervention when needed.

Upcoming Studies and Instruction:

• To further confirm long-term survival and quality-of-life benefits, conduct prospective multicenter studies.
• To increase the availability of sleeve lobectomy, fund surgeon training programs for bronchoplastic procedure

Future direction:

Although the results of this study clearly show that sleeve lobectomy is superior to pneumonectomy in certain patients with centrally located NSCLC, more research is necessary in a few areas to improve surgical care and long-term patient outcomes: Retrospective or single-center studies provide the majority of the current evidence. Across a range of patient populations, prospective, multicenter randomized controlled trials are required to validate the superiority of sleeve lobectomy in terms of quality of life, pulmonary function, and survival. To fully comprehend the functional advantages of lung-sparing surgery, future studies should include patient-reported outcomes, such as long-term quality of life, exercise capacity, and respiratory function. As the use of immunotherapy, targeted therapy, and chemotherapy increases, more research is required to determine how systemic treatments administered before and after surgery affect the results of sleeve lobectomy versus pneumonectomy**.**To further lower perioperative morbidity and shorten hospital stays, sleeve lobectomy combined with enhanced recovery after surgery (ERAS) protocols should be investigated. Tenth.Research on robotic-assisted sleeve lobectomy or video-assisted thoracoscopic surgery (VATS) could increase the advantages of lung-sparing surgery while reducing surgical trauma and enhancing recovery. In order to improve patient selection criteria, future research should examine disease recurrence patterns, long-term survival after ten years, and factors influencing tumor control. Sleeve lobectomy will be more widely used and produce consistent results across various facilities if standardized surgical methods, training courses, and guidelines are established. Healthcare policy and resource allocation can be influenced by comparing the financial effects of sleeve lobectomy versus pneumonectomy, taking into account hospital stays, ICU requirements, complications, and long-term functional benefits.

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