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Clinical Outcomes of Thoracoscopic Segmentectomy Versus Open Thoracotomy: A Cross-Sectional Comparative Study

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ABSTRACT

Background: Surgical approaches for lung segment resection both concern thoracoscopic segmentectomy and open thoracotomy. However, their comparative clinical outcomes are less well understood. Therefore, this study compares postoperative complication incidence between thoracoscopic segmentectomy and open thoracotomy.

Methods: This was a comparative cross-sectional study conducted at Sheikh Zayed Medical College Rahim Yar khan from December 2023 till June 2024. A total of 50 Non-small cell lung cancer (NSCLC) patients aged between 40 and 75 were divided into two surgical groups, each based on tumor characteristics and health status of the patient. The patients were recruited via non probability convenient sampling technique. The data was gathered regarding preoperative, intraoperative, and postoperative complications, length of stay in the hospital, and follow-up results, and make relevant comparisons between the two surgical approaches. Descriptive analysis with frequency and chi square analysis and independent t test was run.

Results: The mean age of participants in thoracoscopic segmentectomy and open thoracotomy group was 56.64±6.05 and 59.04±6.38 respectively. Postoperative complications were slightly less common in the thoracoscopic group, with no mortalities in either group. Cancer recurrence was lower in the thoracoscopic segmentectomy group, n=5 (20%) compare to n=10 (40%) in the open thoracotomy group. The mean difference of hospital stay was -2.96±0.597 (p=0.002) in thoracoscopic segmentectomy vs. open thoracotomy group.

Conclusion: Thoracoscopic segmentectomy is associated with fewer postoperative complications and shorter operative times compared to an open thoracotomy.

Keywords: Lung Neoplasm, Carcinoma, Non-small cell lung, Thoracotomy

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INTRODUCTION

Lung cancer remains one of the commonest and fatal cancers of this time, thereby helping to increase morbidity and mortality rates quite significantly[1]. An estimated 2.2 million new cases and 1.8 million deaths are attributed to lung cancer annually according to the World Health Organization, which therefore shows just how critical it affects global health[2]. Lung cancer management is multidisciplinary, including surgery, radiation therapy, and chemotherapy[3,4,5]. Surgical options range from thoracoscopic segmentectomy to open thoracotomy, each is chosen based on tumor characteristics, the health condition of the patient, and the expertise of the operating surgeon[6,7]. The treatment of lung cancer has evolved significantly over the past decades, and one of the leading contributors to this improved patient outlook is improvement in surgical techniques. Traditionally, open thoracotomy has been considered the standard approach for lung resection[8]. It includes a large, incised opening in the chest through which the diseased portion of the lung is accessed and removed. Though it is effective, open thoracotomy has drawbacks associated with it: significant postoperative pain, longer recovery times, and higher morbidity compared to newer, minimally invasive techniques[9].

Thoracoscopic segmentectomy may be performed using a technique called Video-Assisted Thoracic Surgery (VATS), which is less invasive than the open thoracotomy[10]. This approach uses much smaller incisions and employs the use of a thoracoscope to perform the resection[11]. Thoracoscopic segmentectomy tries to provide equal oncological outcomes while reducing surgical trauma, postoperative pain, and the recovery period in general. In fact, despite all the benefits, the actual effectiveness of thoracoscopic segmentectomy compared with open thoracotomy remains a controversial issue[12]. Thoracoscopic segmentectomy has become increasingly popular because of the perceived advantages that this approach holds over that of open thoracotomy[13]. Due to its minimally invasive nature, intraoperative blood loss is often less, lengths of stay are shorter, and return to routine activities occurs sooner. A few studies report favorable outcomes from thoracoscopic segmentectomy: reduced levels of postoperative pain and complication rates[14]. For example, Shapiro et al. (2009) demonstrated that patients receiving thoracoscopic segmentectomy had a significantly shorter length of stay in hospital and lower incidence of postoperative pneumonia compared to patients receiving open thoracotomy[15].

Besides, thoracoscopic segmentectomy has been associated with comparable oncological outcomes to open thoracotomy. In this regard, a meta-analysis by Zhang et al. (2022) reviewed a number of studies that noted that thoracoscopic segmentectomy offered equivalent 5-year survival rates and recurrence-free survival with open thoracotomy. This makes the application of thoracoscopic techniques feasible in patients with early-stage lung cancer, especially those with small tumors or limited pulmonary reserve[16].

In patients with larger tumors or those requiring extended resections, open thoracotomy remains a cornerstone in the surgical management of lung cancer. The operation allows for visual exposure of the thoracic cavity and proper resection of tumor tissues[17]. There are also various disadvantages to open thoracotomy, such as increased postoperative pain, extended recovery time, and higher percentage of surgical complications[18].

These disadvantages have, however, been pointed out by most studies which have compared open thoracotomy with thoracoscopic segmentectomy. Al-Githmi et al, demonstrated that patients who underwent open thoracotomy had a longer postoperative recovery and a higher incidence of wound infections compared to patients who had undergone thoracoscopic surgery[19]. The findings also point to the need for continued reevaluation of surgical technique in an effort to optimize patient outcomes and reduce surgical morbidity. This study compared the clinical outcomes of thoracoscopic segmentectomy against open thoracotomy in treating patients with early-stage lung cancer regarding postoperative complications, length of stay in hospital, mortality rates, and recurrence rates of the two surgical methods.

METHODS

This study performed using a cross-sectional comparative study design performed at Sheikh Zayed Medical College Rahim Yar khan from December 2023 till June 2024, focused on patients who were eligible for either surgical approach based on clinical assessment. Patients with early stage lung cancer enrolled in the hospital for either thoracoscopic segmentectomy versus open thoracotomy were recruited via convenience sampling technique. Patients with age between 40-75 years, diagnosed with early-stage NSCLC or other lung tumors amenable to surgical resection, enrolled for either thoracoscopic segmentectomy or open thoracotomy, determined by tumor characteristics and patient health status were recruited. Patients with advanced-stage cancer or metastatic disease, or with severe comorbidities that contraindicate either type of surgery or a history of previous thoracic surgeries were excluded. Patients were assigned to one of two groups based on clinical indications:

- **Thoracoscopic Segmentectomy Group:** Patients whose tumors are suitable for thoracoscopic resection based on size, location, and surgical feasibility.

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• **Open Thoracotomy Group:** Patients who require open thoracotomy due to tumor size, location, or other factors that make thoracoscopic surgery impractical.

In the study, an extensive preoperative work-up was performed in all patients by thoroughly reviewing the history of each patient for the stage of malignancy, comorbidities, and any previous treatments. Clinical examination concerning overall physical health, performance status, and operability was performed. All cases underwent imaging studies such as CT scans, PET scans, and/or MRI to determine tumor characteristics and extent of the disease. We also collected demographic data like age, sex, and Body Mass Index (BMI) from the patients' records. Intraoperative, we recorded operative details. For thoracoscopic segmentectomy, the number of segments resected, the time taken for surgery, and intraoperative complications was noted. For open thoracotomy, we recorded the extent of resection, operative time, and any intraoperative issues encountered. The postoperative monitoring included the development of any complication in regards to pneumonia, pneumothorax, and/or pleural effusion during their hospitalization. We noted length of stay as a number of days from the date of surgery to the date of discharge for each subject. We checked mortality related to in hospital or 30-day postoperative deaths. Follow-up visits were also made at 1, 6, and 12 months post-surgery to check for cancer recurrence, imagery and clinical follow-up being done for recurrence within the year. An informed consent was obtained from the participants in which the brief details of the study were provided including the risks and benefits. The study was approved from the ethical review from Sheikh Zayed Medical College Rahim Yar khan (Reference No: 63/IRB/SDMC/SZH). The confidentiality of participants was kept anonymous and the data was secure to protect patient privacy.

For demographic statistics, descriptive statistics was applied for age, gender, and BMI. Frequency and percentages were used to determine the frequency of complications, mortality rate, and reoccurrence rate in both groups. Independent sample t test was run for comparative analysis for duration of stay in hospital.

RESULTS

A total of 50 patients were enrolled in this comparative study. Table 1 is depicting the demographic characteristics and main outcomes between thoracoscopic segmentectomy and open thoracotomy group. The mean age of the patients in the thoracoscopic segmentectomy group was 56.64±6.05 years, while that in the open thoracotomy group was 59.04±6.38 years. The gender distribution in both groups was relatively even: 56% male and 44% female in the thoracoscopic segmentectomy group and 48% male and 52% female in the open thoracotomy group. Mean BMI was lower in the thoracoscopic segmentectomy group when compared to the open thoracotomy group, with 24.86±2.22 and 27.12±2.33, respectively.

Cross-tab was applied between the variables. Regarding postoperative complications, it was noticed that 60% of the patients in the thoracoscopic segmentectomy group had no complications, against 48% of patients in the open thoracotomy group. Both groups have 20% of their patients presenting with pneumonia. Meanwhile, pleural effusion occurred in 20% of the thoracoscopic segmentectomy group and 12% of the open thoracotomy group, while 20% of the open thoracotomy group patients develop pneumothorax without incidence in the thoracoscopic segmentectomy group (p=0.027)

The mortality rates for the two groups were zero, indicating no death within the study period. Regarding recurrence of cancer, it was noted that 20% of the patients in the thoracoscopic segmentectomy group had recurrence, while 40% were from the open thoracotomy group; similarly, 80% and 60%, respectively, of patients within both groups were free from recurrence (p=0.307).

Table 1: Showing Demographic Characteristics of Participants and Primary Outcomes

Variable		Thoracoscopic Segmentectomy N= (25) (Mean±SD)	Open Thoracotomy N= (25) (Mean±SD)	P value
Age (in years)		56.64±6.05	59.04±6.38	0.000
Gender	**Male**	14 (56%)	12 (48%)	-
	Female	11 (44%)	13 (52%)	

BMI		24.86±2.22	27.12±2.33	0.000
Complication	**No complication**	15 (60%)	12 (48%)	0.027
	Pneumonia	5 (20%)	5 (20%)	
	Pleural Effusion	5 (20%)	3 (12%)	
	Pneumothorax	0	5 (20%)	
Reoccurrence Rate	**Yes**	5 (20%)	10 (40%)	0.307
	No	20 (80%)	15 (60%)	

Table 2 presents the hospital stay duration after surgery in thoracoscopic segmentectomy and open thoracotomy patients. Independent sample t test was run to assess the between group comparison. According to the table, the mean hospital duration of stay among patients in the thoracoscopic segmentectomy group was 5.12±1.84 days and that of the patients in the open thoracotomy was 8.08±2.49 days. The weighted mean difference in the length of postoperative hospital stay between both groups was -2.96±0.597 days, with a 95% CI ranging from -4.91 to -0.88 days. This indicates that patients in the thoracoscopic segmentectomy group stayed an average of 2.9 fewer days in the hospital compared with those in the open thoracotomy group. This p-value of 0.002 is smaller than 0.05, thus indicating that the mean difference in length of stay in the hospital between the two surgical approaches is statistically significant.

Table 2: Showing Group Comparison of Patients on Post-Operative Duration of Hospital Stay

Groups	N	Variable	Mean±SD	MD±SD	CI at 95%	P value
Thoracoscopic Segmentectomy	25	Length of hospital stay (in days)	5.12±1.84	-2.96±0.597	-4.91to -0.88	0.002
Open Thoracotomy	25		8.08±2.49			
N=samples size, SD; Standard Deviation, MD; Mean Difference; CI; Confidence Interval						

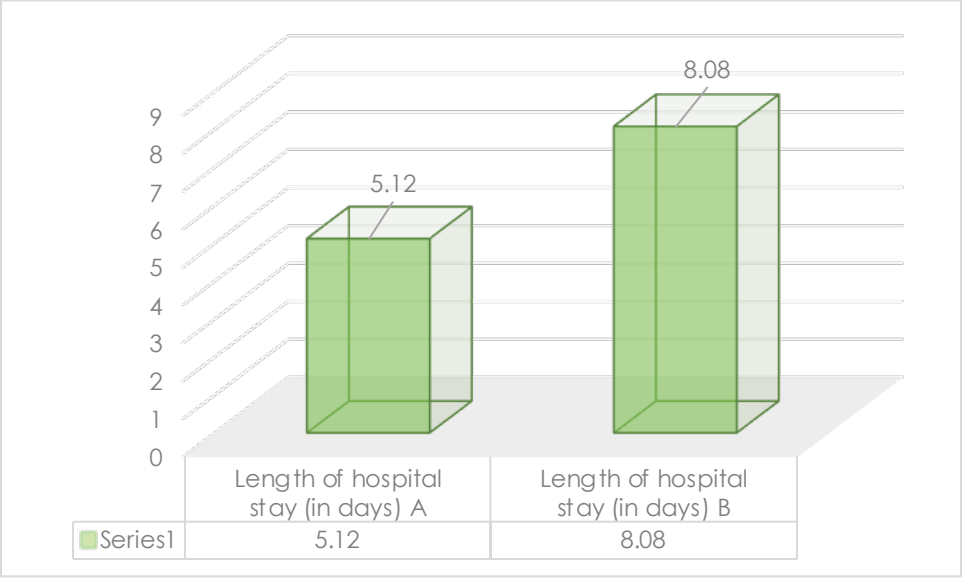

Figure 1 Showing Comparative Mean Value for Hospital Stay in Both Groups

DISCUSSION

The comparison within this article between thoracoscopic segmentectomy and open thoracotomy represents awareness into the results expected for both types of surgical interventions in lung cancer. Our findings showed that thoracoscopic segmentectomy, due to its minimally invasive nature, conveys several advantages compared to the conventional open thoracotomy. Of these, the length of hospital stay was significantly reduced in patients undergoing thoracoscopic segmentectomy, averaging a 2.9-day decrease versus open thoracotomy. This corresponds to the reduced postoperative pain and faster recovery commonly reported for minimally invasive techniques. Moreover, postoperative complications within the group of thoracoscopic segmentectomy were significantly lower, with fewer pneumothoraxes and pleural effusions. This would further indicate that thoracoscopic segmentectomy reduces not only surgical trauma but also potential postoperative complications, consistent with other studies indicating the advantages of minimally invasive surgery in complication reduction. The fact that there was no mortality whatsoever from both groups during the period of study underlines the fact that both surgical approaches are safe.

Despite these positive outcomes associated with thoracoscopic segmentectomy, it is important to consider the implications for oncological efficacy[20-22]. Our study found that recurrence rates were higher in the open thoracotomy group (40%) compared to the thoracoscopic segmentectomy group (20%). While these findings suggest that thoracoscopic segmentectomy may be associated with better control of disease, it is crucial to interpret these results within the context of the broader literature and acknowledge the potential for selection bias in non-randomized studies. According to a study conducted by Dai et al., in patients with peripheral NSCLC ≤ 2 cm, thoracoscopic segmentectomy and lobectomy may yield similar symptom burden and functional impairment in the early postoperative period[23]. A retrospective cohort study of non-small cell lung cancer segmentectomy, with data from the Society of Thoracic Surgeons General Thoracic Surgery Database between 2013 and 2021, showed that minimally invasive surgery has less major morbidity compared with open segmentectomy, with no difference between video-assisted thoracoscopic surgery and robotic-assisted thoracoscopic surgery[24]. However, risk of open conversion is higher with video-assisted thoracoscopic surgery[25]. In another trial, it could be established that segmentectomy might be a safe procedure, without significant differences compared to thoracoscopic lobectomy regarding postoperative morbidity and mortality.

CONCLUSION

Overall, our findings reflect a balance of the benefits and drawbacks of thoracoscopic segmentectomy in comparison to open thoracotomy. While decreased hospital stay and lower complication rates indeed genuinely reflect the advantages of minimally invasive techniques, the mortality rate and recurrence rates are comparable, which reflects an insight into the effectiveness of each approach in managing lung cancer. These results add to the debate and provide important context for clinicians when considering options in the surgical management of patients presenting with early-stage lung cancer.

LIST OF ABBREVIATIONS

Non-small cell lung cancer (NSCLC)
Video-Assisted Thoracic Surgery (VATS)
Body Mass Index (BMI)

DECLARATION

None to declare.

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None

CONFLICT OF INTEREST

None to declare

AUTHOR CONTRIBUTIONS

SA conceptualize the manuscript. **HSN** performed data collection. **MN** performed analysis of data. **SA**, **AI** and **RDA** write the original draft FR performed final revisions and proof reading

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