









# The Purpose of Lung Wedge Resections in Thoracic Surgery Practice

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## ABSTRACT

**Objective:** Lung wedge resection, frequently used in thoracic surgery practice, is the only non-anatomic resection. This study aims to determine the instances in which wedge resection was performed in our center and their frequency.

**Methods:** In this study, we included patients over the age of 18 who underwent wedge resection in our clinic between 01.01.2020 and 01.06.2023. In addition to the demographic information of all patients, we retrospectively analyzed medical records such as diagnosis, applied surgical method, number of resections, duration of drainage, duration of hospitalization, and complications. The obtained data were evaluated statistically.

**Results:** Our team included a total of 166 patients in the study, of whom 109 (65.7%) were male and 57 (34.3%) were female. The mean age of the study population was  $49.89 \pm 19.35$  years,  $49.40 \pm 20.33$  years for males, and  $50.82 \pm 17.43$  years for females. Our team performed diagnostic wedge resections in 81 (48.8%) and curative wedge resections in 85 (51.2%) of the patients included in the study. The mean age of the patients who underwent diagnostic resection was significantly higher than the patients who underwent curative resection. While in diagnostic resection cases, the most common diagnoses were nodule and interstitial lung disease, in curative resection cases, the most common diagnoses were bullae-bleb and CAI (cyst-abscess-infection). We performed video-assisted surgery in 90 cases, thoracotomy in 75 cases, and sternotomy in one case. The rate of multiple wedges was significantly higher in the thoracotomy group than in the video-assisted thoracoscopic surgery (VATS) group. In other comparative analyses, no significant difference was found between the two groups using different surgical techniques.

**Conclusion:** Wedge resections are the most commonly used resection technique by thoracic surgeons in clinical practice. While it is frequently used for diagnostic purposes in metastatic lung diseases and less frequently in interstitial lung diseases, it is particularly used for curative purposes in bullous lung diseases.

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Submitted: 17.07.2024

Revised: 31.10.2024

Accepted: 01.11.2024

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**Keywords:** Curative; diagnostic; resection; wedge.



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## INTRODUCTION

Lung wedge resection, frequently used in thoracic surgery clinical practice, is the only non-anatomic resection. Lung resections are applied in a wide variety of diseases, ranging from lung cancer and metastatic diseases to diagnosis and treatment of lungs' non-malignant parenchymal diseases and infections.

Until the middle of the twentieth century, pneumonectomies were the most accepted type of resection, particularly in lung cancer.<sup>[1,2]</sup> Today, lobectomy is the most commonly used resection method in lung cancer, but recent studies have shown that sub-lobar resections are also successful.<sup>[3]</sup> For this reason, wedge resections, one of the

sub-lobar resection methods, are being used in malignant lung diseases as well as in non-malignant parenchymal diseases.

In our study, we aimed to determine the cases in which wedge resection was performed in our center and their frequencies.

## MATERIALS AND METHODS

In this study, we included patients over the age of 18 who underwent wedge resection in our clinic between 01.01.2020 and 01.06.2023. In addition to the demographic information of all patients, we recorded medical

information such as diagnosis, performed surgery, surgical method, number of wedge resections, duration of drainage, hospitalization, and complications. Patients with insufficient data and patients who required anatomical resection during the procedure or according to the frozen section results were excluded from the study.

The data obtained were statistically analyzed using SPSS (Statistical Package for the Social Sciences Version 22.0; SPSS Inc. Chicago, IL, USA) software. For continuous variables, values with kurtosis and skewness levels between  $\pm 2$  were assumed to show normal distribution.<sup>[4]</sup> Categorical data were presented as number (n) and percentage (%), continuous data not showing normal distribution were presented as median (25th–75th percentiles), and continuous data showing normal distribution were presented as mean  $\pm$  standard deviation. The relationship between categorical data was analyzed by Chi-Square analysis and Fisher's exact test. The relationship between continuous and categorical variables was analyzed by the Independent Groups T-test and Mann Whitney-U test. In the analyses, results with a p-value below 0.05 were considered statistically significant.

Our study was conducted following the decision and approval of the Non-Interventional Clinical Research Ethics Committee of İzmir Katip Çelebi University, with the approval number 0303, dated June 15, 2023.

## RESULTS

We included 166 patients in the study, of whom 109 (65.7%) were male and 57 (34.3%) were female. The mean age of the study population was  $49.89 \pm 19.35$ ,  $49.40 \pm 20.33$  in males, and  $50.82 \pm 17.43$  in females. According to the surgical purpose, the population was divided into two groups: diagnostic resection group and curative resection group. In the patients included in the study, wedge resection was performed for diagnostic purposes in 81 patients (48.8%) and for curative purposes in 85 patients (51.2%). The distribution of the parameters in the whole population and both groups and the results of comparative analysis between the two groups are presented in Table 1.

The mean age of the patients who underwent diagnostic resection was significantly higher than the patients who underwent curative resection. The most common diagnoses were nodule and interstitial lung disease in cases with diagnostic resection, while the most common diagnoses were bullae-bleb and infectious causes in cases with curative resection. The need for additional surgical intervention was most frequently observed in the curative resection group, and the most common additional surgery was decortication. On the other hand, mediastinal lymph node sampling was the most common surgical intervention in the diagnostic resection group. The need for additional treatment, the most common additional treatment being oncological treatment, was mostly observed in the diagnostic resection group.

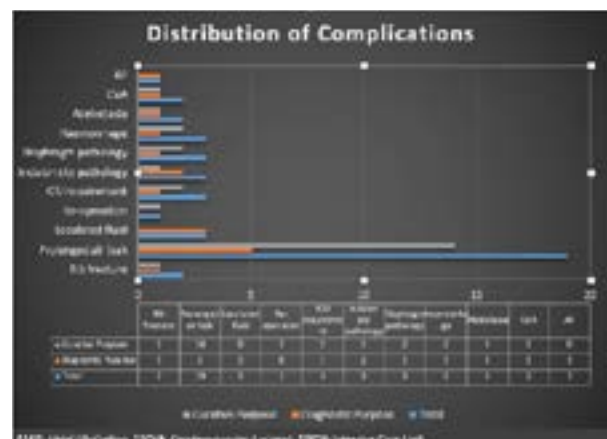
Recurrence was observed in 26 (15.6%) of the patients

who underwent wedge resection, while 2 of the patients with recurrence underwent surgery for hydatid cyst and 7 for pneumothorax. In 17 patients who underwent wedge resection for metastasectomy, new metastatic nodules were observed to develop during their follow-up. There was no significant difference between the two groups in terms of gender, surgical method, wedge count, drainage duration, follow-up time, hospitalization duration, and recurrence. One case in which sternotomy was preferred as a surgical intervention was excluded from the analyses.

Fourteen (8.4%) of the patients underwent resection due to primary lung carcinoma. Three of these patients underwent curative resection. One of the patients who underwent curative resection underwent wedge resection due to limitations in the pulmonary function test. In the other patient, bulla resection was performed due to secondary pneumothorax, and minimally invasive adenocarcinoma with negative surgical margins was detected incidentally, so no additional surgical intervention was considered, and the patient was followed up. In the third patient, the procedure was terminated because the pathological diagnosis was not clear as a result of the frozen examination studied during the surgery. Upon the pathology result of a typical carcinoid tumor and the surgical margins were negative, additional surgical intervention was not considered. In 11 patients with advanced stages, the diagnosis was made by wedge resection of the mass itself or its metastases, as the diagnosis could not be made with minimally invasive procedures.

Various complications were observed in 42 (25.3%) cases during follow-up, and their distribution in all cases and the groups according to the purpose of surgery is presented in Figure 1. The most common complication was found to be prolonged air leak (PAL)-expansion defect in all populations and groups.

Considering the number of wedge resections performed, 121 (72.8%) of 166 patients underwent single wedge resection, and 45 (27.3%) underwent multiple wedge resection. No complications were observed in 71.9% of the patients



**Figure 1.** The distribution of complications according surgical purpose groups.

**Table 1.** The distribution of parameters between groups according to surgical purpose

	Total population	Surgical Purpose Groups		p
		Diagnostic Resection	Curative Resection	
Age (/year)	49.89±19.35 <sup>a</sup>	62.75±11.20 <sup>a</sup>	37.63±17.44 <sup>a</sup>	0.001
Gender				
Male	109(%65.7)	49(60.5)	60 (%70.6)	0.171
Female	57 (%34.3)	32 (%39.5)	25 (%29.4)	
Diagnostic Groups				
Nodule	70 (%42.2)	62 (%76.5)	8 (%9.4)	0.001
Bullae-bleb	68 (%41.0)	1 (%1.2)	67 (%78.8)	
ILD	18 (%10.8)	17 (%21.0)	1 (%1.2)	
C-A-I	10 (%6.0)	1 (%1.2)	9 (%10.6)	
Surgical method				
VATS	90 (%54.2)	39 (%48.1)	51 (%60.7)	0.105
Thoracotomy	75 (%45.2)	42 (%51.9)	33 (%39.3)	
Sternotomy	1 (%0.6)	-	-	-
Wedge count				
Singular	121 (%72.9)	55 (%67.9)	66 (%77.6)	0.158
Multiple	45 (%27.1)	26 (%32.1)	19 (%22.4)	
Additional surgical intervention				
None	26 (%15.7)	17 (%21.0)	9 (%10.6)	0.001
Decortication	67 (%40.4)	6 (%7.4)	61 (%71.8)	
Cyst treatment	2 (%1.2)	-	2 (%2.4)	
Mediastinal LN sampling	57 (%34.3)	46 (%56.8)	11 (%12.9)	
Decortication+LN sampling	13 (%7.8)	12 (%14.8)	1 (%1.2)	
Mediastinal mass excision	1 (%0.6)	-	1 (%1.2)	
Duration of drainage (/day)	4.0(2.0-5.0) <sup>b</sup>	4.0 (2.0-5.0) <sup>b</sup>	4.0 (3.0-7.0) <sup>b</sup>	0.119
Duration of hospitalisation (/day)	6.0 (4.0-9.0) <sup>b</sup>	6.0 (4.0-8.0) <sup>b</sup>	7.0 (4.0-9.0) <sup>b</sup>	0.151
Additional treatment requirement				
None	138 (%83.1)	57 (%70.4)	81 (%95.3)	0.001
Oncological treatment	21 (%12.7)	20 (%24.7)	1 (%1.2)	
PM treatment	7 (%4.2)	4 (%4.9)	3 (%3.5)	
Recurrence				
Yes	140 (%84.3)	64 (%79.0)	76 (%89.4)	0.065
No	26 (%15.7)	17 (%21.0)	9 (%10.6)	

ILD: Interstitial Lung Disease; C-A-I: Cyst-Abcess Infection; VATS: Video-Assisted Thoracoscopic Surgery; LN: Lymph Node; PM: Pulmonary Medicine a: Mean±Standard deviation; b: median (25.-75th percentile).

who underwent single wedge resection and 82.2% of the patients who underwent multiple wedge resection. Of the patients who underwent curative wedge resection, 66 had single wedge resection and 19 had multiple wedge resections. The mean postoperative drain follow-up was 5.18 days, 5.52 days in patients with single wedge resection, and 4.82 days in patients with multiple wedge resection. There was no significant difference between drain follow-up or hospital stay in patients who underwent single or multiple wedge resection.

We divided the study population according to the surgical method into two groups as video-assisted thoracoscopic surgery (VATS) group (n:90) and the thoracotomy group (n:75) and presented the distribution and comparative analyses of various parameters between the groups in

Table 2. In the comparative analyses, the sternotomy case (n:1) was excluded from the analysis. The rate of multiple wedges was significantly higher in the thoracotomy group compared with the VATS group. The mean age of the cases in which the VATS method was used was significantly lower than in the cases in which the thoracotomy method was used. The most common diagnosis was bullae-bleb in the VATS group, while the most common diagnosis was nodule in the thoracotomy group. In cases in which thoracotomy was used, the rate of multiple wedges was significantly higher than in the VATS group. In other comparative analyses, no significant difference was found between the two groups using different surgical techniques.

The distribution of postoperative complications in all cases and cases with different surgical methods is presented in

**Table 2.** The distribution of parameters between groups according to surgical method

	Total population	Surgical method groups		p
		VATS	Thoracotomy	
Age (/year)	49.87±19.40 <sup>a</sup>	46.20±21.74 <sup>a</sup>	54.29±15.16 <sup>a</sup>	0.007
Gender				
Male	108 (%65.5)	57 (%63.3)	51 (%68.0)	0.530
Female	57 (%34.5)	33 (%36.7)	24 (%32.0)	
Diagnostic Groups				
Nodule	69 (%41.8)	36 (%40.0)	33 (%44.0)	0.011
Bullae-bleb	68 (%41.2)	44 (%48.9)	24 (%32.0)	
ILD	18 (%10.9)	9 (%10.0)	9 (%12.0)	
C-A-I	10 (%6.1)	1 (%1.1)	9 (%12.0)	
Surgical purpose				
Diagnostic	81 (%49.1)	39 (%43.3)	42 (%56.0)	0.105
Curative	84 (%50.9)	51 (%56.7)	33 (%44.0)	
Wedge count				
Singular	120 (%72.7)	72 (%80.0)	48 (%64.0)	0.022
Multiple	45 (%27.3)	18 (%20.0)	27 (%36.0)	
Additional surgical intervention				
None	26 (%15.8)	10 (%11.1)	16 (%21.3)	0.094
Decortication	67 (%40.6)	42 (%46.7)	25 (%33.3)	
Cyst treatment	2 (%1.2)	-	2 (%2.7)	
Mediastinal LN sampling	56 (%33.9)	29 (%32.2)	27 (%36.0)	
Decortication+LN sampling	13 (%7.9)	9 (%10.0)	4 (%5.3)	
Mediastinal mass excision	1 (%0.6)	-	1 (%1.3)	
Duration of drainage (/day)	4.0 (2.0-5.0) <sup>b</sup>	4.0 (2.0-6.0) <sup>b</sup>	4.0 (2.5-5.0) <sup>b</sup>	0.861
Duration of hospitalisation (/day)	6.0 (4.0-9.0) <sup>b</sup>	6.0 (4.0-9.0) <sup>b</sup>	7.0 (5.0-9.5) <sup>b</sup>	0.094
Additional treatment requirement				
None	137 (%83.0)	79 (%87.8)	58 (%77.3)	0.200
Oncological treatment	21 (%12.7)	8 (%8.9)	13 (%17.3)	
PM treatment	7 (%4.2)	3 (%3.3)	4 (%5.3)	
Recurrence				
Yes	139 (%84.2)	76 (%84.4)	63 (%84.0)	0.938
No	26 (%15.6)	14 (%15.6)	12 (%16.0)	

ILD: Interstitial Lung Disease; C-A-I: Cyst-Abcess Infection; VATS: Video-Assisted Thoracoscopic Surgery; LN: Lymph Node; PM: Pulmonary Medicine. a: Mean±Standard deviation; b: median (25.-75th percentile).

Figure 2. The number of complications in VATS cases was 24 (26.7%), while the number of complications in thoracotomy cases was 17 (22.7%), and there was no difference between the groups in terms of complication occurrence. The most common complication in both groups was found to be prolonged air leak-expansion defect.

When our patients with complications were evaluated according to the Clavien-Dindo surgical complication classification, the complications of the patients were grade 1 in 26, grade 2 in eight, grade 3A in one, grade 3B in three, and grade 4A in three. None of the patients who underwent surgery developed grade 5 complications.

## DISCUSSION

After dividing the cases into two groups (diagnostic re-



**Figure 2.** The distribution of observed complications according to surgical method groups.

section group and curative resection group), we reached a similar number of patients, but we discovered that the mean age was significantly lower in patients who underwent resection for curative purposes. The reason for this may be that the surgical indications differ significantly in the curative and diagnostic groups. We believe that the cause of this difference was the fact that pneumothorax cases, which we observed more frequently in the young patient group, were more common in the curative group and that the nodules that underwent surgical procedures due to suspicion of malignancy were more common in the diagnostic group. However, in the surgical treatment of early-stage non-small cell lung carcinoma (NSCLC), the trend on resection type has recently been towards sub-lobar resections, with wedge resection being among the alternatives.<sup>[5-6]</sup> In the future, wedge resections may be more common in the early-stage curative surgical treatment of NSCLC and should be considered as a factor that may affect the mean age.

Significant differences were observed between the two groups in the variety of additional surgical interventions. While decortication was the most common additional procedure in curative procedures, mediastinal lymph node sampling was the most common in diagnostic wedge resections performed for suspected malignancy. The main factor in this difference was considered to be the widespread use of apical pleurectomy in pneumothorax surgery<sup>[7]</sup> and the need to reveal the lymph node metastasis status in operations performed for suspected malignancy.<sup>[8]</sup> When malignancy is proven after wedge resections performed due to suspicion of malignancy, oncological methods step in the treatment process in appropriate patients.<sup>[9]</sup> Therefore, oncological treatment has come into prominence as the most common additional treatment after the operation.

While evaluating our complications, we observed that, in accordance with the literature, the most common complication in both groups was prolonged air leak-expansion defect.<sup>[10-12]</sup> Although not only air leaks exceeding 5 days but also minimal expansion defects observed after drainage termination were included in this complication group, complications were observed within the rates stated in the literature.<sup>[11]</sup>

While evaluating the wedge resections according to the surgical method used, we observed that VATS was used more frequently in our clinic, and the mean age of patients who underwent VATS was significantly lower than thoracotomy ( $p=0.007$ ). Currently, in the surgical treatment of pneumothorax, which is observed more frequently in young patients, thoracotomy is rarely used.<sup>[13]</sup> In other indications as well, VATS, which offers more patient comfort and has been shown to shorten the duration of hospitalization, is more prominent as stated in the literature.<sup>[14]</sup> However, thoracotomy is still an actively used method due to the need for diagnosis by detecting increasingly small nodules, technical difficulties in detecting deeply located nodules, and the need for digital examination in the presence of multiple nodules.<sup>[15]</sup> In our study, it was shown that

thoracotomy was used more frequently in patients who needed multiple wedge resection.

Although there are studies in the literature showing that VATS can be performed with lower complication rates, there are also studies indicating more air leak complications.<sup>[16,17]</sup> In our study, no significant difference was observed in both groups in terms of complication occurrence.

## Conclusion

Wedge resections are the most common type of resection used by thoracic surgeons in clinical practice. They can be performed for diagnostic or curative purposes in different patient groups. Nowadays, with the inclination towards less invasive methods, VATS has become a more frequently used method in wedge resections in our clinic too. However, it should be kept in mind that thoracotomy, which has similar complication rates, can also be used in necessary cases.

## Ethics Committee Approval

The study was approved by the Izmir Katip Çelebi University Non-Interventional Clinical Research Ethics Committee (Date: 15.06.2023, Decision No: 2023/303).

## Informed Consent

Retrospective study.

## Peer-review

Externally peer-reviewed.

## Authorship Contributions

Concept: M.K., A.C.Y.; Design: M.K., M.Ü., A.C.Y.; Supervision: M.K., M.Ü., A.C.Y.; Fundings: M.K., N.A., N.B.S., M.Ü., S.Ş., K.İ.T., A.C.Y., E.B.; Materials: N.A., N.B.S., S.Ş., K.İ.T.; Data collection &/or processing: N.A., N.B.S., S.Ş., K.İ.T.; Analysis and/or interpretation: A.C.Y.; Literature search: M.K., M.Ü., A.C.Y.; Writing: M.K., M.Ü., A.C.Y., E.B.; Critical review: M.K., E.B.

## Conflict of Interest

None declared.

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## Göğüs Cerrahisi Pratiğinde Akciğer Kama Rezeksiyonlarının Kullanım Amacı

**Amaç:** Akciğer kama rezeksiyonu, göğüs cerrahisi pratiğinde kullanılan tek anatomik olmayan rezeksiyondur ve sıklıkla uygulanmaktadır. Bu çalışmada, kama rezeksiyon uygulanan durumları ve sıklıklarını belirlemeyi amaçladık.

**Gereç ve Yöntem:** Çalışmamıza 01.01.2020–01.06.2023 tarihleri arasında kliniğimizde kama rezeksiyon uygulanan 18 yaş üzeri olgular dahil edildi. Tüm olguların demografik bilgileri yanında tanı, uygulanan cerrahi yöntemi, rezeksiyon sayıları, dren kalış süreleri, hastane yatış süreleri ve komplikasyonları gibi tıbbi kayıtları retrospektif olarak incelendi. Elde edilen veriler istatistiksel olarak değerlendirildi.

**Bulgular:** Çalışmaya toplam 166 hasta dahil edilmiş olup bunların 109'u (%65.7) erkek; 57'si (%34.3) kadındı. Çalışma popülasyonunun yaş ortalaması 49.89±19.35 olup erkeklerde 49.40±20.33; kadınlarda ise 50.82±17.43 olarak izlendi. Çalışmaya dahil edilen hastalara wedge rezeksiyon işlemi 81'inde (%48.8) tanısal amaçlı, 85'inde (%51.2) küratif amaçlı yapıldığı görüldü. Tanısal amaçlı rezeksiyon yapılan vakaların yaş ortalamaları, küratif amaçlı rezeksiyon yapılan vakalara göre anlamlı olarak yüksek saptanmıştır. Tanısal amaçlı rezeksiyon yapılan vakalarda en sık izlenen tanılar nodül ve interstisyel akciğer hastalığı iken, küratif amaçlı rezeksiyon yapılan vakalarda en sık izlenen tanılar bül-bleb ve kist-abse-enfeksiyon olarak izlendi. Çalışmadaki vakaların 90'ına cerrahi yöntem olarak video yardımlı cerrahi uygulanırken, 75 vakaya torakotomi ve 1 vakaya ise sternotomi uygulanmıştır. Torakotomi kullanılan vakalarda wedge sayısının multipl olma oranı VATS kullanılan gruba göre anlamlı olarak yüksek izlenmiştir. Yapılan diğer karşılaştırmalı analizlerde farklı cerrahi teknik kullanılan iki grup arasında anlamlı farklılık saptanmamıştır.

**Sonuç:** Kama rezeksiyonlar, klinik uygulamada göğüs cerrahları tarafından en sık kullanılan rezeksiyon şeklidir. Sıklıkla metastatik akciğer hastalıklarında ve daha nadir olarak interstisyel akciğer hastalıklarında tanısal amaçlı kullanılırken, özellikle büllöz akciğer hastalıklarında küratif amaçlı uygulanmaktadır.

**Anahtar Sözcükler:** Kama; küratif; rezeksiyon; tanısal.