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**ORIGINAL ARTICLE**

# What the pandemic has taught us: a different look at lung cancer surgical treatment

# Pandeminin bize öğrettikleri: akciğer kanseri cerrahi tedavisine farklı bir bakış

[1]Hacer BOZTEPE YEŞİLÇAY , [1]Şencan AKDAĞ

[1]Department of Thoracic Surgery, Antalya Training and Research Hospital, Health Sciences University, Antalya, Türkiye

**Correspondence**

Hacer BOZTEPE YEŞİLÇAY
Varlık Mahallesi, Kazım Karabekir Caddesi, 07100 /Antalya

**E-Mail:** drhacer83@hotmail.com

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**ABSTRACT**

**Aim:** The aim of this study was to evaluate and compare the outcomes of patients who underwent surgery for non-small cell lung cancer in our clinic before and during the COVID-19 pandemic.
**Methods:** Between March 2019 and June 2021, 185 patients aged over 40 who were operated on at our clinic and were diagnosed with non-small cell lung cancer following pathology were included in the study. Patients who underwent surgery before March 11, 2020 (control group), and those who underwent surgery after this date (pandemic group) were divided into two groups. In both groups, patients without a preoperative diagnosis underwent surgery based on PET-CT findings supporting malignancy. In the pandemic group, additional pre-, intra-, and postoperative measures were in use. In the pandemic group, segmentectomy was preferred to lobectomy in cases with tumour diameter <2 centimetres (cm) and peripherally located tumours.
**Results:** When comparing both groups for the incidence of chronic diseases, the increase in the pandemic group was statistically significantly higher than in the control group ($p < 0.05$). It was noted that two patients in the pandemic group had been infected with Covid-19 prior to the operation. When comparing the groups for preoperative biopsy, the decrease in the number of preoperative biopsies in the pandemic group was statistically significant ($p < 0.05$). There was a reduction in drain removal and hospital stay in the pandemic group. This difference was highly statistically significant ($p < 0.001$). Additionally, none of the patients in the pandemic group were readmitted to the hospital for a second time after discharge. There were no deaths in the control group, while one death in the pandemic group was due to kidney failure. No patient in the pandemic group had contracted Covid-19 during the post-operative follow-up.
**Conclusions:** Experience has shown that delaying lung cancer surgery during the pandemic may lead to more serious consequences than the devastating effects of the pandemic itself. This delay has necessitated the adoption of new surgical interventions and modifications to conventional surgical procedures. These changes can help guide healthcare professionals in avoiding the unnecessary use of hospital resources and reduce healthcare expenditures

**Keywords:** COVID-19, cancer, perioperative, VATS

**ÖZ**

**Amaç:** Bu çalışmada kliniğimizde pandemi öncesi ve pandemi sürecinde küçük hücreli dışı akciğer kanseri tanısı ile opere edilen hastaların sonuçlarını tartışmayı amaçladık.
**Gereç ve Yöntemler:** Göğüs Cerrahisi Kliniğinde Mart 2019-Haziran 2021 tarihleri arasında opere edilmiş ve patolojik inceleme sonucu küçük hücreli dışı akciğer kanseri tanısı almış 40 yaş üstü 185 olgu çalışmaya dahil edildi. Olgular 11 Mart 2020 öncesi (kontrol grubu) ve sonrası (pandemi grubu) opere edilenler olarak iki gruba ayrıldı. Her iki grupta da preoperatif tanısı olmayan olgular, PET-CT de maligniteyi destekleyen bulgu saptanması nedeniyle opere edildi. Pandemi sürecinde opere edilen gruba preoperatif, intraoperatif ve postoperatif ek önlemler alındı. Pandemi grubunda, tümör çapı<2 santimetre (cm) ve periferik yerleşimli tümörü olan olgularda lobektomi yerine segmentektomi tercih edildi.
**Bulgular:** Kronik hastalık görülme oranı açısından her iki grup karşılaştırıldığında; pandemi grubundaki artış kontrol grubuna göre istatistiksel olarak anlamlı derecede yüksek bulundu ($p<0.05$). Pandemi grubunda 2 hastanın operasyondan önce Covid-19 enfeksiyonu geçirdiği tespit edildi. Gruplar preoperatif biyopsi açısından karşılaştırıldığında pandemi grubunda preoperatif biyopsi sayısındaki düşüş istatistiksel olarak anlamlı bulundu ($p<0.05$). Gruplar karşılaştırıldığında; pandemi grubunda dren çekme ve hastanede kalış süresinde düşüş mevcut olup, istatistiksel olarak ileri derecede anlamlı fark bulundu ($p<0.001$). Ayrıca pandemi grubunda taburculuktan sonra 2. defa hastaneye yatan olgu saptanmadı Gruplar mortalite açısından değerlendirildiğinde; kontrol grubunda mortalite saptanmazken, pandemi grubunda bir hasta renal yetmezlik nedeniyle ex oldu. Pandemi grubunda postoperatif izlem süresince covid-19 enfeksiyonu geçiren olmadı.
**Sonuçlar:** Pandemi sürecinde akciğer kanseri cerrahisinin ertelenmesi, pandeminin yıkıcı etkilerinden daha ciddi sonuçlara yol açabileceği deneyimlerle anlaşılmıştır. Bu süreç yeni cerrahi önlemler almayı ve alışılagelmiş postoperatif takiplerin modifikasyonunu zorunlu kılmıştır. Bu modifikasyonlar sağlık profesyonellerine gereksiz hastane kaynakları kullanımından uzaklaştırıp, sağlık harcamalarının azaltılmasında yol gösterici olabilir.

**Anahtar Kelimeler:** COVİD-19, kanser, perioperatif, VATS

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## INTRODUCTION

Global health experts were caught off guard by the COVID-19 pandemic that emerged in late 2019, despite their experience with previous pandemics. COVID-19 affected the entire world and threatened the health of millions of people. It caused severe droplet-transmitted pneumonia and quickly led to a shortage of intensive care beds and mechanical ventilation capacity (1). This situation prompted countries to take urgent and radical action based on their own health infrastructure and resources. Cancellation or postponement of all elective surgery is one such measure. However, the applicability of this practice, especially in cancer patients, has led to serious debate among thoracic surgeons (2). Although surgery can be postponed for benign tumours of the lung, oesophagus, and chest, this approach can have serious consequences for malignant tumours, particularly lung cancer. Postponement of surgery can lead to tumour growth and metastasis, and the patient may lose the opportunity for surgical treatment. In this uncertainty, a guideline published by the American College of Surgeons (ACS) attempted to guide surgeons. In this guideline, hospitals were classified according to COVID-19 patient density and adequacy of health resources, and oncology patients were divided into three groups: cases requiring early surgery, cases that could be postponed for three months, and cases that could be evaluated with alternative treatment (3).

In this study, we performed surgery on all patients admitted to our clinic during the pandemic who were considered operable for malignancy, modifying current perioperative measures according to the specific conditions of the patients without adhering to the ACS guidelines.

## MATERIALS and METHODS

The study was conducted following the approval of the Antalya Health Sciences University Training and Research Hospital Ethics Committee on 05/08/2021, with registration number 11/11. A total of 185 patients over 40 years of age who underwent surgery at the Thoracic Surgery Clinic between March 2019 and June 2021 and were diagnosed with non-small cell lung cancer based on pathological examination were identified.The cases were divided into two groups as patients operated before (control group) and after (pandemic group) 11 March 2020. 11 March 2020, the date when the first COVID-19 case was reported in Turkey, was accepted as the reference point. Demographic characteristics such as age and gender; complaints at presentation, clinical and radiological findings; diagnoses, surgical methods applied; surgical treatment results, postoperative intensive care needs and pathological stages of all patients were retrospectively evaluated. In addition, the preoperative and postoperative COVID-19 status, the precautions taken in the perioperative period and their results were also analysed in patients operated during the pandemic period.

The group operated before the pandemic underwent routine thoracic oncological surgery procedure in the preoperative, intraoperative and postoperative periods. In the group that underwent surgery during the pandemic, in addition to preoperative preparation, a detailed medical history was taken. This included questions about symptoms of covid-19, travel history, and contact status with the patient with covid-19. Pulmonary function testing was not preferred because it would increase the

aerosolised viral load. Stair climbing and 6-minute walk tests were used instead of respiratuar function test (RFT). Polymerase chain reaction (PCR) was performed one day before surgery. Patients without positive results were admitted to the hospital in single rooms and were allowed to be accompanied by the same companion throughout the procedure. Patients with a history of contact or suspected COVID-19 on chest computed tomography, despite a negative PCR test, underwent surgery following two weeks of home isolation and confirmation of test negativity. The operations of COVID-19 confirmed cases were postponed for four weeks and rescheduled upon obtaining a negative test result. In both groups, patients with no preoperative diagnosis were operated on because of PET-CT findings supporting malignancy (Standardised Uptake Value (SUVmax) of 5 or higher). Intraoperative frozen section analysis was performed. In cases where the frozen section was reported as positive for malignancy, resection was carried out. Patients whose frozen section results were reported as benign were excluded from the study.

In the pandemic surgery group, the entire surgical team used sterile gowns, N95 masks, and safety glasses as personal protective equipment. All patients were intubated with a double-lumen tube. The position of the intubation tube was assessed through inspection and auscultation. Bronchoscopy was not preferred, as it could have increased the aerosolized viral load. Segmentectomy was preferred over lobectomy in patients with peripherally located tumors smaller than 2 cm in diameter. Air-tight trocars were used in video-assisted thoracoscopic surgery (VATS) procedures, and air leakage was checked after closing all trocar entry points, except for the chest tube. The incision was covered with a sterile drape and an air leak check was performed for procedures performed via thoracotomy. Postoperatively, all patients were extubated in the operating theatre and monitored for 2 hours in the postoperative recovery room, which we used routinely in both groups. Patients with stable vital signs during postoperative monitoring were transferred to the ward. Patients were allowed to stay with the same companion only in case of need. Home isolation was recommended for 14 days after discharge. Outpatient clinic visits were made on days 15 and 30. During the outpatient visits, patients were again asked about COVID-19 symptoms.

Statistical analyses were performed after data were entered into SPSS version 21. In addition to descriptive statistical methods (mean, standard deviation, frequency), the Student t test was used to evaluate quantitative data with normal distribution between two groups, the Mann-Whitney U test was used to evaluate quantitative data without normal distribution between two groups, and the chi-squared test was used to evaluate qualitative data between two groups. Significance was considered significant at a level of $p<0.05$.

## RESULTS

A total of 116 cases (101 males and 15 females) in the control group and 69 cases (60 males and 9 females) in the pandemic group were included in the study. When comparing the number of cases, it was found that the number in the pandemic group decreased by 40%. When analyzing both groups by age, it was found that most

cases were diagnosed between the 5th and 7th decades. No significant difference was found between the two groups in terms of age (mean age in the pandemic group: 64.06 ± 7.47 years; mean age in the control group: 64.08 ± 9.52 years; p = 0.685) and sex (p = 0.982) (p> 0.05).

Chest pain (11.5%) in the pandemic group and cough (24.1%) in the control group were the most common symptoms. Comparing the groups regarding smoking, no significant difference was found between both groups (p>0.05). When the two groups were compared in terms of the incidence of chronic diseases (diabetes, hypertension, lung disease, cardiovascular disease and others), the increase was statistically significantly higher in the pandemic group than in the control group (p=0.031, p<0.05). The demographic and clinical characteristics of the patients are shown in Table 1.

In the pandemic group, two patients were found to have Covid-19 infection before the operation. The operations of the patients were postponed for 4 weeks. After the PCR test negativity at the end of the process, the operation was rescheduled and performed. When the groups were compared in terms of preoperative biopsy, the decrease in the number of preoperative biopsies in the Pandemic group was statistically significant (p=0.034, p<0.05). Thoracotomy, video-assisted thoracoscopic surgery and robotic-assisted thoracoscopic surgery were used as the surgical method. There was no significant difference between the two groups (p>0.05) when comparing the operation methods. Thoracotomy was the most preferred operation method in both groups. There were no significant differences between the groups for resection (p>0.05). However, the rate of segmentectomy was highly significant in the pandemic group compared to the control group (p=0.003, p<0.01). The surgical procedure is shown in Table 2.

The mean diameter of the removed tumours was 4.24±2.642 cm (1-13) in the pandemic group and 3.70±2.324 cm (1-12) in the control

**Table 1:** Patients' characteristics.

| Patients' Characteristics | Control Group (n=116) | Pandemic group (n=69) | p-value |
|---|---|---|---|
| Age (years) | 64,08±9,5171 | 64,06±7,4712 | 0.685 |
| Gender | | | |
| Female | 15 (87.1%) | 9 (13%) | 0.982 |
| Male | 101 (12.9%, | 60 (87%) | |
| Comorbidity | | | |
| Yes | 45 (38.8%) | 38 (55.1%) | 0.031 |
| No | 71 (61.2%) | 31 (44.9%) | |
| Preoperative Bx | | | |
| Yes | 50 (43.1%) | 19 (27.6%) | 0.034 |
| Bronchoscopic Bx | 27 (23.3%) | 7 (10.2%) | 0.054 |
| TTNAB | 23 (19.8%) | 12 (17.4%) | 0.87 |
| No | 66 (56.9%) | 50 (72.4%) | |

Bx: Biopsy, TTNAB: Transthoracic Needle Aspiration Biopsy.

**Table 2.** Surgical method and postoperative patient management.

| Operation Management | Control Group (n=116) | Pandemic group (n=69) | p-value |
|---|---|---|---|
| Operation type | | | |
| Thoracotomy | 87 (75%) | 48 (69.6%) | 0.421 |
| VATS | 28 (24.1%) | 20 (29%) | 0.467 |
| RATS | 1 (0.9%) | 1 (%1,4) | 0.709 |
| Resection Type | | | |
| Pneumonectomy | 9 (%7,8) | 9 (13.8%) | 0.241 |
| Bilobectomy | 6 (5.2%) | 3 (4.3%) | 0.801 |
| Lobectomy | 79 (68.1%) | 41 (59.4%) | 0.232 |
| Segmentectomy | 4 (3.4%) | 11 (15.9%) | 0.003 |
| Wedge | 18 (15.5%) | 5 (%7,2) | 0.099 |
| Chest tube duration (days) | 3,67±1,53666 (1-7) | 2,53±1,36748 (1-6) | 0.000 |
| Duration of hospitalization | 4,89±1,80521 (2-11) | 3,94±1,18674 (2-7) | 0.000 |
| Complication | | | |
| Yes | 13 (%11,1) | 7 (%10) | 0,822 |
| Arrhythmia | 2 (%1,7) | 2 (%2,9) | |
| Atelectasis | 6 (%5,1) | 2 (%2,9) | |
| Prolonged air leak | 3 (%2,6) | 1 (%1,4) | |
| Expansion defect | 2 (%1,7) | 1 (%1,4) | |
| Renal failure | - | 1 (%1,4) | |
| No | 103 (%88,9) | 62 (%90) | |
| Intensive care follow-up | 9 (%7,8) | 5 (%7,2) | 0,899 |

VATS: Video-Assisted Thoracoscopic Surgery, RATS: Robot-Assisted Thoracoscopic Surgery.

group. There was no statistically significant difference between the groups (p=0.147, p>0.05), although there was an increase in tumour diameter in the pandemic group. When the groups were compared in terms of pathological stages, a decrease in the number of stage I cases and an increase in the number of stage II and stage III cases were observed in the pandemic group, but no statistically significant difference was found (p>0.05). Tumour characteristics are shown in Table 3.

**Table 3.** Tumor characteristics

| | Control Group (n=116) | Pandemic group (n=69) | p-value |
|---|---|---|---|
| **Tumor diameter (cm)** | 3,70±2,324 | 4.24±2.642 | 0,147 |
| **Stage** | | | |
| **Stage I** | 47 (%40,5) | 22 (%31,9) | 0,240 |
| **Stage II** | 29 (%25) | 23 (%33,3) | 0,223 |
| **Stage III** | 31 (%26,7) | 19 (%27,5) | 0,904 |
| **Stage IV** | 9 (%7,8) | 5 (%7,2) | 0,899 |

The mean chest tube duration was 2.53±1.36748 days (1-6) in the pandemic group and 3.67±1.53666 days (1-7) in the control group. The mean hospital stay was

3.94±1.18674 days (2-7) in the pandemic group and 4.89±1.80521 days (2-11) in the control group. When the groups were compared, a decrease in the duration of drain removal and hospital stay was observed in the pandemic group, and a highly statistically significant difference was found ($p<0.001$). Additionally, in the pandemic group, no cases were readmitted to the hospital after discharge. There was no significant difference ($p>0.05$) between the two groups in terms of postoperative complications and the need for intensive care (Table 2). When the groups were evaluated with regard to mortality, no mortality was observed in the control group, whereas one patient with known chronic renal failure in the pandemic group developed multi-organ failure syndrome and died. The patient's postoperative PCR test was negative. No one in the pandemic group had a COVID-19 infection during the postoperative follow-up period.

## DISCUSSION

Lung cancer is the leading cause of cancer-related death worldwide (4). Early diagnosis and treatment are crucial for prognosis and survival (5). The COVID-19 pandemic has caused significant changes in the management of lung cancer. Both the disease itself and the decrease in hospital admissions due to fear of contracting the virus, along with the measures and restrictions imposed during the pandemic, have resulted in delays in early diagnosis and treatment (6). In our study, consistent with the literature, there was a 40% reduction in the number of cases in the pandemic group compared to the control group.

The postponement of elective surgery, which is one of the measures taken in the Covid-19 pandemic, has led to disagreement among surgeons. The ACS has published some guidelines according to the current situation in hospitals. This guideline states that lung cancer cases with a tumour diameter >2 cm should be operated on as soon as possible, while cases with a tumour diameter <2 cm can be postponed for up to 3 months. Non-surgical treatment alternatives are recommended for locally advanced lung cancer (3). In early stage non-small cell lung cancer (NSCLC), the time from diagnosis to surgical treatment is known to be longer than 6-12 weeks, which has a negative impact on survival (7,8). Additionaly, each week of delay between diagnosis and surgical treatment increases mortality by 4% when adjusted for age, clinical stage and tumour size (9,10). To mitigate the negative consequences of the delays caused by the pandemic, our clinic adapted its approach to surgical decision-making. During this period, decisions were based on the current status of hospital resources rather than strictly adhering to the guidelines recommended by the ACS. Surgeries were performed according to the routine indications for lung cancer surgery. Kato et al. published a study comparing the number of Stage I lung cancer cases between 2018-2019 and 2020-2021, following the pandemic. They found a decrease in Stage IA cases and an increase in Stage IB cases during the pandemic (11). These results support the decision not to postpone surgical treatment in our clinic. In our study, although surgical treatment was not delayed for any patient, there was an increase in the mean tumor diameter and the number of Stage II and III patients, as well as a decrease in the

number of Stage I patients in the pandemic group, although these changes were not statistically significant. We believe that patients' fear of visiting hospitals due to the effects of the pandemic, coupled with difficulties in contacting their doctors, may have contributed to these results.

Bronchoscopy and endobronchial bronchoscopy-guided biopsy, which is an important diagnostic tool for lung cancer, is not recommended because it leads to high aerosol production in the COVID-19 pandemic (12,13,14). In the literature, it has been reported that there was an increase in the number of patients who underwent surgery without a definitive preoperative diagnosis and underwent pathological examination during surgery in 2020 (15). In our study, the number of preoperative diagnostic bronchoscopy and biopsy procedures decreased significantly in the pandemic group, while the number of intraoperative frozen section and pathological examinations increased. There was no change in the surgical approach or type of resection in patients who underwent surgery for NSCLC during the pandemic (11). In our study, the number of patients who underwent segmentectomy increased significantly in the pandemic group compared to the control group. This parenchyma-sparing procedure was preferred to protect patients with limited respiratory reserve from the adverse outcomes of a potential postoperative COVID-19 infection.

Advanced age, male gender, smoking, and the presence of at least one comorbidity (such as hypertension, diabetes, cardiovascular disease, chronic obstructive pulmonary disease, or cancer) are high-risk factors that increase morbidity and mortality in both COVID-19 and the postoperative course of NSCLC, often necessitating intensive care unit (ICU) follow-up (10,15). Studies conducted before the pandemic reported that the need for postoperative intensive care differed between hospitals. According to these studies, ICU care is recommended for patients who have undergone pneumonectomy, for patients with low expected postoperative respiratory capacity and comorbidities, and for patients who have undergone non-pneumonectomy resection (16,17). In our study, the need for postoperative intensive care was determined not by the type of resection, but by the patient's expected postoperative respiratory capacity and their vital signs following two hours of monitored observation in the postoperative recovery room. In our clinic, the use of postoperative intensive care was already limited in the pre-pandemic period, and our experience in monitoring patients on the ward was a key factor that facilitated our adaptation during the pandemic. Therefore, despite a higher number of patients with comorbidities in the pandemic group, there was no significant difference between the two groups in terms of postoperative intensive care utilization. Studies conducted in China during the early stages of the pandemic reported high morbidity and mortality associated with COVID-19 infection following surgical treatment for non-small cell lung cancer (18). Similarly, in a retrospective study conducted in Wuhan, postoperative COVID-19 infection was detected in 7 out of 139 patients who underwent surgery during the early phase of the pandemic, and 3 of these patients were reported to have died from respiratory failure (19).It is well known that postoperative complications,

particularly infections, increase with prolonged drain duration and length of hospital stay following lung resection. In our study, no COVID-19-related morbidity or mortality was observed in the pandemic group within the first 30 days after surgery. We believe that factors such as the short duration of drainage and hospitalization, the avoidance of unnecessary intensive care unit (ICU) stays, and the meticulous implementation of perioperative precautions by both healthcare personnel and patients contributed significantly to this outcome.

### Limitations of the Study

This study is a single-center, single-team retrospective analysis. Studies conducted across multiple centers may provide more robust and generalizable results. The patient group in this study is limited to those who underwent surgery and are registered in the database of a single center, and therefore, it does not represent the entire lung cancer patient population. Additionally, patients may have delayed or avoided treatment due to reasons such as hospital overload due to COVID-19 and social isolation, without consulting a specialist.

## CONCLUSION

This study demonstrates that perioperative strategies implemented during the pandemic were not merely temporary adaptations but also offer valuable insights that can enhance traditional surgical practices. Our findings suggest that diagnostic processes, and the preference for parenchyma-sparing surgical techniques can be safely applied without compromising clinical outcomes. The reduction in chest tube duration and hospital stay, without an increase in complications, indicates a more efficient use of healthcare resources. These results may guide future restructuring of healthcare delivery. In conclusion, the pandemic has not only posed challenges but also presented an opportunity to reassess and modernize certain aspects of conventional perioperative approaches.

### Conflict of interest

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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