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Original Article

# Our Major Thoracic Surgery Practices in End-Stage Renal Disease: Analysis of 16 Cases

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**Keywords:** Chronic renal failure; hemodialysis; lung cancer; major thoracic surgery; thoracotomy; video-assisted thoracoscopic surgery.



## ABSTRACT

**Objective:** Thoracic surgery is an operation with relatively high morbidity and mortality. It requires even greater care in patients undergoing hemodialysis (HD) because they are at greater risk than the general population. In light of the literature, we examined the results of major thoracic surgery performed at our clinic in patients with chronic renal failure (CRF) undergoing HD.

**Methods:** Patients who underwent major thoracic surgery while receiving HD at our clinic between December 2015 and October 2021 were included in the study. The patients were analyzed in terms of pulmonary function values, smoking status, serum urea–creatinine values, comorbidities, ejection fraction, type of surgery, amount of drainage, discharge time, intensive care requirement, histopathological diagnosis, morbidity, and mortality.

**Results:** Major thoracic surgery was performed in 15 patients receiving HD. Of the patients, 12 were males and 3 were females. The mean age was 61.2±15.8 years. The surgical approach was video-assisted thoracoscopic surgery in 6 patients, thoracotomy in 8, and sternotomy in 1. The most common surgical intervention was lobectomy. The mean length of stay in the intensive care unit was 0.9 days. Postoperative morbidity was observed in 4 patients (26.7%). Mortality due to pneumonia occurred in 1 patient (6.7%).

**Conclusion:** The number of patients requiring HD is globally increasing every year. Therefore, HD patients with lung cancer or requiring major thoracic surgery for other reasons are constantly increasing. Therefore, after a detailed risk assessment, we consider that operations should be performed in experienced centers with multidisciplinary perioperative management.

## INTRODUCTION

Lung cancer ranks first in cancer-related deaths in the world.[1] In early-stage lung cancer, surgery is the treatment method with the best survival advantage.

It has been reported that concomitant chronic renal failure (CRF) in patients with lung cancer is associated with increased mortality.[2] However, information regarding morbidity and mortality associated with major thoracic surgery in this fragile patient group is limited in the literature.[3,4] In patients undergoing hemodialysis (HD), the risk of morbidity and mortality is higher compared with both the general population and patients with standard CRF.[3] Major surgery in this group of patients requires special attention and certain precautions.

This study aimed to present the postoperative results of major thoracic surgery performed in patients undergoing HD due to CRF in our clinic and to evaluate postoperative outcomes, including morbidity and mortality.

## MATERIALS AND METHODS

### Patient selection

Patients who underwent major thoracic surgery in our clinic between December 2015 and October 2021 while undergoing HD were included in the study. Patients with CRF who underwent only minor surgery without receiving HD preoperatively were excluded. None of the patients had received neoadjuvant chemotherapy or radiotherapy. The study was designed retrospectively, and the patients' medical records were reviewed. Informed consent for the operation was obtained from all the patients in the preoperative period. The ethics committee approved the study of our institution (approval number: 2021/514/216/22, date: December 29, 2021).

### Surgical assessment

Thoracic computed tomography was performed in all the

patients preoperatively. Fiberoptic bronchoscopy (FOB) or transthoracic fine-needle aspiration biopsy was performed in patients suitable for histological examination. Positron emission tomography and brain magnetic resonance imaging were performed for staging and distant metastasis screening in patients who were scheduled for surgery for lung tumors. The patients' respiratory function and cardiac conditions were evaluated in the preoperative period. HD was applied one day before and one day after the operation. No other HD was applied on the day of operation. Postoperative HD was applied without heparin until the chest tube was removed, ensuring hemostasis. All the patients were given low molecular weight heparin during this period. Antibiotherapy was routinely applied preoperatively and postoperatively. If there was no need for additional antibiotic therapy in the postoperative period, 1 g of cefazolin was given to the patients starting from the preoperative period.

All the patients were intubated with a double-lumen tube on the operating table. Mediastinal mass excision was performed with the patient placed supine, while all the remaining operations were undertaken in the lateral decubitus position. Lung resection was performed with video-assisted thoracoscopic surgery (VATS) or thoracotomy. A biportal approach, one for camera and one for working incision, was used in the patients who underwent VATS. In the thoracotomy group, a standard lateral thoracotomy incision was made. In all the patients who underwent lung resection, the surgical staging was undertaken by performing systemic mediastinal lymph node dissection.

Preoperative and postoperative FOB was performed on the patients who underwent lung resection for control and secretion clearance on the operating table. FOB was repeated in the patients postoperatively if deemed necessary. According to clinical necessity, all the patients were extubated on the operating table and taken to the intensive care unit (ICU) or ward. The heart rhythm, oxygen saturation, and noninvasive systemic blood pressure parameters were monitored for the patients admitted to the ward. All the patients underwent respiratory physiotherapy in the postoperative period and mobilized regularly. In addition, an intercostal nerve block was applied to all the patients for pain control in the postoperative period. If necessary, epidural catheter and paravertebral block were used for patient-controlled analgesia.

Morbidity and mortality were recorded for the first 30 days postoperatively, and the thoracic morbidity and mortality classification was used for evaluation.[5] All the patients included in the study were evaluated in terms of pulmonary function values, smoking status, serum urea–creatinine values, comorbidities, ejection fraction, type of surgery, amount of drainage, duration of discharge, intensive care requirement, histopathological diagnosis, morbidity, and mortality status.

### Statistical analysis

Patient demographics and collected data were entered into IBM® SPSS® (Statistical Package for the Social Sciences) version 23. Descriptive statistical methods were used. Variables were characterized as mean and standard deviation, while qualitative variables used percentage values.

## RESULTS

Major thoracic surgery was performed on 15 patients undergoing HD at our clinic between the specified dates. Of the total patients, 12 were males and 3 were females. The mean age was calculated as 61.2±15.8 years. All the patients had end-stage renal disease and were undergoing HD. There was a history of smoking in 66.6% of the patients. In addition to CRF, the most common comorbidities were hypertension and coronary artery disease. Three patients had a renal transplant history. The mean ejection fraction was 60.45%, the forced expiratory volume in the first second was 79.40%, and the diffusion capacity of the lung for carbon monoxide was 80.77%. The demographic data of the patients are given in Table 1.

**Table 1.** Demographic characteristics of the patients

| Variables | n (%) | Mean±SD |
|---|---|---|
| Gender | | |
| Male | 12 (80.0) | |
| Female | 3 (20.0) | |
| Age (years) | | 61.2±15.8 |
| Preoperative serum urea (mg/dL) | | 80.93±36.79 |
| Preoperative serum creatinine (mg/dL) | 3.59±1.97 | |
| Preoperative glomerular filtration rate (mL/min/1.73 $m^2$) | 14.08±12.07 | |
| Smoking status | | |
| Smoker | 9 (60.0) | |
| Nonsmoker | 6 (40.0) | |
| Comorbidities | | |
| Hypertension | 6 (40.0) | |
| Coronary artery disease | 6 (40.0) | |
| Diabetes mellitus | 5 (33.3) | |
| Chronic obstructive pulmonary disease | 4 (26.6) | |
| Renal transplant | 3 (20.0) | |
| Coronary bypass history | 2 (13.3) | |
| Cerebrovascular event | 1 (6.6) | |
| Deep vein thrombosis | 1 (6.6) | |
| Sleep apnea syndrome | 1 (6.6) | |
| ASA score 3 | 15 (100.0) | |
| Ejection fraction (%) | | 60.45±3.50 |
| $FEV_1$ (L) | | 2.12±0.94 |
| $FEV_1$ (%) | | 79.40±31.34 |
| DLCO (%) | | 80.77±36.85 |

$FEV_1$: Forced expiratory volume in the first second; DLCO: Diffusing capacity of the lungs for carbon monoxide; ASA: American Society of Anesthesiologists; SD: Standard deviation.

Concerning the factors related to the operation, surgery was performed on the right side in 7 patients and the left side in 7 patients. One patient was operated on via sternotomy. In addition, 6 patients underwent surgery with VATS, 8 with thoracotomy, and 1 with sternotomy. The most performed surgery was lobectomy (54.5%). The mean length of stay in ICU was 0.9 days, and two patients required rehospitalization due to respiratory arrest and bronchopleural fistula. Operative data are summarized in Table 2.

Pneumonia was the most common morbidity within the postoperative 30 days. Morbidity was observed in a total of 4 patients (26.7%). According to the thoracic morbidity

**Table 2.** Surgery-related data

| Variables | n (%) | Mean±SD |
|---|---|---|
| Side | | |
| Right | 7 (46.6) | |
| Left | 7 (46.6) | |
| None | 1 (6.6) | |
| Approach | | |
| VATS | 6 (40.0) | |
| Thoracotomy | 8 (53.3) | |
| Sternotomy | 1 (6.6) | |
| Type of surgery | | |
| Lobectomy | 8 (53.3) | |
| Bilobectomy | 1 (6.6) | |
| Pneumonectomy | 1 (6.6) | |
| Wedge resection | 1 (6.6) | |
| Mediastinal mass excision | 3 (20.0) | |
| Decortication | 1 (6.6) | |
| Amount of drainage (mL) | | 481.81±315.65 |
| Drain withdrawal time (days) | | 4.90±2.88 |
| ICU stay (days) | | 0.93±1.03 |
| Repeated ICU admission | | |
| Respiratory arrest | 1 (6.6) | |
| Bronchopleural fistula | 1 (6.6) | |
| Discharge time (days) | | 6.20±3.42 |

VATS: Video-assisted thoracoscopic surgery; ICU: Intensive care unit; SD: Standard deviation.

**Table 3.** Postoperative morbidity and mortality

| Postoperative outcome | | n (%) |
|---|---|---|
| Morbidity | Pneumonia | 2 (13.3) |
| | Prolonged air leak | 1 (6.6) |
| | Bronchopleural fistula | 1 (6.6) |
| TM&M classification | I | 1 (6.6) |
| | II | 1 (6.6) |
| | IVa | 2 (13.3) |
| | V | 1 (6.6) |
| Mortality | Pneumonia | 1 (6.6) |

TM&M: Thoracic morbidity and mortality.

**Table 4.** Detailed evaluation of HD patients

| Patient | Comorbidities | Smoking pack-year | Surgery performed | Diagnosis | Morbidity | Mortality |
|---|---|---|---|---|---|---|
| 1 | Renal transplant | 0 | Mediastinal mass excision with VATS | Thymoma | – | – |
| 2 | None | 20 | Left lower lobectomy with VATS | Bronchiectasis | – | – |
| 3 | HT, DM, CAD, CABG, CVE | 50 | Bilobectomy superior to thoracotomy | Squamous cell carcinoma | – | – |
| 4 | HT, DM | 0 | Mediastinal mass excision with sternotomy | Thymoma | Pneumonia | – |
| 5 | HT, DM | 45 | Right upper lobectomy with VATS | Adenocarcinoma | – | – |
| 6 | Renal transplant | 25 | Right upper lobectomy with thoracotomy | Adenocarcinoma | – | – |
| 7 | HT | 50 | Right lower lobectomy with thoracotomy | Squamous cell carcinoma | – | – |
| 8 | COPD, CAD | 0 | Right decortication with VATS | Fibrous pleuritis | PAL | – |
| 9 | DM | 0 | Left lower lobectomy with thoracotomy | Adenocarcinoma | Pneumonia | + |
| 10 | CAD | 60 | Left wedge resection with thoracotomy | Adenocarcinoma | – | – |
| 11 | COPD | 70 | Left upper lobectomy with VATS | Squamous cell carcinoma | BPF | – |
| 12 | None | 0 | Left mediastinal mass excision with VATS | Squamous cell carcinoma metastasis (cervical) | – | – |
| 13 | HT, DM, CAD, CABG, OSAS | 80 | Left upper lobectomy with thoracotomy | Squamous cell carcinoma | – | – |
| 14 | HT, renal transplant | 35 | Left lower lobectomy with VATS | Squamous cell carcinoma | – | – |
| 15 | CAD, DVT | 40 | Left pneumonectomy with thoracotomy | Squamous cell carcinoma | – | – |

HD: Hemodialysis; HT: Hypertension; DM: Diabetes mellitus; CAD: Coronary artery disease; CABG: Coronary artery bypass graft; CVE: Cerebrovascular event; COPD: Chronic obstructive pulmonary disease; VATS: Video-assisted thoracoscopic surgery; PAL: Prolonged air leak; BPF: Bronchopleural fistula; OSAS: Obstructive sleep apnea syndrome; DVT: Deep vein thrombosis.

and mortality classification, the patients were mainly in the IVa group. Pneumonia-related mortality was detected in 1 patient (6.7%). The patients' postoperative morbidity and mortality data are presented in Table 3. The data of each patient are separately given in Table 4.

## DISCUSSION

The lifetime cancer incidence and requirement of an operation are higher in HD patients compared with other patients.[6,7] This is due to the weakening of their immune system and ineffective functioning of mechanisms to prevent tumor development and the complications of dialysis itself. In addition, postoperative morbidity and mortality rates are higher in patients undergoing thoracic surgery while under HD compared with the general population.[3,6,7] Considering the high morbidity and mortality rates of thoracic surgery, there is a need for maximum care and attention in selecting cases suitable for surgery among those receiving HD.

With the development of surgical techniques, modernization of anesthesia methods, and increased adoption of the minimally invasive approach, major thoracic surgery has become applicable in cases with high morbidity. Increasing life expectancy has necessitated thoracic surgery even in patients with cardiopulmonary diseases, which has led to an increase in postoperative morbidity in this population. This risk is similarly high in patients with renal pathologies.[3]

The number of individuals with renal pathologies is increasing globally day by day. The reason for this is the increase in HD facilities and hence the life expectancy in patients with CRF globally. With these developments, the mortality rate associated with cardiovascular events has decreased in HD patients, while there has been an increase in the death rate due to infection and malignancy.[8] According to the definition proposed by the US National Kidney Foundation in 2002, CRF includes all chronic renal damage or dysfunction, regardless of the primary disease. CRF is defined as a glomerular filtration rate of <60 mL/min/1.73 $m^2$ or deterioration in renal function for ≥3 months.[9]

Prolonged air leak, bronchopleural fistula, arrhythmia, and chylothorax are common complications seen in HD patients after thoracic surgery. However, the specific complications of thoracic surgery are not observed very frequently in these patients; instead, pneumonia, cerebral infarction, and cardiac complications are more frequent in this patient group.[3] Another case series reported that the most common complication after surgery in HD patients was pneumonia.[10–12] This may be due to the susceptibility of HD patients to infection as a result of the suppression of their immune system.[13] Another reason may be alveolar hypoventilation, which develops to maintain an average partial carbon dioxide level due to the diffusion of carbon dioxide into the dialysate fluid, causing the development of hypoxemia.[14] Furthermore, a double-lumen intubation tube is used during the operation in thoracic surgery, and single lung ventilation may deepen hypoxia by triggering shunt formation.[15] In the current study, the most common complication was pneumonia although the number of patients was limited.

It has been reported that the overall survival of patients with CRF who have undergone lung resection is poorer than those without CRF, regardless of the presence of HD. This result is probably due to the limited treatment possibilities for this patient group in the presence of recurrent disease, which results in settling for nonoptimal treatment options. Patients with CRF do not always have the chance to receive systemic treatment as required, and surgery is the most critical treatment step for this patient group. Because these patients tend to have poor respiratory capacity, selecting the patient for surgery is extremely important, and the surgeon should carefully maintain the balance of benefit and harm.[6]

A previous study reported that age, just by itself, was not a risk factor for the development of morbidity and mortality in patients with CRF. However, this risk increased in patients with more comorbidities. Regardless of age, the risk of morbidity and mortality was also higher in emergency operations than in elective procedures.[16] Another study stated that the postsurgical survival of diabetic patients with CRF was determined to be poorer than that of nondiabetic patients with CRF. It was emphasized that strict acid–base control was crucial in patients with CRF and chronic metabolic acidosis as postoperative metabolic acidosis will also need to be managed after lung resection.[17]

Even in healthy populations, acute kidney injury (AKI) can be seen after surgery. AKI refers to ischemic and inflammatory renal damage due to preoperative and intraoperative agents. It has been reported that AKI can significantly increase the length of hospital stay, treatment cost, and mortality.[18] More importantly, patients with AKI have poorer outcomes in the postoperative period than those without AKI, even if their renal function completely recovers.[19] In different studies, postoperative AKI has been reported to vary between 5.9% and 15.1% in thoracic surgery.[20,21] It has been stated that AKI is observed more frequently in older patients and is associated with a more extended hospital stay.[21] The use of synthetic colloid and volume expander fluids increases the risk of AKI; however, it has been suggested that this risk is lower in operations performed with VATS. It has also been emphasized that respiratory system complications are higher, and hospital stay is prolonged in patients who develop AKI in the early postoperative period than those without AKI.[20]

Although it is generally accepted that the female gender is an independent risk factor for AKI development in the postoperative period, there are also publications suggesting the opposite.[22,23] In a meta-analysis by Neugarten et al.,[23] the rate of AKI development following cardiothoracic surgery was statistically significantly lower in female patients than in male patients (odds ratio, 0.75; 95% confidence interval, 0.65–0.87; r=0.001). In light of this information, it should not be forgotten that an individual who

preoperatively has healthy renal function may develop renal failure in the postoperative period, or a patient with CRF who preoperatively does not receive HD may require HD. At the same time, intensive care requirements may arise in patients receiving HD. Considering that those receiving HD represent the most vulnerable patient group among these three groups, their careful management is vital in preoperative and postoperative periods.

Fluid management is an essential issue in thoracic surgery, and patients should be given neither too much nor too little fluid. The fluid requirement of each patient should be calculated individually. Too much fluid may cause respiratory problems and trigger the development of acute respiratory distress syndrome. Respiratory distress happens more frequently and is riskier in patients who have undergone a pneumonectomy. It is also more common in the right pneumonectomies than the left pneumonectomies.[24] On the contrary, the administration of insufficient fluid may lead to the development of AKI with hypovolemia and deterioration of tissue perfusion.[25]

Perioperative patient management is much more specific in patients with CRF receiving HD. In these patients, there is a need for multifaceted evaluation, including the selection of the appropriate patient-surgical approach, treatment of hypertension and heart failure, preoperative dialysis and evaluation of bleeding risk, treatment of hyperkalemia and hypercalcemia, management of renal anemia, control of blood sugar, fluid management and selection of fluid to be used, hemodynamic monitoring and evaluation, determination of transfusion risk, and selection of the anesthetic–analgesic drug to be used and its administration route.[26]

### Limitations

This is a retrospectively designed study showing the results of a single center. However, our institution has an attentive archive of patient medical records and is a referral center from many surrounding hospitals.

## CONCLUSION

Patients receiving HD due to CRF require exceptional follow-up in the perioperative period due to their weak immune systems, anemia, and hemodynamically unstable conditions. Therefore, it is essential to develop a specific multidisciplinary approach to prevent complications in these patients.

Morbidity and mortality associated with major thoracic surgery are higher in this patient group than in other patients. However, we consider that the morbidity and mortality rates of patients with CRF undergoing thoracic surgery while receiving HD can be reduced by ensuring the selection of appropriate cases for surgery, operations being performed in experienced centers, and rapid and controlled perioperative surgery and careful anesthesia management, and good postoperative care.

### Ethics Committee Approval

This study approved by the Kartal Dr. Lütfi Kırdar City Hospital Clinical Research Ethics Committee (Date: 29.12.2021, Decision No: 2021/514/216/22).

### Informed Consent

Retrospective study.

### Peer-review

Internally peer-reviewed.

### Authorship Contributions

Concept: T.D.; Design: T.D.; Supervision: R.D.; Materials: B.Ç., M.B., A.Ö.; Data: S.K.; Analysis: F.D.G.; Literature search: T.D.; Writing: T.D.; Critical revision: T.D.

### Conflict of Interest

None declared.

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## Son Dönem Böbrek Yetersizliğinde Majör Toraks Cerrahisi Uygulamalarımız: 16 Olgunun Analizi

**Amaç:** Toraks cerrahisi morbiditesi ve mortalitesi nispeten yüksek olan bir cerrahidir. Bununla birlikte hemodiyalize (HD) giren hastaların riski normal popülasyona göre daha fazla olduğu için, cerrahi büyük bir özen gerektirir. Çalışmamızda kliniğimizde kronik renal yetersizlik (KBY) hastası olup HD'ye giren hastalarda yapılan majör toraks cerrahisinin sonuçlarını literatür bilgileri ışığında irdeledik.

**Gereç ve Yöntem:** Kliniğimizde Aralık 2015–Ekim 2021 tarihleri arasında majör toraks cerrahisi uygulanan ve HD'ye giren hastalar çalışmaya alındı. Hastalar solunum fonksiyon değerleri, sigara içimi, serum üre-kreatin değerleri, ek komorbiditeler, ejeksiyon fraksiyonu, cerrahi tipi, drenaj miktarı, taburculuk süresi, yoğun bakım ihtiyacı, histopatolojik tanı, morbidite ve mortalite kriterleri bakımından analiz edildi.

**Bulgular:** HD'ye giren 15 hastaya majör toraks cerrahisi uygulandı. Hastaların 12'si erkek ve üçü kadındı. Yaş ortalaması 61.2±15.8 idi. Altı hasta video-yardımlı torakoskopik cerrahi yöntemle, sekiz hasta torakotomiyle opere edilirken, bir hastaya sternotomi yapıldı. En sık yapılan cerrahi girişim lobektomiydi. Ortalama yoğun bakım ünitesinde kalış süresi 0.9 gündü. Ameliyat sonrası morbidite dört hastada izlendi (%26.6). Bir hastada ise pnömoni nedeniyle mortalite gerçekleşti (%6.6).

**Sonuç:** Dünyada her geçen yıl HD gerektiren hasta sayısı artmaktadır. Bunun sonucunda akciğer kanserli veya başka sebeplerden dolayı majör toraks cerrahisi gerektiren HD hastaları da sürekli artış göstermektedir. Bu nedenle, detaylı bir risk değerlendirmesi sonrası, multidisipliner perioperatif yönetimle hastaların deneyimli merkezlerde opere edilmesi gerektiği kanaatindeyiz.

**Anahtar Sözcükler:** Akciğer kanseri; hemodiyaliz; kronik böbrek yetersizliği; majör toraks cerrahisi; torakotomi; video-yardımlı torakoskopik cerrahi.