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ORIGINAL ARTICLE

Life-threatening complications after pulmonary resection for lung cancer in patients on chronic hemodialysis

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Abstract

Purpose The morbidity and mortality associated with lung cancer surgery in patients on chronic hemodialysis (CHD) is high; however, the relationship between the severity of postoperative complications and clinicopathological features is unclear.

Methods Among 1214 consecutive patients who underwent pulmonary resection for primary lung cancer in our institute between 2004 and 2015, we identified 21 patients on CHD, who were the subjects of this study. Life-threatening postoperative complications were defined as grade 4 and 5 per the Clavien–Dindo classification.

Results Fourteen (67%) of these 21 patients suffered postoperative complications, which were life threatening in 5. There was a higher frequency of interstitial pneumonia (IP) in the patients with life-threatening postoperative complications than in those with complications that were not life threatening ($p = 0.032$). The rates of acute exacerbation and 90-day mortality in the patients with IP were 50% and 75%, respectively. The overall survival (OS) rate of the patients with life-threatening postoperative complications was significantly lower than that of those with complications that were not life threatening (1- and 3-year OS rates: 40% and 0% vs. 80% and 57%, respectively, $p = 0.001$).

Conclusions Postoperative mortality and morbidity were high in patients on CHD who underwent pulmonary resection, especially if they had coexisting IP. Although IP is not a contraindication to pulmonary resection, the surgical strategy for CHD patients with IP should be considered carefully.

Keywords Lung cancer · Chronic hemodialysis · Interstitial pneumonia

Introduction

Malignant tumors develop more frequently in patients on chronic hemodialysis (CHD) than in the general population [1, 2]. These patients have an increased risk of cancer for several reasons, including age, chronic infection of the urinary tract, immunosuppressive drug use, and nutritional and systemic deficiencies [2]. An international collaborative study of patients on CHD found that the relative risks of cancer are increased in the urinary tract and endocrine organs, but not in the lung, colorectum, breast, or stomach [2]. However, the number of Japanese patients on CHD has increased each year and was recorded as 3.2 million in 2016, according to the Japanese Society for Dialysis Therapy (JSDT) [3]. Many CHD patients with lung cancer require pulmonary resection.

In patients on CHD, the cardiopulmonary function changes dynamically following pulmonary resection and the rate of postoperative complications is high [4, 5]. Although a few reports have described the clinical outcomes of patients with lung cancer on CHD [4–8], the relationship between the severity of postoperative complications and clinicopathological features remains unclear. We evaluated, retrospectively, the clinicopathological features, including perioperative CHD status, postoperative complications, and prognosis, of patients with primary lung cancer on CHD to identify the factors predictive of postoperative complications in these patients.

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Materials and methods

Patients

A total of 1214 consecutive patients with lung cancer underwent pulmonary resection at the Division of Thoracic Surgery in the Department of Surgery at Kindai University Faculty of Medicine, between January 2004 and December 2015. The subjects of this study were 21 of these patients, who were on CHD. Patients on hemodialysis for postoperative acute renal failure were excluded from the analysis. The medical records of all 21 patients were reviewed to extract data regarding their clinicopathological features, including perioperative CHD status, 90-day postoperative complications, and prognosis. We evaluated comorbidity using the American Society of Anesthesiologists score [9] and the Charlson Comorbidity Index (CCI) [10]. Perioperative CHD status was defined as follows: a 5% or more increase in dry weight, 4 h or more of CHD, and hypotension (100 mmHg or less). Life-threatening complications were defined as grades 4 and 5 according to the Clavien–Dindo classification [11].

The cohort comprised 19 men and 2 women, with a median age of 72 years (range 65–83 years). Seven patients had a history of smoking. The underlying renal diseases included diabetic nephropathy in 11 patients, glomerulonephritis in 2, hypertensive nephropathy in 1, nephrotic syndrome in 1, polycystic kidney disease in 1, and unknown in 4. The median duration of CHD before surgery was 4 years (range 0.4–13 years). The surgical procedures performed were lobectomy in 18 patients and limited resections, which consisted of either segmentectomy or wedge resection, in 3. The tumors included 13 adenocarcinomas, 7 squamous cell carcinomas, and 1 small cell carcinoma. Based on the definitions provided in the seventh edition of the TNM classification for lung cancer [12], 18 patients had pathological-stage (p-stage) I disease, 2 had p-stage II disease, and 1 had p-stage III disease (Tables 1, 2).

Patients underwent CHD on the days before and after surgery and were managed in the intensive care unit until the day after surgery. Subsequently, CHD was managed according to the normal schedule. Perioperative fluid balance was controlled based on continuous monitoring of the peripheral artery pressure until the postoperative restart of CHD. Unfractionated heparin is given routinely for anticoagulation when CHD is performed; however, nafamostat mesilate was given instead to prevent postoperative bleeding complications. Nafamostat mesylate is an ultra-short-acting multienzymatic inhibitor that prolongs clotting times only in the extracorporeal circuit.

All patients were followed up routinely at 3- to 6-month intervals for 5 years, by a physical examination, either chest radiography or CT, brain magnetic resonance imaging (MRI), and an analysis of tumor markers. When recurrence was suspected, either bone scintigraphy or 18F-fluorodeoxyglucose-positron emission tomography was performed as needed. This study was reviewed and approved by the Ethics Committee of the Faculty of Medicine at Kindai University (29–118). Because many patients had already died or were lost to follow-up, we posted information regarding this research plan on our website (http://www.kindai-geka.jp/biomarker/2018/02/post-19.html) for those from whom informed consent could not be obtained. We also provided an opportunity for individuals to request exclusion of their data from the analyses through the website according to recommendations made by our institutional review board.

Radiographic classification in patients on CHD harboring interstitial pneumonia

The radiologic findings on chest CT were classified into two groups: a usual interstitial pneumonia (UIP) pattern group and a non-UIP pattern group, according to the American Thoracic Society in 2011 [13]. The former group had basal-predominant and subpleural honeycomb lesions, which were multiple equal-sized cystic lesions with a thick wall. The latter group had basal-predominant ground glass opacities and infiltrative shadows, inconsistent with UIP patterns.

Clinical data of patients on CHD in Japan and relative overall survival

The latest clinical data of patients on CHD in Japan were obtained from the website of the JSDT and were based on data from 2015 [3]. The interpretation and reporting of these data were the responsibility of the authors and should in no way be considered an official policy or interpretation of the JSDT. The natural overall survival (OS) rates of patients after the induction of CHD in 2010 were 88%, 80%, 73%, 67%, and 61% at 1, 2, 3, 4, and 5 years, respectively.

When a comorbidity had a prognostic impact, the relative OS rate was used to evaluate the natural risk of death linked to the comorbidity. The relative OS rate was calculated as follows: the actual OS rate of the cohort divided by the natural OS rate of patients with that comorbidity.

Statistical analysis

The Chi square test or Fisher's exact test were used to compare values expressed as percentages among the groups. The means of clinical data in the two groups were compared using Student's *t* test. Kaplan–Meier curves were used to estimate the survival rate, and the log-rank test was used to evaluate differences between the groups. A two-sided value

Table 1 Clinicopathological characteristics of the chronic hemodialysis patients with life-threatening postoperative complications after lung cancer resection

Characteristics	All patients ($n=21$)	With life-threatening complications ($n=5$)	Without life-threatening complications ($n=16$)	p
Age (median)				
Median (range)	72 (64–83)	71 (65–75)	72.5 (64–83)	0.609
Gender				
Male/female	19/2	5/0	14/2	> 0.999
Smoking status				
Never/ever	14/7	3/2	11/5	> 0.999
ASA score				
1/2/3/4	0/3/18/0	0/0/5/0	0/2/13/0	0.548
Charlson Risk Index				
≥ 4/4 >	14/7	4/1	10/6	0.048
CEA (ng/ml)				
≥ 5/5>	10/11	3/2	7/9	0.635
WBC (× 1000/μl)				
Median (range)	6.3 (3.9–12.4)	6.7 (6.0-10.1)	5.8 (3.9–12.4)	0.240
Ht (%)				
Median (range)	34.7 (25.3–40.7)	34.7 (25.3–36.8)	35.0 (28.8–40.7)	0.267
BUN (mg/dl)				
Median (range)	46 (30–90)	36 (30–49)	47 (31–90)	0.067
Cre (mg/dl)				
Median (range)	7.3 (3.9–13.8)	7.7 (5.1–7.8)	7.2 (3.9–13.8)	0.177
K (mEq/L)				
Median (range)	4.6 (2.9–5.4)	4.9 (3.7–5.4)	4.5 (2.9–5.4)	0.636
TP (g/dl)				
Median (range)	6.9 (6.1–8.5)	7.4 (6.4–7.7)	6.8 (6.1–8.5)	0.708
pH				
Median (range)	7.36 (7.31–7.50)	7.35 (7.31–7.50)	7.38 (7.34–7.48)	0.829
pCO_2 (mmHg)				
Median (range)	39.9 (33.6–49.1)	39.9 (33.6–43.1)	40.3 (34.2–49.1)	0.512
pO_2 (mmHg)				
Median (range)	87.6 (70.9–98.4)	83.8 (78.7–98.4)	88.7 (70.9–97.2)	0.977
%VC (%)				
≥ 80/80>	13/8	2/3	11/5	0.325
FEV1.0% (%)				
≥ 70/70>	16/5	4/1	12/4	> 0.999
IP on chet CT				
Yes/no	4/17	3/2	1/15	0.032
p-Stage				
I/II–III	18/3	4/1	14/2	> 0.999
Histopathology				
AD/other	13/8	2/3	11/5	0.325
Perioperative status				
Surgical procedure				
Standard/limited	18/3	5/0	13/3	0.548
Operation time (min)				
Median (range)	198	194	199	0.811
Intraoperative bleeding (ml)				
Median (range)	114	100	132	0.334
Blood transfusion				
Yes/no	3/18	1/4	2/14	> 0.999

Table 1 (continued)

Characteristics	All patients ($n=21$)	With life-threatening complications ($n=5$)	Without life-threatening complications ($n=16$)	p
Transfusion (ml/h/kg)				
≥1.0/1.0>	4/17	0/5	4/12	0.532
Perioperative CHD status				
Reason for CHD				
DM/other	11/10	3/2	8/8	>0.999
Duration of CHD (years)				
Median (range)	4.0 (0.4–13.0)	5.1 (0.9–8.9)	3.4 (0.4–13.0)	0.932
Anticoagulation				
Heparin/not	6/15	1/4	5/11	>0.999
BW gain (>5% of DW)				
Yes/no	2/19	1/4	1/15	0.428
Hypotension (<100 mmHg)				
Yes/no	9/12	2/3	7/9	>0.999
Prolonged time of CHD (>4 h)				
Yes/no	14/7	4/1	10/6	0.624

of $p<0.05$ was regarded as significant. Statistical calculations were performed using the statistical software package StatView (version 5.0; SAS Institute Inc., NC, USA).

Results

Clinicopathological characteristics of patients with life-threatening postoperative complications

Fourteen (67%) of the 21 CHD patients who underwent lung cancer on CHD had 90-day postoperative complications, which were life threatening in 5 (Tables 1, 2). Table 1 summarizes the clinicopathological features of the patients with life-threatening postoperative complications. The incidences of CCI scores higher than 4 points and interstitial pneumonia (IP) were much greater in the patients with, than in those without, life-threatening complications (80% vs 63%, $p=0.048$ and 60% vs 6%, $p=0.032$, respectively). No significant differences in other clinicopathological features, such as postoperative infusion, cause of CHD, preoperative CHD period, and perioperative CHD status, were found between the two groups.

Postoperative complications in CHD patients with resected lung cancer

Three of the five patients with life-threatening postoperative complications died without recovering from their complications (Table 2, patients 1–3). Two of these patients suffered acute exacerbation (AE) of IP, and one suffered a traumatic subarachnoid hemorrhage (SAH) after discharge, which was probably not related to the surgery. The AE and mortality rates in the CHD patients with IP were 50% (2/4) and 75% (3/4), respectively (Table 2). The IP showed a UIP pattern in one of the four patients (Table 2, patient 1) and a non-UIP pattern in the other three (Table 2, patients 2, 3 and 10). Unfractionated heparin and nafamostat mesilate were given to 6 and 15 patients, respectively, for postoperative anticoagulation. Two patients with bleeding complications (patients 3 and 7) received nafamostat mesilate for postoperative anticoagulation; however, 1 (patient 3), who was being treated as an outpatient, received unfractionated heparin at the time of injury. Postoperative hyperkalaemia was diagnosed in only two patients and treated with emergency hemodialysis (Table 2, patients 8 and 9).

Survival analysis of the CHD patients with resected lung cancer

The median follow-up period after surgery was approximately 4.0 years (range 81–3554 days). The 30- and 90-day mortality rates were 4% (1/21) and 14% (3/21), respectively (Table 2). The 1-, 2-, 3-, 4- and 5-year actual OS rates were 71%, 52%, 42%, 34% and 26%, respectively, for all 21 patients on CHD (Fig. 1a). The actual OS rate of patients with life-threatening postoperative complications was significantly worse than that of the patients without life-threatening postoperative complications (log-rank test, $p=0.001$; Fig. 1b).

Discussion

We analyzed retrospectively the clinicopathological characteristics of 21 patients on CHD who underwent resection of primary lung cancer. Fourteen (67%) patients suffered

Table 2 Clinical outcomes of the 21 patients on chronic hemodialysis who underwent lung cancer resection

No.	Age/sex	His.	p-stage	Cause of CHD	CRI	IP	Anticoag.	Life-threatening complications	Non-life-threatening complications	Overall survival (day)	Cause of death
1	68M	SQ	IB	DN	5	+	NM	AE of IP	–	28†	AE of IP
2	75M	SQ	IB	PCK	2	+	NM	AE of IP	–	48†	AE of IP
3	71M	AD	IB	HN	5	+	NM	SAH*, pneumonia	Delirium	38†	SAH, pneumonia
4	65M	AD	IIIA	DN	4	–	NM	AE of CHF	–	399†	AE of CHF
5	75M	SQ	IA	DN	5	–	NM	CI, pneumonia	–	768†	–
6	83M	SQ	IIA	DN	4	–	UH	–	Acute cholecystitis	81	–
7	67M	AD	IA	DN	6	–	NM	–	Intrathoracic bleeding	3033	–
8	74M	AD	IB	GN	7	–	UH	–	Hyperkalemia**, delirium	645	–
9	65M	AD	IB	–	4	–	NM	–	Hyperkalemia**	178†	Lung metastasis
10	78M	SQ	IB	DN	7	+	NM	–	AE of ASO	478†	–
11	73M	AD	IA	NS	3	–	NM	–	Hypotension, sputum retention	325†	Colon cancer
12	68M	SQ	IB	DN	4	–	NM	–	Hypotension	2255†	–
13	67M	AD	IB	DN	4	–	NM	–	Sputum retention	832†	Lung metastasis
14	64M	AD	IA	–	2	–	NM	–	Prolonged air leakage (> 7 day)	3554†	–
15	81M	AD	IIB	HN	2	–	UH	–	–	225†	AHF
16	73F	AD	IA	DN	4	–	NM	–	–	554†	–
17	75M	AD	IB	–	3	–	NM	–	–	1211†	Lung metastasis
18	68M	SM	IA	DN	5	–	NM	–	–	1660†	–
19	78M	SQ	IB	–	3	–	NM	–	–	554	–
20	70F	AD	IA	GN	2	–	UH	–	–	743	–
21	72M	AD	IA	DN	5	–	UH	–	–	1287	–

His histology, *p-stage* pathological stage, *CRI* Charlson Comorbidity Index, *Anti-coag*. postoperative anticoagulation, *CHD* chronic hemodialysis, *SQ* squamous cell carcinoma, *AD* adenocarcinoma, *SM* small cell carcinoma, *DM* diabetes nephropathy, *PCK* polycystic kidney, *HN* hypertensive nephropathy, *GN* glomerulonephritis, *NS* nephrotic syndrome, *CRI* Charlson Risk Index, *NM* nafamostat mesilate, *UH* unfractionated heparin, *SAH* subarachnoid hemorrhage, *CHF* chronic heart failure, *AHF* acute heart failure, *CI* cerebral infarction, *AE* acute exacerbation, *IP* interstitial pneumonia, *ASO* arteriosclerosis obliterans

*Traumatic SAH after discharge, **hyperkalemia requiring emergency hemodialysis, †dead

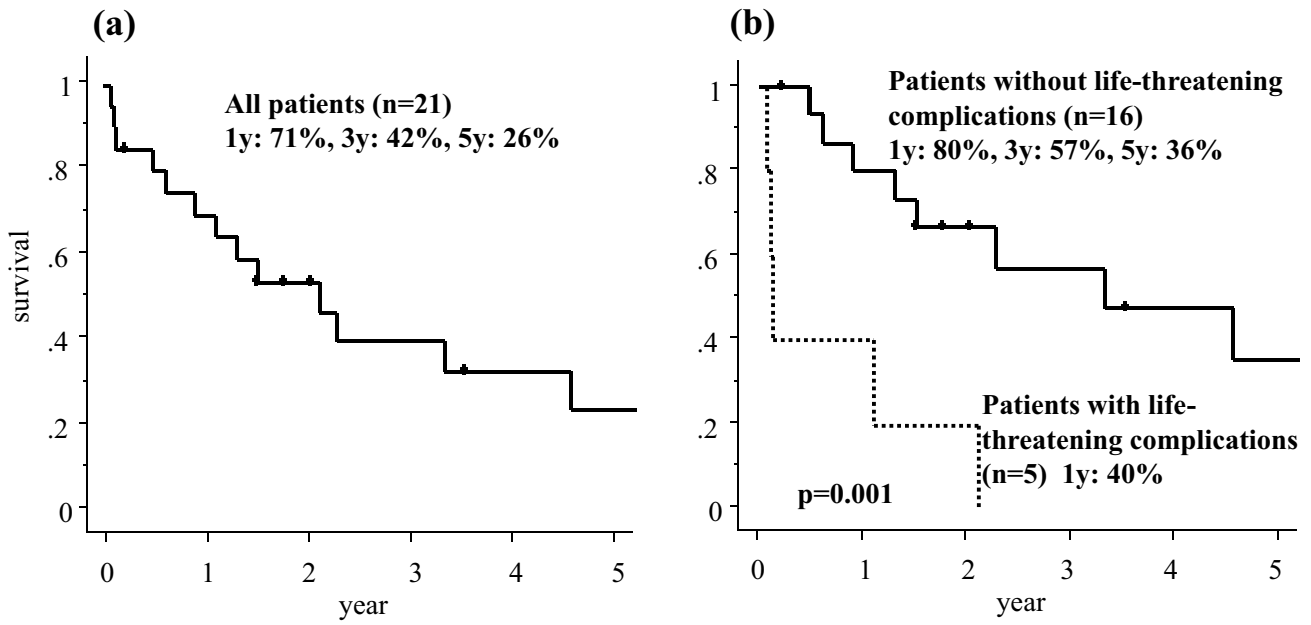

Fig. 1 Overall survival curves for patients on chronic hemodialysis who underwent lung cancer resection. **a** The 5-year actual overall survival (OS) rate of all patients was 26%. **b** The prognosis of patients with life-threatening postoperative complications was poorer than that of patients without life-threatening complications (1-year actual OS rate: 40% vs 80%, $p = 0.001$)

90-day postoperative complications. Previously reported morbidity rates range from 27 to 100% [4–8, 14], with most studies reporting an incidence of 40–70% [4, 6, 8, 14], consistent with our findings (Table 3). In this study, life-threatening postoperative complications were defined as grade 4 or 5 based on the Clavien–Dindo classification, and 5 of the 21 patients had life-threatening postoperative complications (24%). Takahama et al. reported postoperative complications in 13 of 24 patients on CHD (54%, Table 3), which were documented as "life-threatening heart failure" in 2 patients with poor pulmonary function, although the definition of "life-threatening" was not clear [4]. They also reported the importance of the strict management of perioperative fluid balance using a central venous catheter. In our cohort, only one of the five patients with life-threatening postoperative complications had postoperative heart failure (Table 2, patient 5). Managing the perioperative fluid balance for this patient did not involve a central venous catheter, and he was discharged without complications 1 week after surgery. Although he was hospitalized again with heart failure 35 days after surgery, he was discharged after it improved with intensive care.

Nafamostat mesilate is generally used instead of unfractionated heparin to prevent postoperative bleeding complications in CHD patients undergoing lung cancer surgery. In our cohort, two patients suffered postoperative bleeding complications (Table 2; patients 3 and 7), and were given nafamostat mesilate for postoperative anticoagulation. However, one patient (patient 3) received unfractionated heparin when traumatic SAH occurred after discharge. According to

Table 3 Summary of reports on chronic hemodialysis patients who underwent lung cancer resection

Authors	Years	Number of patients	Morbidity		30-day mortality		90-day mortality		5-year actual OS rate
Present report	–	21	13	62%	1	5%	3	14%	26%
Tsuchida et al. [5]	2001	7	7	100%	1	14%	2	28%	–
Ciriaco et al. [6]	2005	6	4	67%	0		0		–
Obuchi et al. [7]	2009	11	3	27%	0		0		28%
Takahama et al. [4]	2010	24	13	59%	0		0		43%
Matsuoka et al. [13]	2013	5	2	40%	0		0		–
Park et al. [8]	2015	7	3	43%	0		1	14%	43%

IP interstitial pneumonia, *OS* overall survival

the details of postoperative anticoagulation therapy in our series and previous reports [4–6, 14], 7 of a total 65 patients on CHD were given unfractionated heparin without suffering postoperative bleeding complications. Meanwhile, although 58 of the 65 patients received nafamostat mesilate, 4 suffered postoperative bleeding complications. Two patients were from our cohort (Table 1; patients 3 and 7) and the other two were described in previous reports [4, 5]. One patient suffered cerebral bleeding 2 months after surgery [5] and another patient suffered vitreous hemorrhage with an unclear onset [4]. Nafamostat mesilate is popularly used after surgery for patients on CHD; however, unfractionated heparin might be sufficient.

The 90-day mortality rate in our cohort was 14% (3/21). Previous 90-day mortality rates range widely, from 0% [4, 6, 7, 14] to 14% (1/7) [5] or 28% (2/7) [8]. These 90-day mortality rates are higher than the 90-day mortality rate of 0.7% documented in the Japanese registry [15]. The 5-year actual OS rate of all patients and patients without life-threatening postoperative complications in our cohort were 26% and 36%, respectively (Fig. 1a, b). These findings are similar to those of previous reports (5-year actual OS rates 28–43%) [4, 7, 8]. However, CHD itself has a prognostic impact, and it is necessary to consider the natural risk of death linked to CHD. We calculated the relative OS rates of patients on CHD, as described in "Methods". The 5-year relative OS rates of all patients and the patients without postoperative life-threatening complications were 43% and 59%, respectively. Although patients on CHD had a poor prognosis, pulmonary resection was not contraindicated.

Four of the 21 patients in this series had IP, which was significantly associated with life-threatening postoperative complications (Table 1; $p = 0.032$). Two of these patients died of AE of their IP (Table 1; patients 1 and 2). None of the previously reported 60 CHD patients with resected lung cancer had IP [4–8, 14]. Sato et al. [16] reported AE in 164 of 1763 Japanese patients (9.3%) with non-small cell lung cancer who had undergone pulmonary resection, but patients on CHD were not included in the study. Although the number of CHD patients with IP in our cohort was small, their risk of AE might be higher than that of patients not on CHD. Fairshter et al. described the lung pathology of 46 patients on CHD to clarify the incidence of lung disease. Chronic lung diseases were detected in 37 of these 46 patients on CHD (80.4%), and the most common pathology was interstitial fibrosis (21/46, 45.7%) [17]. Although the relationship between AE of IP and CHD is unknown, the surgical indications for patients with lung cancer harboring IP should be considered carefully.

In conclusion, postoperative mortality and morbidity rates were high in patients on CHD who underwent pulmonary resection, especially when they had coexisting IP. Although IP is not a contraindication to pulmonary resection, the surgical strategy for patients on CHD should be considered carefully.

Compliance with ethical standards

Conflict of interest We have no conflicts of interest to declare.

References

1. Butler AM, Olshan AF, Kshirsagar AV, Edwards JK, Nielsen ME, Wheeler SB, et al. Cancer incidence among US Medicare ESRD patients receiving hemodialysis, 1996–2009. Am J Kidney Dis. 2015;65:763–72. https://doi.org/10.1053/j.ajkd.2014.12.013.
2. Maisonneuve P, Agodoa L, Gellert R, Stewart JH, Buccianti G, Lowenfels AB, et al. Cancer in patients on dialysis for end-stage renal disease: an international collaborative study. Lancet. 1999;354:93–9. https://doi.org/10.1016/S0140-6736(99)06154-1.
3. Masakane I, Taniguchi M, Nakai S, Tsuchida K, Goto S, Wada A, et al. Annual dialysis data report 2015, JSDT renal data registry. Ren Replace Ther. 2018;4:19. https://doi.org/10.1186/s41100-018-0149-82018.
4. Takahama M, Yamamoto R, Nakajima R, Tsukioka T, Tada H. Pulmonary resection for lung cancer patients on chronic hemodialysis: clinical outcome and long-term results after operation. Interact Cardiovasc Thorac Surg. 2010;11:150–3. https://doi.org/10.1510/icvts.2009.230003.
5. Tsuchida M, Yamato Y, Aoki T, Watanabe T, Hashimoto T, Shinohara H, et al. Complications associated with pulmonary resection in lung cancer patients on dialysis. Ann Thorac Surg. 2001;71:435–8. https://doi.org/10.1016/S0003-4975(00)02226-8.
6. Ciriaco P, Casiraghi M, Melloni G, Carretta A, Libretti L, Augello G, et al. Pulmonary resection for non-small-cell lung cancer in patients on hemodialysis: clinical outcome and long-term results. World J Surg. 2005;29:1516–9. https://doi.org/10.1007/s00268-005-0047-4.
7. Obuchi T, Hamanaka W, Yoshida Y, Yanagisawa J, Hamatake D, Shiraishi T, et al. Clinical outcome after pulmonary resection for lung cancer patients on hemodialysis. Ann Thorac Surg. 2009;88:1745–8. https://doi.org/10.1016/j.athoracsur.2009.08.010.
8. Park JY, Kim MH, Han SS, Cho H, Kim H, Ryu DR, et al. Recalibration and validation of the Charlson comorbidity index in Korean incident hemodialysis patients. PLoS One. 2015;10:e0127240. https://doi.org/10.1371/journal.pone.0127240.
9. Daabiss M. American Society of Anaesthesiologists physical status classification. Indian J Anaesth. 2011;55:111–5. https://doi.org/10.4103/0019-5049.79879.
10. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40:373–83. https://doi.org/10.1016/0021-9681(87)90171-8.
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205–13. https://doi.org/10.1097/01.sla.0000133083.54934.ae.
12. Rusch VW, Asamura H, Watanabe H, Giroux DJ, Rami-Porta R, Goldstraw P, et al. The IASLC lung cancer staging project: a proposal for a new international lymph node map in the forthcoming seventh edition of the TNM classification for lung cancer. J Thorac Oncol. 2009;4:568–77. https://doi.org/10.1097/JTO.0b013e3181a0d82e.

13. Raghu G, Collard HR, Egan JJ, Martinez FJ, Behr J, Brown KK, et al. An official ATS/ERS/JRS/ALAT statement: idiopathic pulmonary fibrosis: evidence-based guidelines for diagnosis and management. Am J Respir Crit Care Med. 2011;183:788–824. https://doi.org/10.1164/rccm.2009-040GL.
14. Matsuoka K, Kuroda A, Kang A, Imanishi N, Nagai S, Ueda M, et al. Video-assisted thoracoscopic surgery for lung cancer in patients on hemodialysis. Ann Thorac Cardiovasc Surg. 2013;19:263-7. https://doi.org/10.5761/atcs.oa.12.01973.
15. Tomizawa K, Usami N, Fukumoto K, Sakakura N, Fukui T, Ito S, et al. Risk assessment of perioperative mortality after pulmonary resection in patients with primary lung cancer: the 30- or 90-day mortality. General Thorac Cardiovasc Surg. 2014;62:308–13. https://doi.org/10.1007/s11748-014-0375-0.
16. Sato T, Teramukai S, Kondo H, Watanabe A, Ebina M, Kishi K,et al. Impact and predictors of acute exacerbation of interstitial lung diseases after pulmonary resection for lung cancer. J Thorac Cardiovasc Surg. 2014;147:1604–11. https://doi.org/10.1016/j.jtcvs.2013.09.
17. Fairshter RD, Vaziri ND, Mirahmadi MK. Lung pathology in chronic hemodialysis patients. Int J Artif Organs. 1982;5:97–100.