

## Perioperative Complications in Patients with End-Stage Renal Disease Undergoing Pulmonary Resection

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### Abstract

**Introduction:** Among the perioperative complications encountered in patients with renal failure, there is a high risk of events such as heart failure and increased susceptibility to infection. Herein, we report the results of our investigation of perioperative management in patients with chronic renal failure who underwent a pulmonary resection.

**Methods:** The subjects were 21 hemodialysis patients with renal failure who underwent pulmonary resection for lung cancer. We retrospectively investigated their clinical characteristics and perioperative management. The patients were classified into two groups; those with and without symptoms of postoperative acute heart failure. Intergroup comparisons of preoperative examinations and management were performed.

**Results:** The most common preoperative comorbidity was cardiac complications, which occurred at a high incidence of 38%. There were no serious perioperative complications. In contrast, postoperative complications associated with renal failure were numerous, including acute heart failure in 3 (14%) and hyperkalemia in 2 (9.5%). We concluded that preoperative respiratory function, intraoperative fluid infusion volume, and preoperative cardiac comorbidities are potential risk factors for postoperative heart failure in such patients.

**Conclusion:** Although there were no cases with perioperative mortality, postoperative complications were encountered, including heart failure and hyperkalemia, suggesting that more stringent cardiovascular and respiratory management techniques are necessary.

**Keywords:** Pulmonary resection; Renal failure; Dialysis; Complications; Acute heart failure

### Introduction

The number of patients who receive maintenance hemodialysis due to chronic renal failure is steadily increasing. However, there is an elevated risk of perioperative complications in patients with renal failure, such as heart failure and increased susceptibility to infection. Especially in those who undergo pulmonary resection surgery, acute postoperative heart failure is a key concern, due to the abrupt decrease in total pulmonary vascular cross-sectional area, increased pulmonary vascular resistance, and enhanced pulmonary vascular permeability [1]. We investigated perioperative management methods used and the incidence of complications in hemodialysis patients with chronic renal failure who underwent a pulmonary resection procedure at our hospital. Based on our findings, we also point out potential problems encountered when performing perioperative management in regard to safe pulmonary resection procedures in the increasing number of hemodialysis patients and discuss various solutions.

### Subjects and Methods

The subjects were 21 patients with renal failure and receiving maintenance hemodialysis who underwent pulmonary resection surgery for lung cancer at our hospital between 1995 and 2007. Following approval from the institutional review board, we performed a retrospective investigation of the clinical characteristics and perioperative anesthetic procedure methods used, as well as complications in those patients.

Postoperative complications were defined as follows: 1) heart failure diagnosed via echocardiography by a cardiovascular specialist (inferior vena cava dilation >23mm, respiratory change <40%) and characterized by findings of pulmonary congestion on chest radiography, which required catecholamine treatment for decreased blood pressure (systolic blood pressure <80mmHg) within 3 days after surgery; 2) pneumonia

shown by a white cell count of 12 000 mm<sup>-3</sup> or greater, a fever of 38 degrees or greater and findings of decreased permeability in both lung fields by chest radiography, with diagnosis made by a radiologist who specializes in respiratory disease within 1 week after surgery; and 3) the presence of hyperkalemia, as indicated by a potassium level of 6.5 mEq L<sup>-1</sup> or greater in blood tests on the day of surgery.

Patients were classified into two groups, those with (Group H) and without (Group N) symptoms of postoperative acute heart failure. Intergroup comparisons were retrospectively performed in regard to the preoperative examinations and case management.

Statistical analysis was conducted using Student's *t*-test or a chi-square test, with differences of *p*<0.05 regarded as statistically significant.

### Results

Preoperative clinical data are summarized in (Table 1). There were 17 men and 4 women, with a mean (+SD) age of 66±8.6 years (range, 55 to 83 years). The indications for hemodialysis were diabetes mellitus in 10 patients, chronic nephropathy in 6, post-nephrectomy in 1, chronic heart failure in 1, hypertensive nephropathy in 1, renal hemorrhage in 1, and unknown in 1. The mean period of hemodialysis before surgery was

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Patient	Gender / Age	Body weight (kg)	Renal Disease	Duration Of Dialysis (year)	Hematocrit (%)	TP (g/dL)	VC %VC	FEV <sub>1</sub> %FEV <sub>1</sub>	Complications
1	M/61	58	CGN	13	25.5	6.1	92.2	74.8	HT
2	F/70	65	DM	1	32.3	7.5	73.3	81.8	HT, DM
3	M/55	55	DM	4	37.8	7.3	90.9	81.4	CI, DM
4	M/65	60	DM	Unknown	25.8	6.9	95.6	78.2	HT, DM
5	M/69	67	Unknown	Unknown	29.1	6.5	81.7	72.3	HT, AP, DM
6	M/71	80	HT	7	28.9	6.5	76.5	83.6	HT, TIA
7	M/70	67	DM	3	33.9	7.7	70.3	83.3	HT, AP
8	F/65	63	DM	6	31.1	6.2	102	79	HT
9	M/70	65	DM	2	34	6.8	108	73	HT, AP
10	M/46	64	DM	11	32.1	6.9	89.2	84.4	HT, DCM, DM
11	M/78	62	DM	2	24.6	7.3	79	67	HT
12	F/60	49	Renal bleeding	23	30.3	6.2	107	85.2	DM
13	M/63	56	DM	1	28.8	6.7	82	66.3	AP, DM
14	M/62	59	CGN	1	38.3	6.2	91	106.1	ICH, DM
15	M/75	63	CGN	5	43.5	7.8	81	69	Asthma, DM
16	M/55	67	DM	3	32.9	7.2	83.4	76.7	None
17	M/75	55	CGN	10	30.9	6.5	78	87	AP, DM
18	M/67	45	CGN	6	31.5	6.6	74.2	69	HT, AP
19	M/66	45	CHF	1	28.8	6.6	67.8	90	AMI, DM
20	F/57	60	CGN	36	25.8	6.4	117	77.7	HT
21	M/83	45	postnephrectomy	19	38.9	6.3	77.1	37.3	HT
Mean ± standard deviation	65.9 ±8.63	59.6 ±8.66		8.11 ±9.19	31.66 ±4.883	6.77 ±0.551	86.5 ±13.3	77.2 ±12.9	

FEV1=forced expiratory volume in 1 second; TP=total protein; VC=vital capacity.  
 CGN=Chronic glomerulonephritis, DM=Diabetes mellitus, HT=Hypertension, CHF=Chronic heart failure  
 CI=Cerebral Ischemia, AP=Angina pectoris, DCM= Dilated cardiomyopathy, ICH=Intracranial hemorrhage, AMI=Acute myocardial infarction

Table 1: Profile of the patients

Patient	Anesthesia method	Procedure (node dissection)	Operative/ Anesthesia (minutes)	Total infusion (mL)	Blood Transfusion (mL)	Blood loss (mL)	Monitor	Serum potassium (mEq/L)	Post operation Dialysis	Complication	Discharge
1	General	RUL(2a)	210/268	400	+(560)	500	CVP	5.3	POD1	Chylothorax	29
2	General	RUL(2a)	198/244	400	-	300	none	3.8	POD1	None	12
3	General	RLL(2a)	160/210	500	-	220	none	6.5	POD1	Pulmonary fistula, pneumonia, hyperkalemia	15
4	General	LLL(2a)	160/205	400	-	200	none	6.6	POD1	Pulmonary fistula, hyperkalemia	18
5	General	RUL(2a)	135/188	200	-	85	none	4.9	POD1	None	16
6	General	LLSeg(1)	240/293	1600	-	575	none	4.5	POD1	None	14
7	General	RLL(2a)	175/224	650	-	250	none	3.4	POD1	None	15
8	General	RLL(2a)	190/246	400	-	230	none	2.7	POD1	Pneumonia	9
9	General	LLL(2a)	140/192	450	-	80	none	3.3	POD1	Pulmonary fistula	15
10	General	LLL(1)	150/199	450	-	50	none	4.2	POD1	Vitreous hemorrhage	9
11	General	LLL(1)	155/203	550	-	280	none	5	POD1	None	19
12	General	RML(2a)	205/262	580	-	280	none	4	POD1	None	9
13	General	RLL(2a)	230/288	950	-	180	CVP	4.4	POD1	Pulmonary fistula	24
14	General	RLL(2a)	166/211	650	-	160	none	4.2	POD1	Pulmonary fistula	20
15	General	RLL(2a)	276/333	900	-	200	none	4.5	POD1	None	20
16	General	LLL(2a)	185/233	590	-	170	CVP	5.1	POD1	Pulmonary fistula	21
17	General	RLL(2a)	111/163	800	-	270	CVP	5.4	POD1	Heart failure	12
18	General	RML(2a)	255/300	1200	-	250	CVP	5	POD1	Heart failure	14
19	General	RLL(2a)	347/387	1750	+(560)	450	CVP	3.5	POD1	Heart failure	21
20	General	RLL(2a)	245/293	1000	+(560)	690	none	4.2	POD1	Pneumonia	15
21	General	LUP(2a)	130/186	1300	0	400	none	4.9	POD1	Pulmonary fistula	19
Mean ± standard deviation			193±56.9/244±56.2	749 ±419		277 ±164		4.5 ±0.88			16.5 ±5.1

\*Measured immediately after the operation. POD=Postoperative day; CVP=central venous pressure  
 LLL=left lower lobectomy; LLSeg=Left lower segmentectomy; RLL=right lower lobectomy; RUL=right upper lobectomy  
 RML=Right middle lobectomy; LUP=Left upper partial resection

Table 2: Perioperative Findings

8.1±9.2 years (range, 1 to 36 years). Preoperative comorbidity factors were angina pectoris in 6 patients, myocardial infarction in 1, and dilated cardiomyopathy in 1, indicating that a history of heart disease was present in 8 of the 21 patients (38%). Preoperative hemodialysis was performed on the day before surgery.

Table 2 shows perioperative patient data. The surgical procedure utilized was pulmonary lobectomy in 19, pulmonary segmentectomy

in 1, and partial lung resection in 1. For the anesthetic method, general anesthesia alone using oxygen with sevoflurane, vecuronium, and fentanyl was used in all cases, with no epidural anesthesia given in any. The choice of anesthetic agents and anesthetic management method was left up to the judgement of the anesthesiologist in charge. Arterial line was placed in all cases, and arterial blood gas data analysis was measured as needed. There was no cases with desaturation (SpO<sub>2</sub><96%, PaO<sub>2</sub><100mmHg) during surgery. The central venous pressure line was

Variable	Group N (n=18)	Group H (n=3)	P value
<b>Preoperative data</b>			
Number of patients with preoperative cardiac comorbidities	5 (%)	3 (100%)	0.017
NYHA classification I, II (cases)	18	3	
III, IV (cases)	0	0	1.0
Hugh-Jones classification I, II (cases)	18	3	
III,IV(cases)	0	0	1.0
Respiratory function FEV <sub>1.0</sub> , %	76.5±13.3	82.0±11.4	0.509
%VC, %	88.7±13.0	73.3±5.15	p<0.05
Laboratory Findings Hematocrit (%)	31.9±5.24	30.4±1.42	0.340
Total Protein (g/dl)	6.81±0.55	6.57±0.06	0.091
<b>Intraoperative data</b>			
Operation time, min	186±41.7	238±119	0.532
Anesthesia time, min	238±43.4	283±113	0.558
Infusion, ml/kg/hr	2.81±1.81	5.57±0.398	p<0.05
Blood loss, ml/kg/hr	1.11±0.696	1.49±0.354	0.378
Cases of blood transfusion, cases	2 (11.1%)	1 (33.3%)	0.899

**Table 3:** Perioperative data of the patients without/with postoperative cardiac heart failure

secured and its pressure monitored only in surgical cases with high preoperative risk or a high level of difficulty. Monitoring of central venous pressure was performed in only 7 patients. Following surgery, all subjects were managed in the surgical ward as critically ill patients. For postoperative pain relief, we used IV-PCA (fentanyl 20 mcg/hr). In all cases, hemodialysis was performed on the first postoperative day. The serum potassium level immediately after surgery was  $4.5 \pm 0.88$  mEqL<sup>-1</sup> ( $3.5$  to  $6.5$  mEqL<sup>-1</sup>) and hyperkalemia was seen in 2 patients. There were no serious perioperative complications, whereas postoperative complications, consisting of bronchopleural fistula in 7 patients (33%), acute heart failure in 3 (14%), pneumonia in 3 (14%), hyperkalemia in 2 (9.5%), and vitreous hemorrhage in 1 (4.8%), were encountered.

Table 3 shows data for the two groups with and without signs of postoperative acute heart failure. There were no significant differences in regard to preoperative hematocrit value, total protein concentration, or intraoperative blood loss volume. All patients were preoperatively classified as grade I or II according to both the New York Heart Association (NYHA) and Hugh-Jones classifications.

As for preoperative respiratory functions, preoperative blood gas data (in room air) did not significantly differ between the two groups, whereas percent vital capacity (%VC) was significantly lower in Group H. In addition, forced expiratory volume in 1 second (FEV<sub>1.0</sub>) was not significantly different. Intraoperative fluid infusion volume and the number of patients with preoperative cardiac comorbidities were significantly greater in Group H (p<0.05). There were no significant differences for the durations of surgery and anesthesia, or the number of patients requiring blood transfusion.

## Discussion

In patients with chronic renal failure, the incidence of malignant neoplasia is increasing due to various latent factors, such as decreased immune function, decreased antioxidant activity, and chronic infection or inflammation [2-5]. Maisonneuve et al. [2] reported that the incidence rates of renal cancer, bladder cancer, and thyroid cancer were high in dialysis patients, while the rates for lung cancer, stomach cancer, colon cancer, and breast cancer were not necessarily elevated [2]. However, as the number of hemodialysis patients increases, the frequency of surgical procedures will also inevitably increase, along with the possibility of performing surgery for lung cancer in patients undergoing hemodialysis.

Two areas of concern have been cited for hemodialysis patients who undergo pulmonary resection [1]. The first involves preoperative undernutrition, anemia, electrolyte abnormalities, bleeding tendency, and decreased immune function [6-13]. In the present study, preoperative cardiac comorbidity factors included angina pectoris and myocardial infarction, and were seen at a high frequency in 8 of the 21 patients (38%). Such conditions should be corrected as much as possible preoperatively, with reference to the recommended values for hematocrit, serum creatinine, blood urea nitrogen, and serum potassium, which are 30%, 6 mg/ml, 60 mg/ml, and 4.0 mEq/L, respectively [10]. We performed dialysis for all patients on the day before surgery in order to correct for electrolyte abnormalities and other abnormal findings. However, none of our patients received a preoperative blood transfusion to correct the hematocrit value. Additionally, some of our patients had postoperative electrolyte abnormalities that caused concern. We performed blood analysis immediately after surgery, which showed hyperkalemia with a serum potassium level of 6.5 mEq/L or higher in 2 patients (9.5%). Hemodialysis was performed in all patients on the day after surgery, with no serious complications encountered, such as ventricular arrhythmia. Postoperatively, the original hemodialysis schedule should be resumed as soon as possible, though postoperative bleeding due to treatment with anticoagulants may present a problem. In our patients, nafamostat mesilate, an ultra-short-acting anticoagulant that is effective in patients at high risk for postoperative bleeding [14], was administered for anticoagulation prior to postoperative dialysis and there was no clinically significant postoperative bleeding in any.

The second area of concern is in regard to cardiorespiratory complications, as pulmonary hypertension due to a decrease in the total pulmonary vascular cross-sectional area is prone to occur after a pulmonary resection procedure. In patients with renal failure, management of water balance is extremely difficult and there is a high likelihood of postoperative pulmonary edema. Postoperative heart failure was seen in 3 of our patients (14%). For prevention, perioperative fluid overload must be avoided and vasoactive agents should be used to reduce the need for perioperative fluid replacement. In the present study, there were significant differences between the two groups with and without postoperative acute heart failure in regard to preoperative respiratory function, intraoperative fluid infusion volume, and number of patients with preoperative cardiac comorbidities.

There was no perioperative mortality in our series, while Tsuchida

et al. [1] reported 1 perioperative death among 7 patients receiving hemodialysis treatment who underwent pulmonary resection [1]. In a study of various types of surgery for patients with chronic renal failure, the perioperative mortality rate ranged from 0~6%, with the main causes of death including heart failure, hemorrhage, septicemia, liver failure, pneumonia, and hyperkalemia [6]. Additionally, since cardiorespiratory complications due to decreased lung volume and difficulty maintaining water homeostasis may occur during a pulmonary resection procedure, it is expected that perioperative mortalities will increase as the number of such procedures increase. In particular, a decrease in pulmonary function is believed to be an important predictive factor of postoperative heart failure. In order to prevent postoperative heart failure in patients with decreased respiratory function, care must be taken to institute hemodialysis and maintenance hemodialysis at an early stage.

Significant limitations to this study include that this is a retrospective chart review over many years where there have been considerable advances in care of patients on hemodialysis, cardiac risk stratification and better assessment of fluid status. In addition, the choice of anesthetic agents and anesthetic management (use of central venous line) were not standardized, but rather varied according to updated information during the extended study period from 1995 to 2007. Another limitation is that the number of patients is very small and is not enough to produce statistical significance. In spite of these limitations, our findings showed that preoperative respiratory function, intraoperative fluid infusion volume, and preoperative cardiac

## Conclusions

We performed a retrospective investigation of patients with chronic renal failure who underwent pulmonary resection surgery procedures performed at our hospital. Although there were no perioperative deaths, postoperative complications occurred, including heart failure in 3 patients (14%) and hyperkalemia in 2 (9.5%). We concluded that preoperative respiratory function, intraoperative fluid infusion volume, and preoperative cardiac comorbidities are potential risk factors for postoperative acute heart failure. Thus, stringent cardiorespiratory management is essential for hemodialysis patients undergoing pulmonary resection surgery, especially in those with decreased preoperative pulmonary function and without cardiac reserve.

## Declaration

We have no conflict of interest. The contents have not been published elsewhere and the paper is not being submitted elsewhere. The manuscript has been read and approved by all co-authors

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