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Original Article

Video-Assisted Thoracoscopic Surgery for Lung Cancer in Patients on Hemodialysis

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Purpose: Surgical treatment of lung cancer in patients receiving hemodialysis carries a high risk because of poor cardiac function and a fragile electrolyte balance. Because the number of patients receiving hemodialysis has increased, the proportion of such patients with lung cancer is expected to rise. However, few studies have examined the results of surgery for lung cancer in hemodialysis patients, especially by video-assisted thoracoscopic surgery (VATS).

Methods: We conducted a retrospective analysis of 5 hemodialysis patients who underwent VATS for lung cancer.

Results: All patients were men, and the mean age was 70.4 years. The operative procedure was lobectomy in 4 patients and segmentectomy in 1. During the perioperative period, none required urgent hemodialysis. There were no critical complications and in-hospital deaths. Three of the 5 patients are currently alive and recurrence-free. One patient died of recurrence at 4 month after surgery, and the other patient died at 17 months after surgery without cancer recurrence.

Conclusions: VATS appears to be a safe procedure for hemodialysis patients with lung cancer, and the long-term outcome is satisfactory.

Keywords: hemodialysis, lung cancer, video-assisted thoracic surgery

Introduction

Because the number of patients receiving hemodialysis has increased, a proportionate increase of such patients with lung cancer is expected, and therefore surgical resection of lung cancer in this patient population would undoubtedly increase. However, few previous studies have analyzed the results of surgery for lung cancer in hemodialysis patients.

Hemodialysis patients who undergo surgery represent a high-risk group requiring careful perioperative management to avoid electrolyte imbalance and hemodynamic instability. In such patients, damage to the chest wall muscles may lead to an increase in the blood levels of creatinine and potassium after surgery. Unlike thoracotomy, video-assisted thoracoscopic surgery (VATS) creates less chest wall damage. Therefore, VATS may be advantageous for treatment of lung cancer in hemodialysis patients.

Here we report 5 hemodialysis patients with lung cancer who underwent lobectomy or segmentectomy using VATS, and suffered no severe complications or mortality.

Patients and Methods

Between January 2006 and December 2008, 5 lung cancer patients who were receiving hemodialysis underwent resection of their cancers using VATS at our institution. In the same periods, we have no patients

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with lung cancer on hemodialysis who received lung surgery through an open thoracotomy. We retrospectively investigated their surgical complications during the perioperative period, and also their long-term outcome.

All of the 5 patients were male, and the mean age was 70.4 years (range 58–76 yrs). Diseases for which hemodialysis had become necessary were diabetic nephropathy in 3 patients, IgA nephropathy in 1, and septic shock in 1. All the patients had a history of smoking. The mean preoperative hemodialysis period was 53 months (range 1–96 months). None of the patients had ischemic heart disease. The American Society of Anesthesiologists (ASA) score was 2 in all patients. The day before surgery, all of the patients were scheduled for routine hemodialysis. All surgical procedures were performed while viewing a monitor via the thoracoscope. For the VATS procedure, a mini-thoracotomy incision approximately 3 cm long was made in the 4th intercostal space on the anterior axillary line as an access port. Two other stab wounds each approximately 2 cm long were made. One of these wounds was placed in the 7th intercostal space on the mid-axillary line and used as the camera port, and the other wound was placed in the 6th or 7th intercostal space at the lower edge of the scapula, and used as an assist port. Mechanical wound retractor was not used and all surgical procedures were done under complete VATS. The thoracoscope was 10 mm in diameter and had a 30' lens. The pulmonary arteries were usually ligated using absorbable thread (3–0 Vicryl, polyglactin, Ethicon Inc., Japan), and the pulmonary veins were dissected using an Endo-Stapler with staple dimensions of 2.0 to 2.5 mm. The lobar bronchus, segmental bronchus and interlobar fissures were divided using the Endo-Stapler with staple dimensions of 3.8 to 4.0 mm. The operative specimens were carefully removed via the wound in the anterior 4th intercostal space. Infusions were managed by continuous monitoring of peripheral artery pressure during surgery. No central venous line was placed in any of the 5 patients. Postoperative infusion was conducted with potassium-free solution at 40-60 ml/h until resumption of meals on the day after surgery.

Perioperative clinical data and complications were collected retrospectively from the clinical records. Last actualization of survival data was done in May 2011.

The Institutional Review Board approved this retrospective study. The need for subsequent individual consent from patients whose records were evaluated was waived because the individuals were not identified in this study.

Results

Patients' characteristics and preoperative laboratory findings are shown in **Table 1**. The tumors were discovered as abnormal chest shadows on routine chest CT examination in 3 patients, an abnormal chest shadow detected at the start of hemodialysis in 1, and by production of bloody sputum in 1. The tumors of 4 patients include small cell carcinoma (Patient 2) were diagnosed preoperatively as non-small cell carcinoma by bronchofiberscope or percutaneous needle cytology. The case of adenocarcinoma combined with small cell carcinoma (Patient 3) was not diagnosed preoperatively (**Table 2**).

The operative procedure was lobectomy in 4 patients and segmentectomy in 1. Systemic mediastinal lymph node dissection was performed in 4 patients. In the segmentectomy case, the tumor was located in the periphery of the left upper segment and its size was less than 20 mm. Moreover, CT findings demonstrated a ground glass opacity shadow, and intraoperative histological examination revealed no malignant cells in the upper bronchial lymph node. On the basis of these findings, systemic mediastinal lymph node dissection was omitted in the segmentectomy case.

The mean operation time was 111.6 min (range 67–145 min). Mean blood loss was 77.6g (range 10–150g) and blood transfusions were not conducted in any of the cases (**Table 2**). Three patients underwent hemodialysis on the day after surgery, and 2 patients did so 2 days after surgery. To avoid risk of postoperative bleeding, we conducted hemodailysis using nafamostat mesilate, which is an ultra-short-acting anticoagulant agent, until the chest drainage tube was withdrawn. During the perioperative period, none of the patients had a potassium level exceeding 6.0 mEq/dl, and no patients required urgent hemodialysis. Postoperative complications after VATS included paroxysmal atrial fibrillation in 1 patient, and atelectasis necessitating toileting with a bronchofiberscope in 1. There were no critical complications. The average postoperative drainage period was 3.2 days (range 2–5 days), and the average postoperative hospital stay was 8.2 days (range 3–15 days). There were no operative or in-hospital deaths. Three of the 5 patients are currently alive and recurrence-free

Table 1 Patients characteristics

Patient	Age	Sex	Renal disease	Duration of dialysis	Smoking (pack years)
1)	73	Male	DM nephropathy	4 year	30
2)	74	Male	DM nephropathy	8 year	81
3)	58	Male	IgA nephropathy	1 month	60
4)	71	Male	DM nephropathy	2 year	50
5)	76	Male	Nephrotic syndrome, sepsis	8 year	100
Patient	**BUN (mg/dl)**	**Cre (mg/dl)**	**Alb (g/dl)**	**K (mEq/L)**	**Hct (%)**
1)	43	6.3	4.3	4.6	38.0
2)	35	7.9	4.5	3.8	39.3
3)	78	7.8	4.0	5.4	26.3
4)	57	7.4	3.7	5.1	32.4
5)	53	11.2	4.1	3.8	46.8

BUN: blood urea nitrogen; Cre: creatinine; Alb: albumin; K: potassium; Hct: hematocrit; DM nephropathy: diabetes mellitus nephropathy

Table 2 Perioperative characteristics of the hemodialysis patients

Patient	Histology	p-Stage	Surgical procedure	Operation time (min)	Blood loss (g)
1)	Adeno	1A	LUseg	67	10
2)	Small	2B	LLL	120	68
3)	Adeno. combined with small	2B	RUL	93	60
4)	Squamous	1B	RUL	133	150
5)	Squamous	2A	LUL	145	100
Patient	**Postoperative drainage periods**	**Length of hospital stay**	**Postoperative complication**	**Outcome (month)**	**Cause of death**
1)	2	3	non	20 alive	
2)	2	5	non	4 death	Cancer recurrence
3)	5	10	non	17 death	Unknown (noncancer)
4)	2	15	Atrial fibrillation	54 alive	
5)	5	8	Atelectasis	59 alive	

p-Stage: pathological stage; LUseg: left upper segmentectomy; LLL: left lower lobectomy; RUL: right upper lobectomy; LUL: left upper lobectomy

(59, 54, and 20 months after surgery). One patient died of recurrence at 4 months after surgery, and the other died suddenly at 17 months after surgery without cancer recurrence.

Discussion

In Japan, the number of patients receiving hemodialysis continues to increase annually. In 2009, over 290000 patients underwent hemodialysis, which was 3 times the corresponding number 20 years ago (Renal Data Registry Committee, Japanese Society for Dialysis Therapy. The illustrated, overview of chronic dialysis in Japan as of 31 December 2009). Because the number of hemodialysis patients has increased, the number of such patients undergoing surgical resection for lung cancer is expected to rise.

Thoracic surgery for patients receiving hemodialysis is associated with a high rate of morbidity, and surgical treatment of lung cancer in such patients carries a high risk because of poor cardiac function and a fragile electrolyte balance. Because patients with destructive renal failure had no ability to keep electrolyte balance, they suffered critical hyperkalemia easily. Moreover, patients on hemodialysis have abnormality of calcium and phosphorus metabolism, and this leads to ectopic calcification of arterial walls and cardiac valves. Calcification of the coronary artery leads to the development of ischemic heart disease. Ohtake and colleagues reported that coronary angiography showed

Table 3 Reports of the pulmonary resection for lung cancer in patients receiving hemodialysis

	Year	Author	Number of patients	Operative procedure	Number of each operative procedure	Morbidity (rate)
1)	2001	Tsuchida	7	Lobectomy	7	7 (100%)
2)	2001	Morita	5	Lobectomy	5	-
3)	2005	Ciriaco	6 (7)	Lobectomy	5	4 (57%)
				Pneumonectomy	1	
				Wedge resection	1	
4)	2009	Obuchi	11	Lobectomy	9	3 (28%)
				Pneumonectomy	1	
				Wedge resection	1	
5)	2009	Takahama	24	Lobectomy	22	13 (59%)
				Segmentectomy	1	
				Wedge resection	1	
6)	2010	Akiba	2	Lobectomy	1	0 (0%)
				Segmentectomy	1	
7)	this		5	Lobectomy	4	2 (40%)
				Segmentectomy	1	
total			60 (61)		61	

	Critical complication		Mortality (rate)	Death (non-cancer death)	5-year survival rate
1)	Pulmonary edema	1	1 (14.3%)	5 (2)	
	Hyperkalemia	4			
2)	None		0	3 (3)	
3)	Hyperkalemia	2	0	1 (1)	
4)	Pneumonia	2	0	6 (4)	28%
5)	Heart failure	2	0	8 (2)	43%
6)	None		0	-	
7)	None		0	2 (1)	
total		11	1	25 (13)	

significant coronary artery stenosis in 53% of 30 asymptomatic chronic kidney disease patients at the start of hemodialysis.[1] Sclerosis of the cerebral arteries tends to cause cerebral infarction and cerebral bleeding. In fact, 36% of patients receiving hemodialysis in Japan die of arterial diseases such as myocardial infarction, cerebral infarction or cerebral bleeding. Renal dysfunction also hampers immune function, and the production of cytokines and antibodies important for maintenance of the immune system is reduced by hemodialysis. As a consequence, patients receiving hemodialysis may tend to develop surgical site infection and have poor wound healing ability. Because of these unfavorable conditions, hemodialysis patients have high operative morbidity and mortality.

We found 6 reports describing the results of surgery for lung cancer in patients receiving hemodialysis, except case reports (**Table 3**).[2–7] These reports covered 61 surgical cases (60 patients), for which the perioperative morbidity rate was 0%–100% and the mortality rate 0%–14.3%. Critical surgical complications such as hyperkalemia exceeding 6 mEq/dl, pulmonary edema, heart failure or pneumonia occurred in 11 cases. Morita et al. reported that the postoperative creatine phosphokinase (CPK) value was correlated with the postoperative serum potassium level, as well as with the amount of muscle resection.[3] They considered that antero-axillary thoracotomy might be advantageous for minimizing the increase in the potassium level after surgery in patients receiving hemodialysis, as this approach involves less muscle resection than standard postero-lateral thoracotomy. Because VATS requires less muscle resection than antero-axillary thoracotomy, VATS might be advantageous for minimizing the postoperative increase of serum potassium. Moreover, because VATS had advantage in making skin incision smaller, reducing post-operative pain and pulmonary function loss, VATS was reported to decrease the frequency of post-operative surgical site infection, atelectasis and pneumonia.[8] Simultaneously, reduction of post-operative pain and

pulmonary function loss decreased cardiac load due to sympathetic stress. Therefore, VATS might be useful and had advantage for the patients receiving hemodialysis. Indeed, among the patients included in these previous reports, 6 underwent VATS, and none of them suffered critical surgical complications or in-hospital death. When considered together with our present results, VATS lung resection may be a safe procedure for patients receiving hemodialysis although there were only 11 cases and we need more cases to verify the effectiveness of VATS for the patients with hemodialysis.

In hemodialysis patients who undergo surgery for malignant tumors, the prognosis is considered to be poor because of decreased immune function and death from other cause.[9,10] The previously reported 5-yr survival rates for surgically treated hemodialysis patients with lung cancer ranged from 28% to 43%. Even in stage IA patients, the 5-yr survival rate was only 70%.[5,6] Because patients receiving hemodialysis in Japan have a 5-yr survival rate of about 60%, and over half of such patients die of arterial disease or infections disease, many of those with lung cancer might die due to causes other than lung cancer. Among the previous and present cases, 25 of 60 patients died. Among these 25 patients, 12 died of cancer recurrence and 13 died due to causes other than cancer. As it seems inevitable that many hemodialysis patients with lung cancer will die of non-cancer-related causes, the reported 5-yr survival rates for those who undergo surgery may not seem excessively poor. In our series, 4 patients had no cancer recurrence and 3 patients are still alive without recurrence. We consider that this represented a favorable long term result.

Conclusion

VATS appears to be a safe procedure for hemodialysis patients with lung cancer, and has a satisfactory long-term outcome.

Disclosure Statement

All authors have no financial or other interest in the manufacture or distribution of the device.

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