福岡大医紀（*Med. Bull. Fukuoka Univ.*）：34(3), 203–207, 2007

Resection and Prosthetic Reconstruction of the Superior Vena Cava for Non–small Cell Advanced Lung Cancer and Mediastinal Tumor Patients

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Abstract： Purpose and background：In Western countries, the indications of a superior vena cava（SVC）resection and reconstruction for patients with non–small cell lung cancer（NSCLC）still remain controversial. The purpose of this study is to evaluate our experience and discuss the indications for surgery in non–small cell lung cancer and malignant mediastinal tumor patients. Patients and Methods：From 1994 to 2006, eight non–small cell lung cancer patients and seven thymic tumor patients with superior vena cava（SVC）invasion underwent a lung resection and SVC prosthetic reconstruction. Unilateral innominate vein resection and reconstructions were performed for two non–small cell lung cancer patients and six malignant mediastinal tumor patients. Results：Lung lobectomies were performed for seven patients, in whom three patients underwent a lung lobectomy with a carinal resection and two patients underwent a lung lobectomy with bronchoplasty for non–small cell lung cancer patients. One another patient underwent a right sleeve pneumonectomy. All bilateral reconstructions were performed from the right atrium to left innominate vein first, and then proximal SVC to right innominate vein anastomosis using ringed expanded polytetrafluoloethyrene（PTFE）vascular graft(10 or 12 mm in diameter). There was no patient with a re–operation due to massive bleeding or thrombosis in the grafts. Fifteen of the eighteen (83.0%) graft anastomoses were patent. Three patients died within 30 days postoperatively. Two patients are alive without malignancy, five patients died due to lung cancer recurrence at from 180–845 post–operative days. In the unilateral resection group, 100% grafts were patent and five of eight patients with unilateral innominate vein reconstructuin survived without any recurrence of the malignant tumor. Conclusions：The prognosis of combined resection of SVC of the thoracic malignancies is generally unfavorable. Although this is a challenging study, unilateral innominate vein reconstruction and a resection for thoracic malignancies included the possibility of a radical operation for advanced thoracic tumors.

Key words：Superior vena cava reconstruction, Non–small cell lung cancer, mediastinal malignant tumor

Introduction

In Western countries, the surgical option for advanced lung cancer is not considered to be indicative, especially T4 lung cancer. There have been reports of a combined resection of the left atrium, descending aorta, carina. However, the indications for a superior vena cava (SVC) resection and reconstruction for patients with non–small cell lung can-

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cer (NSCLC) still remain controversial. Spaggiari[1] et al described the prognosis of the patients with SVC replacement with a prosthesis to be very dramatically worse than after a tangential SVC partial resection. We performed a combined resection and replacement of SVC with a lung resection for nine non–small cell lung cancer patients and seven malignant mediastinal tumor patients. In addition, we also performed a unilateral innominate vein resection and reconstruction for eight patients. The purpose of this study is to evaluate our experience and discuss the indications for surgery in non–small cell lung cancer and malignant mediastinal tumor patients.

Patients and methods

From 1994 to 2006, eight non–small cell lung cancer patients and seven thymic tumor patients with superior vena cava (SVC) invasion underwent a lung resection and SVC prosthetic reconstruction. The unilateral innominate vein resection and reconstructions were performed for two non–small cell lung cancer patients and six malignant mediastinal tumor patients (Table 1). This is a challenging study, and informed consent was obtained from all patients, who also all requested surgery. Seventeen patients were male, while the others were female. The mean age was 50.5 (29–79) year–old. In this study, all patients underwent an SVC system resection with prosthetic replacement, patients with an SVC partial resection without graft replacement were excluded from this study.

Induction chemo–radiation therapy was performed in case 7, 40 Gy radiation therapy and low dose CDDP (10 mg/body/day)＋5–FU (250 mg/body/day)for 4 weeks. In addition, two lung cancer patients with unilateral innominate vein reconstruction underwent induction radiation therapy of 50 Gy. There were no other patients with preoperative adjuvant therapy. In two patients, SVC syndrome was observed preoperatively.

Table 1.

SVC reconstruction		Unilateral innominate vein reconstruction	
male	12	male	4
female	4	female	3
Age	29–79	Age	40–71
〈Diagnosis〉		〈Diagnosis〉	
Lung cancer	8	Lung cancer	2
Thymic tumor	7	Thymic tumor	4
		Osteosarcoma	1
		adenosquamous	1

Operative procedure

The operative procedures for the SVC resection and reconstruction were as follows：A median–sternotomy was performed for all patients. Lung lobectomies were performed for eight patients. Three patients underwent a carinal lobectomy and two patients underwent a sleeve lobectomy. One patient underwent a right carinal pneumonectomy (Table 2).

Table 2. SVC reconstruction for lung cancer patient

No	Patient	TNM	Pathology	SVC syndrome	operation	Post–operative graft patency	Prognosis (days)
(1)	62M	T4N2M0	Sq	(−)	RUL ＋carina	good/good	215dead
(2)	50M	T4N2M0	AD	(＋)	RUL ＋carina	good/good	7dead
(3)	49F	T4N3M0	AD	(−)	RUL ＋carine	good/good	10dead
(4)	65M	T4N2M0	AD	(＋)	RUL＋ bronchoplasty	good/obstructed	1,120alive
(5)	70M	T4N2M0	large	(−)	Rt− sleevpnemo	good/good	1dead
(6)	51M	T4N3M1	AD	(−)	RUL	good/obstructed	185dead
(7)	51M	T4N2M1	Sq	(−)	RUL＋ bronchoplasty	obstructed/good	180dead
(8)	79M	T4N0M0	Sq	(−)	RUL	good/good	188dead

Bilateral innominate vein reconstructions, including the right innominate vein–SVC or right atrium and left innominate vein–right appendage, were performed for eight patients. The vein reconstruction was performed in the right atrium to left innominate vein anastomosis first, and then proximal SVC to right innominate vein anastomosis was performed. All of the vascular reconstructions used ringed expanded polytetrafluoloethyrene (e–PTFE) vascular grafts (10 or 12 mm in diameter). Heparinazation was not performed in any of the patients before SVC clumping.

Postoperative pathological examination

In the pathological diagnosis of the SVC resection group, four patients had adenocarcinoma, three patients had squamous cell carcinoma, while the remaining one patient had large cell carcinoma (Table 2). All patients had direct SVC invasion, and there was no case of SVC invasion by metastatic lymph node.

The lymph node status was N0 in two patients, N2 in six patients, N3 in two patients. In the thymic tumor group, the pathologic diagnosis of all patients was invasive thymoma (Table 3). In the unilateral innominate vein reconstruction group, the diagnosis of two patients was primary lung cancer, while in four patients it was invasive thymoma, in one patient it was osteosarcoma, and in one patient it was adenosquamous cell carcinoma (Table 4).

Results

There was no patient with a re–operation due to massive bleeding or thrombosis. Twenty–five (83.3%) of all thirty grafts were patent in the SVC reconstruction group (Tables 2, 3), and 100% of the grafts were patent (100%) in the unilateral innominate vein reconstruction group according to enhanced CT scan (Table 4).

There were three cases of early postoperative death. Each cause of death was postpneumonectomy edema (case 5), vascular fistula due to airway anastomotic dehiscence (case 2), and brain edema (case 3) in patients who had undergone an operation for brain metastasis more than 8 weeks perviously, respectively. Five patients died of lung cancer recurrence after 180–845 post–operative days.

In the lung cancer group, two patients are doing well without malignant disease past over 1,000 days after operation. In the unilateral innomi-

Table 3. SVC reconstruction for thymic tumor patient

No	Patient	Diagnosis	SVC syndrome	Post–operative graft patency	Prognosis (days)
(1)	45F	Thymic tunor	(−)	good/good	845dead
(2)	39M	Thymic tunor	(+)	good/good	282dead
(3)	29F	Thymic tumor	(−)	good/good	340dead
(4)	48F	Thymic tumor	(−)	good/good	610dead
(5)	65F	Thymic tumor	(−)	good/good	1,280alive
(6)	42M	Thymic tumor	(+)	obstructed/good	582alive
(7)	69M	Thymic tumor	(+)	good/obstructed	480dead

Table 4. Unilateral innominate vein reconstruction

No	Patient	Diagnosis	Vein graft	Post–operative graft patency	Prognosis (days)
(1)	50M	Rt–Lung ca	Rt	good	845dead
(2)	58M	Lt–Lung ca	Lt	good	520alive
(3)	48F	Thymic tumor	Lt	good	467dead
(4)	71M	Thymic tumor	Lt	good	20dead
(5)	40M	Thymic tumor	Lt	good	2,030alive
(6)	45F	Thymic tumor	Lt	good	1,812alive
(7)	63F	Osteosarcoma	Lt	good	1,340alive
(8)	48M	adenosquamous	Lt	good	35alive

nate vein resection and reconstruction group, there are five surviving patients without any recurrence of primary disease (Table 4).

Discussion

A previous report[1] suggested an SVC system resection and prosthetic reconstruction to be contraindicated in patients with non-small cell lung cancer, on the other hand, some reports presented the possibility of prognostic effectiveness under severe patients selection.[2)-6)]

We performed an SVC resection for non-small cell lung cancer patients and mediastinal tumor patients as a trial. Three casesunderwent a lobectomy and carina resection, two cases underwent a lobectomy and bronchoplasty, and one case underwent a sleeve pneumonectomy among the non-small cell lung cancer patients. We had three cases of early operative death, and four patients who died within 215 days due to lung cancer recurrence. We recognized that surgical damage of this type operation is not insignificant, however, we also recognized that two lung cancer patients after SVC prosthetic reconstruction still alive without lung cancer recurrence longer than 1,000 days after the operation.

One patient underwent induction chemotherapy and radiation therapy, while another patient had induction radiation therapy. The effect of the first patient was only a 30% reduction, and this patient prognosis within 180 days. The effect of the second patient was a 90% reduction, and this patient is still doing well without cancer recurrent. There may be some important suggestions in the induction therapy for improving the outcome ofnon-small cell lung cancer patients with SVC invasion.

The prophylactic effect of perioperative systemic heparinazation for thrombosis after SVC reconstruction still remain unclear. We believe there are no significant differences in the graft patency between prosthetic SVC replacement patients with and without systemic heparinization. As a result, in this study, we had no patients with systemic heparinazation perioperatively. In this series, 83.3% of the grafts were patent in the SVC reconstruction group and 100% of the grafts were patent in the unilateral innominate vein reconstruction group without heparinazation.

Complete SVC clamping causes important variations in the head and neck venous system. However, some examinations have demonstrated that SVC clumping of one hour might be well tolerated.[7)-8)] We experienced a female case of severe brain edema after SVC replacement. She had previously undergone a brain operation due to solitary brain metastasis. Therefore, long-term SVC clamping for after craniotomy may thus be a contraindication.

The prognosis of the three patients who underwent a carinal resection with SVC reconstruction is very poor with early complications postoperatively. As a result, an SVC reconstruction with carinal resection is contraindicated in lung cancer patients with SVC invasion. However, we did experience two patients who survived for over 1,000 days after operation. In these two patients, the cancerous tumors were completely resected with a wide margin. In addition, one of the two patients underwent induction radiation therapy and a 90% of reduction was successfully obtained. We therefore believe that the most important factor of for successful operations is the possibility of a complete resection of the malignant tumor.

Five of the eight patients undergoing a unilateral innominate vein resection and reconstruction are still alive. As a result, a radical operation in the unilateral innominate vein invasion group of thoracic malignant tumor may thus be feasible.[9)]

Conclusions

The prognosis of a combined resection of SVC of thoracic malignancies is generally unfavorable. Bases on our above findings, a unilateral innominate vein reconstruction and resection for thoracic malignancies, including the possibility of a radical operation, may therefore be indicated for advanced thoracic tumors.

Reference

1) Spaggiari L, Thomas P, Nagdeleinat P, Kondo H, Rollet G, Regnard JF, Tsuchiya R, Paatorino U. Superior vena cava resection with prosthetic re-

placement for non-small cell lung cancer: long-term results of a multicentric study. Eur J Cardiothorac Surg 8: 177-82, 1994.
2) Spaggiari L, Regnard JF, Magdeleinat P, Jauffret B, Puyo P, Levasseur P. Extended resections for bronchogenic carcinoma invading the superior vena cava system. Ann Thorac Surg 69: 233-6, 2000.
3) Tsuchiya R, Asamura H, Kondo H, Goya T, Naruke T. Extended resection of the left atrium, great vessels, or both for lung cancer. Ann Thorac Surg 57: 960-5, 1994.
4) Thomas P, Magnan PE, Moulin G, Giudicelli R, Fuentes P. Extended operation for lung cancer invading the superior vena cava. Eur J Cardiothorac Surg 8: 177-82, 1994.
5) Dartevelle PG, Chapelier A, Pastorino U, Corbi P, Lenot B, Cerrina J, Bavoux EA, Verley JM, Neveaux JY. Long-term follow-up after prosthetic replacement of the superior vena cava combined with the resection of mediastinal-pulmonary malignant tumors. J Thorac Cardiovasc Surg 102: 259-65, 1991.
6) Nakahara K, Ohno K, Matsumura A, Hirose H, Matsuda H, Nakano S, Shirakura R, Kawashima Y. Extended operation for lung cancer invading the aortic arch and superior vena cava. J Thorac Cardiovasc Surg 97: 428-33, 1989.
7) Urayama H, Kawase Y, Ohtake H, Kawasuji M, Watanabe Y. Physiological changes during acute obstruction of the superior vena cava, azigos, and internal thoracic veins in dogs. J Cardiovasc Surg 38: 87-92, 1997.
8) Gonzales-Fajardo JA, Garcia-Yuste M, Florez S, Ramos G, Alvarez T, Coca JM. Hemodynamic and cerebral repercussions arising from surgical interruption of the superior vena cava. Experimental model. J Thorac Cardiovasc Surg 107: 1044-9, 1994.
9) Spaggiari L, Leo F, Veronesi G, Solli P, Galetta D, Tatani B, Petrella F, Dadice D. Superior vena cava resection for lung and mediastinal malignancies: A single-center experience with 70 cases. Ann Thorac Surg 83: 223-30, 2007.

(Received on April 2, 2007,
Accepted of June 25, 2007)