Wallstent Endovascular Prosthesis for the Treatment of Superior Vena Cava Syndrome

Objective: **We assessed the clinical outcome of self-expanding Wallstent endovascular prosthesis in the treatment of superior vena cava syndrome due to malignant tumors.** ***Methods:*** **Eleven patients with malignant superior vena cava syndrome were treated by percutaneous implantation of the self-expanding Wallstent endovascular prosthesis across the stricture site. Patency was defined by the absence of symptoms and signs of superior vena cava syndrome.** ***Results:*** **Ten of the 11 experienced complete symptomatic relief within 3 days of stent implantation. The remaining 1 did not benefit, and required a second procedure, dying of heart failure 5 days after stent implantation. Ten patients remain symptomatically free of superior vena cava syndrome to date or until death in follow-up lasting 17 to 227 days.** ***Conclusion:*** **Implantation of the self-expanding Wallstent endovascular prosthesis for malignant superior vena cava syndrome provides rapid symptomatic relief and improves the patient's quality of life. (JJTCVS 2001; 49: 165–170)**

Key words: superior vena cava syndrome, interventional procedure, endovascular prosthesis, self-expanding metallic stent, Wallstent

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Superior vena cava (SVC) syndrome is caused by either significant narrowing or complete occlusion of the SVC due to a variety of malignant and benign entities. The most frequent symptoms include dyspnea, cough, facial swelling, neck swelling, bilateral arm swelling, headache, and cyanosis. The syndrome is most commonly encountered in patients with malignancy — either a primary intrathoracic malignancy, lymphoma, or metastatic tumor — with obstruction caused by tumor invasion or extrinsic compression of the SVC. Benign causes such as mediastinal fibrosis, infection, central venous catheters, intravenous pacemaker wires, and aortic aneurysms are less common.[1]

Radiotherapy or chemotherapy are traditional initial treatments for SVC syndrome resulting from malignant disease, but are often unsuccessful. Radiotherapy usually results in tumor regression and improves symptoms of venous obstruction, but in some cases, it may result in immediate, dramatic progression of SVC syndrome because of tumor edema. Surgical bypass has been used successfully, but requires a major operation by sternotomy. Indications for surgery are limited, while radiotherapy or chemotherapy is neither adequate nor promptly effective. The use of an endoluminal self-expanding metallic stent has become therapeutic option that provides immediate, lasting relief of symptoms. Stent implantation is less invasive than bypass surgery and less cytotoxic than radiotherapy or chemotherapy.

We assessed the clinical outcome of self-expanding metallic Wallstent endovascular prosthesis in 11 patients with malignant SVC syndrome.

Subjects and Methods

From August 1997 to June 2000, 11 consecutive patients — 9 men and 2 women aged 43–82 years (mean: 60 years) — with malignant SVC syndrome underwent treatment with the self-expanding Wallstent endovascular prosthesis (Schneider, Minneapolis, MN). Diagnoses were adenocarcinoma in 4, small cell carcinoma in 4, squamous cell carcinoma in 1, mediasti-

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Table I. *Patient profiles and results*

Patient No.	*Age (yr) /Gender*	*Underlying disease*	*Site of obstruction*	*No. of stents*	*Stent diameter (mm)*	*Stent length (mm)*	*Site of stent implantation*	*SVC syndrome relieved*	*Tumor therapy after stenting*	*Survival (days)*
1	82/M	Small cell carcinoma	SVC	1	10	50	SVC	Yes	Chemothrapy	17
2	53/F	Small cell carcinoma	SVC	1	10	50	SVC	Yes	Radiotherapy	190
3	58/M	Esophagus carcinoma (metastasis)	SVC	1	10	50	SVC	Yes		17
4	48/M	Small cell carcinoma	SVC, RIV, LIV	1	10	90	SVC, RIV	Yes	Chemothrapy	183
5	57/M	Adenocarcinoma	SVC, RIV	1	10	70	SVC, RIV	Yes	Radiotherapy	165
6	61/M	Adenocarcinoma	SVC, RIV, LIV	2	10	70, 50	SVC, RIV	Yes		23
7	74/M	Small cell carcinoma	SVC, RIV	1 1*	10 10	50 70	SVC SVC, RIV	No No		5
8	70/M	Adenocarcinoma	SVC, RIV	1	10	50	SVC	Yes	Chemotherapy	202 Alive
9	43/M	Adenocarcinoma	SVC, RIV	1	10	70	SVC, RIV	Yes	Radiotherapy Chemothrapy	227 Alive
10	71/M	Squamous cell carcinoma	SVC, RIV	1	10	70	SVC, RIV	Yes		59
11	43/F	Colon carcinoma (metastasis)	SVC, RIV, LIV	1	10	70	SVC, RIV	Yes	Radiotherapy	33 Alive

SVC, Superior vena cava; *RIV*, right innominate vein; *LIV*, left innominate vein. *Repeat procedure 3 days after initial implantation.

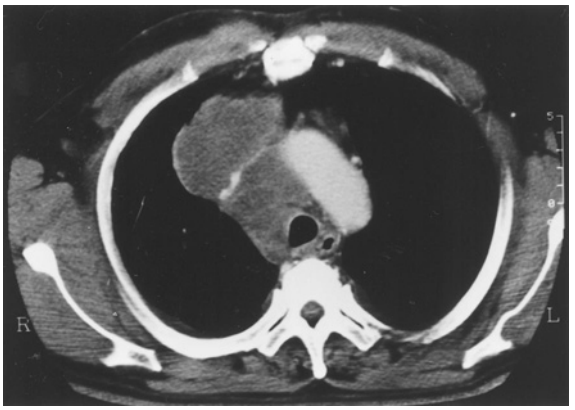

Fig. 1. Patient 4. Chest CT after intravenous injection of contrast medium shows extremely narrowed SVC compressed by tumor mass.

nal metastasis of esophagus carcinoma in 1, and colon carcinoma in 1 (Table I). Informed consent was obtained from all patients after risks and benefits of treatment were fully explained.

Chest computed tomography (CT) was conducted in all patients a few days before stent implantation to determine the nature of the obstruction, the length of stenosis, the presence of simple compression of the SVC or direct tumor invasion, and the pattern of collateral return (Fig. 1).

Digital subtraction superior vena cavography was conducted before stent implantation via simultaneous contrast injection, usually in a cubital vein, on both sides (Fig. 2). After initial cavography, where no thrombus was present and a stenosis or short occlusion was present, the patient was considered suitable for stent implantation.

Stents were implanted in all cases from the femoral vein. Under local anesthesia, a 8 Fr sheath was inserted into the vein. A catheter and guidewire were passed through the right atrium and the stenosis or occlusion of the SVC was crossed. In each instance, passage through stenotic vessels was achieved with a flexible hydrophilic guidewire.

In 5 of the patients, radial pressure of the stent alone was sufficient to relieve obstruction. In the remaining 6, dilation using a 10 mm balloon was required (Fig. 3). A preloaded self-expanding Wallstent endovascular prosthesis of appropriate length (50–90 mm) and expanded diameter (10 mm) was positioned across the stricture and released from its restraining

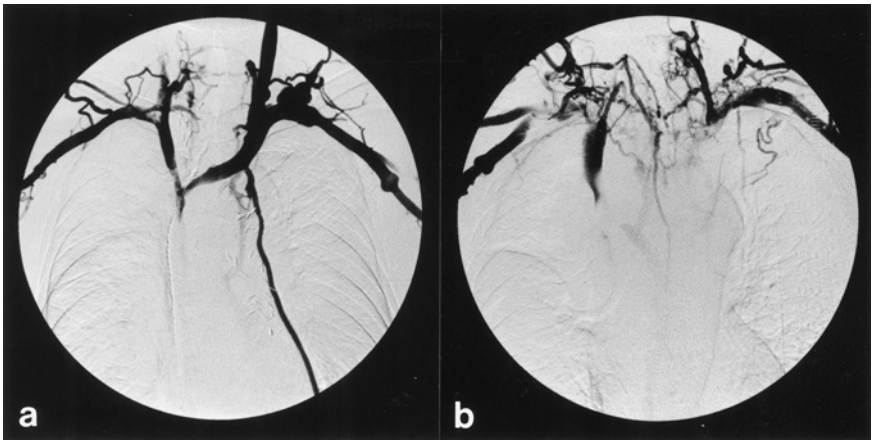

Fig. 2.
a: Patient 3. Digital subtraction superior vena cavography by simultaneous bilateral cubital vein injection demonstrates obstruction of the SVC.
b: Patient 4. Cavogram shows obstruction of the SVC and left innominate vein with extensive collaterals.

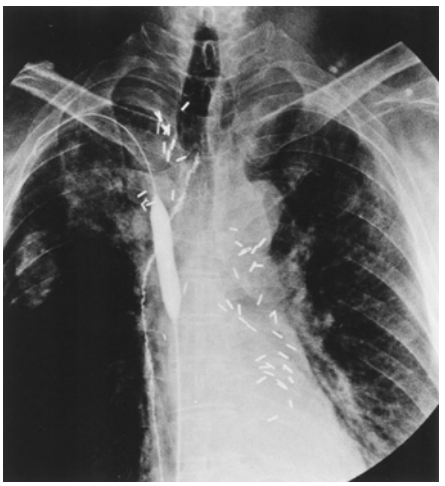

Fig. 3. Balloon dilation of the SVC stricture.

sheath.

After implantation, superior vena cavography was repeated to confirm patency and free flow into the right atrium and pulmonary circulation (Fig. 4), and a chest radiograph was taken to show the position and status of stent expansion (Fig. 5).

All patients were given 5,000 IU heparin intravenously during the procedure. Low-dose heparin (10,000 IU every 24 hours) was given for 3 days, and concurrent full oral anticoagulation with warfarin sodium was started on the same day and continued for at least 3 months.

Results

Table I summarizes patient profiles. Thirteen stents were implanted in 11 patients. Depending on the length or position of the obstructive lesion, 9 received 1 stent, and 2 received 2.

In 7, stenosis involved the confluence of the innominate veins, and a single long stent was implanted in the SVC and caudal portion of the right innominate vein across the ostium of the left innominate vein.

Although a few patients experienced mild transient pain during inflation of the angioplasty balloon, all procedures were successful and stent positioning immediately after the procedure was correct in all 11 patients. No procedure-related complications such as stent dislocation, stent migration, or vascular perforation occurred.

Ten patients noticed rapid resolution of headache, with relief of obstruction. Cyanosis disappeared over the first hour and facial swelling gradually resolved over the first 24 hours. Trunk and arm swelling resolved within 72 hours. In 1 patient, clinical status remained unchanged due to insufficient dilation of the SVC, and required implantation of another stent 3 days after the initial procedure, dying 5 days after the first stent implantation due to heart failure caused by increased venous return superimposed on pulmonary compromise.

Eight of the 11 died between 5 and 190 days (median 82.4 days) due to disease progression. The 3 survivors remain free of SVC syndrome in follow-up periods of 33, 202, and 227 days. Consequently, 10 of

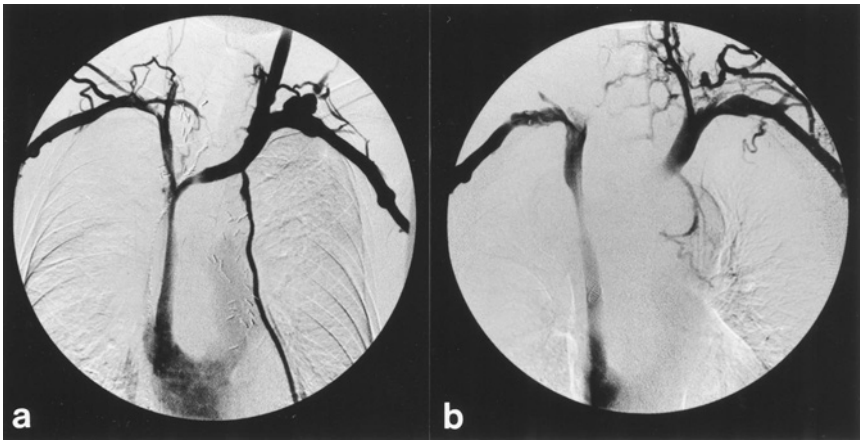

Fig. 4.
a: Patient 3. Superior vena cavogram obtained immediately after stent implantation in the SVC shows free flow through the SVC into the right atrium and pulmonary circulation.
b: Patient 4. The stent was implanted in the right innomonate vein and the SVC across the ostium of the left innominate vein. The SVC is patent but the left innominate vein is encased in a tumor. Collateral veins are no longer opaque especially on the right side.

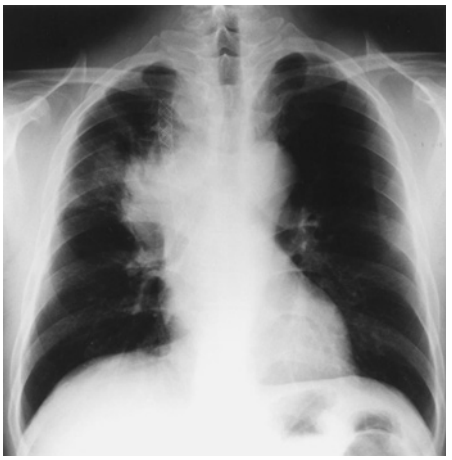

Fig. 5. Radiography after implantation shows a 10-mm-diameter Wallstent in the SVC and right innominate vein.

11 stented patients remained free of obstruction at death or to date.

Discussion

Self-expanding metallic stents were recently developed for dilating stenosed lumina. Charnsangavej et al.[2] first described percutaneous intravenous self-expanding metallic stent implantation for SVC syndrome. Since then, reports of SVC stenting have been numerous. Most clinical experience concerns the self-expanding Gianturco Z-stent,[3–10] while some studies with the balloon-expandable Palmaz stent[11–13] and the self-expanding Wallstent[14–20] have been reported.

The results of treatment of malignant SVC syndrome with self-expanding metallic stents have been more favorable, both with the self-expanding Gianturco Z-stent and with the balloon-expandable Palmaz stent. The reported success rates for the Gianturco Z-stent range from 76% to 94%.[5–10] The few reports on use of the Palmaz stent indicate comparably high success rates.[11–13] The self-expanding Wallstent already has an established role in the treatment of malignant obstruction of the biliary tree and in peripheral and coronary arteries resistant to angioplasty.[14] The success of the self-expanding Wallstent in these applications has led to its increasing use in other clinical areas, such as in stenoses or occlusions of the cephalic vein and the SVC.

Several recent publications have reported comparable patency rates and clinical success rates with the Gianturco Z-stent using Wallstent. The reported success rates for the Wallstent range from 86% to 100%.[15–19] In the present study, 10 of the 11 patients experienced symptomatic relief, with excellent clinical results. The main advantages of the Wallstent include its smaller introduction system, flexibility, and ease of insertion in tortuous vessels. Additionally, because of the tightness of the Wallstent weave, tumor ingrowth may be less of a problem than with the Gianturco Z-stent.

Selection of the correct stent size is a major determinant of Wallstent endovascular prosthesis patency. Implantation in the SVC requires the largest possible stent diameter. The stent diameter must be greater than that of the SVC to prevent stent migration and to compensate for neointimal growth.[16] Stents 16 mm in diameter are the most frequently reported in the literature. It was not possible to obtain optimal stent sizes (14 mm or 16 mm) in Japan until August 2000, so we used stents 10 mm in diameter. Fortunately, dislocation or migration did not occur.The stent length must be adapted to the length of the stenosis to cover the entire lesion. If necessary, 2 or more stents are placed in tandem, overlapping. In the present study, 2 patients received 2 stents.

Careful evaluation with fluoroscopy is required to ensure that the center of the stent lies across the area of maximum stenosis.[14] It is sometimes difficult to implant the stent precisely, mainly because of the necessity to preserve the patency of the main SVC tributaries and their confluence. Implantation of a stent both in the left innominate vein and in the SVC may be difficult, particularly when the left innominate vein runs at a right angle to the SVC or when its caudal portion has stenosis. The Gianturco Z-stent or Palmaz stent are more rigid, and implantation may be more difficult in these cases. Otherwise, because of its flexibility, the Wallstent provides coverage of 2 vessels in a single procedure, usually by 1 long stent alone.[16]

When implanted in the venous system, stents gradually are covered by the tunica intima and incorporated into the vascular wall within a few weeks without impairing the patency of the side branches.[2] Gaines et al.[7] state that when both innominate veins are occluded, it is sufficient to restore patency to only 1 of the veins to provide symptomatic improvement, even when patients present with bilateral upper extremity edema. Qanadli et al.[19] backed this practice. We thus implanted 1 long stent to cover SVC and right innominate vein when both innominate veins were occluded, and attained immediate symptomatic improvement.

A definite contraindication to stent implantation within the SVC is the presence of intraluminal tumor ingrowth.[16] The presence of an intraluminal tumor will prevent correct endothelialization of the stent, and the tumor may grow beyond the interspace of the stent struts.[14,15] If thrombus is found, thrombolytic therapy has been advocated before stent implantation.[7,13,15,18,20] Kee et al.[13] treated 27 patients with acute SVC thrombosis using catheter-directed thrombolytic therapy, and 4 needed no further intervention. Adjuvant thrombolysis, however, has resulted in complications such as intracerebral hemorrhage,[15] gastrointestinal bleeding, and large hematoma.[13] Careful evaluation of the presence of tumor ingrowth or thrombus should therefore be documented before stent implantation.

Among hemodynamic and permeability changes, the most explainable was cardiac incompensation for rapid increase of venous return after reperfusion. Electrocardiographic changes, blood pressure, oxygen content, respiratory sounds, and other physical signs should be monitored. Pulmonary edema due to a sudden increase in venous return after SVC stent implantation has been reported,[6] but is rare and usually managed by diuretics, dopamine, steroids, and oxygen. The case we had with heart failure due to increased venous return after stent implantation was resistant to such management and unfortunately died early.

Anticoagulation therapy after stent implantation is indicated if there is a risk of thromboembolism, but the benefits of this should be weighed against the risk of bleeding complications and inconvenience to terminally ill patients.[21] Published series differ on the need for anticoagulation following stent implantation. Rösch et al.[4] used long-term anticoagulation routinely, whereas Irving et al.[5] did not. However, both groups had almost identical long-term patency rates. Although no clear consensus exists on the role of anticoagulation, we use low-dose heparin for 3 days and overlapping full oral anticoagulation with warfarin sodium for at least 3 months, and all stented patients remained free of obstruction at death or to date.

Although long-term patency rates have not been established, in patients with malignant SVC syndrome, stents usually remain patent for the lifetime of the patient. We have not seen any reccurrence of SVC syndrome after Wallstent implantation from either tumor ingrowth or thrombosis. Because of its rapid, reliable physiologic effect and reduced invasiveness, Wallstent implantation has proved to be useful, easy, safe treatment for refractory SVC syndrome, often in preterminal and inoperable patient. We consider indications for Wallstent implantation include the onset of congestive symptoms, significant stenosis in the initial cavogram, and cases where the underlying disease is not curable.

Conclusion

Percutaneous implantation of the self-expanding Wallstent endovascular prosthesis for malignant SVC syndrome provides rapid symptomatic relief and improves the patient's quality of life.

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