STENTING IN MALIGNANT OBSTRUCTION OF SUPERIOR VENA CAVA

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The treatment of patients with malignant superior vena caval obstruction with minimal morbidity has been made possible by the recent introduction of expandable metal stents as the sole palliative treatment or as an adjunct to other treatment modalities. To alleviate the distressing symptoms of superior vena caval obstruction, self-expanding metal stents were used successfully in 12 (Wallstent device in 6 and Gianturco device in 6 patients) of 13 patients. The diagnoses were small cell carcinoma ($n = 4$), squamous cell carcinoma ($n = 4$), non-Hodgkin's lymphoma ($n = 1$), and mesothelioma ($n = 1$), and a diagnosis of malignancy was not confirmed (although strongly suspected) in the remaining three cases. Eleven patients had immediate relief of obstruction and there was no change in one patient. Mean follow-up was 3.7 months (range 1 to 10 months). Excellent palliation was obtained in all but one patient in whom recurrent superior vena caval obstruction developed 3 months after stenting. Mean survival was 4.8 months (range 1 to 10 months). The ease of insertion with the use of local anesthesia with radiologic control, the self-expanding nature of the stent, and the lack of major complications on follow-up of up to 10 months are particular advantages. The self-expanding superior vena caval stents are a useful addition to our armamentarium in the management of malignant superior vena caval obstruction. (*J Thorac Cardiovasc Surg* 1996; 112:335-40)

Superior vena caval (SVC) syndrome was first described by William Hunter in 1757.¹ The SVC syndrome is caused by malignant disease in 85% to 95% of reported cases.²⁻⁴ The cause is bronchogenic carcinoma in about 80% of the cases, with lymphoma and metastatic disease comprising 15% and 5%, respectively.⁴ Mediastinal inflammation as a result of fibrosing mediastinitis and granulomatous disease caused by histoplasmosis infection predominate the benign causes of SVC syndrome.⁴ With the advent of long-term central venous catheterization for diagnostic or therapeutic interventions, catheter-related thrombosis of the SVC is being increasingly reported.^{2,5}

The symptoms consist of venous congestion and edema of the upper half of the body. The prognosis is poor in the presence of upper airway obstruction

caused by edema or cerebral edema.³ Bypass operations,⁶ radiation therapy,^{7,8} and chemotherapy⁹ have been used to treat SVC syndrome. The indications for operation are limited, and radiation therapy and chemotherapy are not promptly effective.¹⁰ Recurrent SVC obstruction develops in 10% to 19% of the patients after radiotherapy.² Surgical management is associated with high morbidity and mortality particularly in patients with malignant disease with a short life expectancy.

Percutaneous stent placement for the treatment of SVC obstruction has been previously reported with Gianturco stents¹¹⁻¹⁵ (William Cook Europe AS, Bjaeverskov, Denmark), Palmaz stents¹⁶ (Johnson & Johnson Interventional Systems, Warren, N.J.), and Wallstent devices^{17,18} (Schneider Inc., Pfizer Hospital Product Groups, Minneapolis, Minn.). We present our experience of 13 patients, updating our previous report of two cases.¹⁹

Patients and methods

Between May 1991 and March 1995, we placed self-expanding metal stents in 13 consecutive patients with clinical evidence of SVC obstruction. There were eight men and five women, with a mean age of 60 years (range 52 to 74 years). Table I shows the demographic details of the patients and the causes of SVC obstruction. Eleven

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Table I. Demographic details

Patient No.	Sex/age (yr)	Diagnosis	Stent	Response	Follow-up
1	M/67	Small-cell carcinoma	Gianturco, 2 stents	Good	10 months (died)
2	F/60	R paratracheal mass	Gianturco	Good	2 months (died)
3	M/79	R paratracheal mass	Gianturco, 2 stents	Poor	1 month (died)
4	F/58	Small-cell carcinoma	Gianturco, 2 stents	Good	5 months (died)
5	M/64	NHL of mediastinum	Gianturco	Good	6 months (died RTA)
6	M/71	R paratracheal mass	Gianturco, 4 stents	Good	3 months (died)
7	M/74	Recurrent squamous cell carcinoma RUL	Wallstent	Good	1 month
8	M/52	Mesothelioma	Wallstent	Good	Recurrent SVC obstruction 3 months
9	M/68	Squamous cell carcinoma mediastinum	Wallstent	Good	3 months (died)
10	F/58	Squamous cell carcinoma RMB (thrombolysis+)	Wallstent	Good	5 months
11	F/59	Small-cell carcinoma	Wallstent	Good	1 month (died)
12	M/68	Small-cell carcinoma	Wallstent	Good	5 months (died)
13	F/63	Squamous cell carcinoma with mediastinal metastasis	Unsuccessful	—	3 months (died)

R, Right; NHL, non-Hodgkin's lymphoma; RTA, road traffic accident; RUL, right upper lobe; RMB, right main bronchus.

patients had presenting symptoms of severe SVC obstruction, and two patients had recurrent SVC obstruction after radiotherapy. Patients with upper airways compromised by laryngotracheal edema or with symptoms caused by cerebral edema were considered to have severe SVC obstruction.

In all patients diagnosis was confirmed by venography (Figs. 1 and 2) before stenting. Histologic diagnosis of the cause of obstruction was confirmed by bronchoscopy or mediastinoscopy, or both, in 10 cases and in the remaining three cases histologic confirmation was not obtained despite high clinical and radiologic suspicion of malignancy.

Stent insertion with the use of a local anesthetic with radiologic control (see following section) was attempted in 13 patients and was technically successful in 12 patients. One patient needed thrombolytic treatment before stent placement. Six patients received Gianturco stents (earlier series) (Fig. 3) and the most recent six patients had Wallstent devices inserted (Fig. 4). Multiple Gianturco stents were used in five patients in the SVC and the left innominate vein. Six patients received additional radiotherapy or chemotherapy after stent insertion. Two patients had received radiotherapy previously and in the remaining five patients the condition was considered unsuitable for any additional treatment. Complete resolution of symptoms after stent placement was the criterion used to assess the success of the procedure. All patients were examined clinically by the thoracic surgeons and chest physicians.

Technique of insertion. The technique of stent placement has been documented,^{14,18} and only the salient points of the technique are summarized here.

1. Adequate demonstration of the relevant mediastinal venous anatomy is achieved with catheter placed from both arms.

2. A guide wire is negotiated across the stenosed or occluded SVC. This is generally achievable with use of a supporting catheter and hydrophilic guide wire combination familiar to interventional radiologists.
3. The stent is placed across the stenosed or occluded segment ensuring adequate coverage of the lesion, with use of an appropriately sized angioplasty balloon to aid stent expansion when necessary. The use of a long, very stiff exchange wire greatly facilitates this stage of the procedure, preventing coiling in the right atrium and allowing enough length to accommodate the long stent delivery system.
4. A standard sized Wallstent device 12 mm in diameter and 9.6 cm long is adequate for all patients.
5. The accurate placement required in most arterial settings is less important in SVC obstruction because of the length and diameter of the vessel and the availability of effective collateral channels.
6. All patients receive 5000 units heparin before stent deployment and intravenous heparin (24,000 units/24 hours) for 48 hours.
7. Patients who required thrombolysis before stent placement receive long-term warfarin maintenance.

Results

The procedure was technically successful in 12 out of 13 cases, and failure was caused by complete occlusion of the SVC by extensive thrombus. In 10 patients immediate relief of SVC obstruction was seen within 24 to 48 hours, in one patient who had thrombolytic treatment previously clinical relief was not seen until 72 hours after stent placement, and in the remaining one patient clinical status remained unchanged.

Mean follow-up was 3.7 months (range 1 to 10 months). Recurrent SVC obstruction occurred in only one patient (patient 8) 3 months after initial stent insertion. Repeat venogram showed thrombotic occlusion, which responded effectively to thrombolytic treatment and placement of a second Wallstent device within the original stent. Ten patients died during the follow-up period with a mean survival of 4.8 months (range 1 to 10 months).

Discussion

Various modalities of treatment have been advocated for the management of SVC obstruction. With recent advances in percutaneous interventional vascular technology thrombolytic agents, angioplasty, and intravascular stents have been used in the management of SVC obstruction.^{11-13, 20-22} Conventional treatment of this condition has been by radiotherapy, although chemotherapy is of value in small cell carcinoma.²³ Although radiotherapy is successful in relieving obstruction caused by sensitive tumors such as lymphoma the success rate with bronchial carcinoma is less consistent.³ Remission rates of 76% are quoted in such situations.²⁴ Surgical procedures such as venous bypass grafts or pericardial grafts necessitate major operations in patients with limited life expectancy.^{4, 25}

The intraluminal self-expanding metallic stents can be placed percutaneously under local anesthesia with radiologic control. The stent can be compressed and introduced through a Teflon polytetrafluoroethylene catheter sized 8F to 12F depending on the caliber of the wire and the diameter of the stent. When the stent is released from the catheter, it expands to its original diameter. The expansion force varies with the caliber of the wire, the diameter and the length of the stent, and the number and angle of the bends.²⁶ When placed 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.¹¹ The length of the stenosis does not preclude stent insertion because multiple stents can be inserted at the same time as in this series. For long strictures that require multiple stents, the distal stent should be placed first. The major disadvantage of the Gianturco stent used in the early part of this series is its shorter length and its potential to allow tumor ingrowth through its wider gap between the stent wires. The Wallstent device maintains the advantage of the metal stent, and its narrow woven mesh, greater flexibility, and

Fig. 1. Digital subtraction venogram in patient with SVC obstruction.

longer length make it superior to the Gianturco stent.

Patients who are unable to lie flat, those with chronic complete vessel occlusion or severe coagulopathy, and those with cardiac failure are unsuitable candidates for intravascular stent placement.^{27, 28} Pulmonary edema because of a sudden increase in venous return after SVC stent placement has been reported.²⁹ For SVC obstruction caused by benign diseases the stent insertion should be approached with caution. It should only be considered in patients in whom other techniques of palliation have failed or are hazardous. The follow-up to date after such procedures in these patients has been relatively short. However, restenosis as a result of

Fig. 2. Venogram demonstrating complete obstruction of SVC and brachiocephalic veins.

epithelial hyperplasia would not preclude palliation by other means.¹⁴

We have demonstrated a failure rate of 7.1% with the Gianturco stent with no restenosis. This compares favorably with the failure rate of 7.7% and restenosis rate of 14.3% reported in 91 patients in the literature.^{14, 16, 27, 28-30} There have been fewer reports on the use of the Wallstent device. Reported rates of failure and restenosis after Wallstent device insertion are 0% and 9%, with the corresponding rates for our patients in this series at 0% and 16.6%, respectively.^{18, 31}

In a recent review of 56 procedures for relief of SVC obstruction a morbidity rate of 29% and a mortality rate of 4% were observed.²⁷ The reported complications were stent misplacement (10%), stent occlusion (10%), stent migration (5%), and chest pain (4%).²⁷ In this series thrombotic stent occlusion was the only complication seen in one patient (patient 8) and there was no stent-related mortality. Cardiac arrhythmias and stent breakage have also been reported.²⁷ The antagonistic movements of cardiac contraction, diaphragmatic excursion, and tumor compression probably contribute to the mechanism of breakage.²⁷

The stents are thrombogenic and it was initially thought that patients required a short period of

anticoagulation. Rosch and associates¹² used long-term anticoagulation routinely, whereas Irving and colleagues¹⁴ did not. However, both groups had almost identical long-term patency rates. In one patient in our series thrombotic occlusion occurred, which was effectively treated by thrombolytic treatment and placement of a second stent. Anticoagulation therapy after a stent procedure is indicated if there is a risk of thromboembolism. However, the benefits of this measure should be weighed against the risk of bleeding complications and inconvenience to terminally ill patients. If thrombus is present initially, it should be lysed before stent placement, as in patient 10 in our series.^{28, 32} Follow-up periods of up to 1 year in SVC stents and 2 years in inferior vena caval stents have demonstrated long-term patency of these devices.²⁷ In our series the stent was patent up to 10 months after insertion in patient 1.

From our experience and that of others^{12, 27} there is no doubt that stenting is an effective treatment for SVC obstruction. What remains to be decided is the timing of the treatment. Certainly stenting should be the treatment of choice in unrelieved obstruction after treatment and in patients with recurrent obstruction after initially successful treatment and even as a primary treatment modality for

Fig. 3. Chest radiograph showing Gianturco stent in SVC (same patient as in Fig. 1).

Fig. 4. Wallstent device in SVC (same patient as in Fig. 2).

patients who are unfit or in those with threatened cerebral and laryngeal edema. It is a simple, safe, rapidly effective, minimally invasive technique for management of SVC obstruction.

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