

Brachiocephalic-Superior Vena Cava Metallic Stenting in Malignant Superior Vena Cava Obstruction

K Y Lau,*^{MBBS, FRCP, DABR}, L T H Tan,**^{FAMS, MBBS, FRCP}, W W C Wong,**^{MBBS, FRCP, FHKAM},
A S L Lee,***^{BSc}

Abstract

Introduction: We studied the effectiveness of unilateral brachiocephalic (BC)-superior vena cava (SVC) metallic stent therapy in malignant SVC obstruction. **Materials and Methods:** From November 1998 to February 2002, SVC stenting was performed in 11 patients with symptomatic malignant SVC obstruction. There were 10 males and 1 female, with a mean age of 64.2 years (range, 37 to 78 years). The computed tomography (CT) scan and superior vena cavogram findings of all patients showed malignant SVC obstruction. Both internal jugular veins were patent in all patients by ultrasound. SVC stenting was performed with Wallstent (Boston Scientific, Minneapolis, MN, USA) in 10 patients and Memotherm stent (Bard angiomed, Wachhausstraße, Germany) in 1 patient. Pressure gradient, duration of the procedure, peri-procedural morbidity and mortality and the general well-being of the patients were reviewed. **Results:** SVC stenting was performed at a mean duration of 9.6 days (range, 3 to 30 days) after presentation. All were technically successful with 10 across the right BC-SVC and 1 across the left BC-SVC. There was no peri-procedural morbidity or mortality. The entire procedure was completed at a mean duration of 115 minutes (range, 75 to 225 minutes) with good angiographic and pressure results. Immediate symptomatic relief of SVC syndrome was achieved in 10 patients who had received prompt work-up and stenting 3 to 18 days after presentation. The remaining patient, who received work-up and stenting 30 days after presentation, remained dyspnoeic and died of pneumonia 7 days after the procedure. **Conclusion:** Unilateral BC-SVC metallic stenting is an effective measure in malignant SVC obstruction. Prompt pre-stenting work-up and stenting are recommended to achieve a longer symptomatic relief period.

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Introduction

A large majority of superior vena cava (SVC) syndrome is caused by malignancy (74% to 95%).¹ This can either be due to direct SVC invasion or secondary to extrinsic compression. Fifteen per cent of patients with bronchogenic carcinoma (most frequently small cell carcinoma)² and 3% to 8% lymphoma³ developed SVC syndrome. Other causes of SVC syndrome include central venous catheter, pacemaker lead, mediastinal fibrosis and aortic aneurysm. The clinical features include facial, neck and upper limbs swelling with dilated superficial veins over the chest wall. SVC syndrome can be associated with dyspnoea, while visual disturbance and cognitive dysfunction can be due to cerebral venous congestion. The presence of severe venous congestion may preclude mediastinal biopsy because of difficulty in achieving haemostasis after biopsy.

The traditional treatment for malignant SVC obstruction

is either radiation therapy or chemotherapy. Palliative bypass surgery is a major surgical intervention that is associated with significant risk, especially in such pre-terminal condition. SVC stenting is a well-recognised, effective alternative procedure that is less invasive than bypass surgery and less toxic than chemotherapy or radiotherapy. Charnsangavej et al⁴ described SVC stenting using Gianturco Z stents in 1986. Following this, studies using self-expandable Gianturco Z stent,^{5,6} balloon-expandable Palmaz stent^{7,8} and self-expandable Wallstent⁹⁻¹³ have been reported.

It is common for the confluence of the brachiocephalic (BC) veins to be involved in malignant SVC obstruction. However, when both internal jugular veins are patent, unilateral BC-SVC stenting is an effective method to relieve venous congestion and improve quality of life, even though the confluence of the central veins is involved.

* Chief of Service

** Senior Medical Officer

*** Radiographer

Department of Radiology

Pamela Youde Nethersole Eastern Hospital, Hong Kong

Address for Reprints: Dr K Y Lau, Department of Radiology, Pamela Youde Nethersole Eastern Hospital, 3 Lok Man Road, Chai Wan, Hong Kong SAR.

Email: drkylau@yahoo.com

The technique and effectiveness of unilateral BC-SVC stenting using metallic stents in malignant SVC obstruction are presented.

Materials and Methods

From November 1998 to February 2002, BC-SVC stenting was performed in 11 patients with symptomatic SVC obstruction syndrome. There were 10 males and 1 female with a mean age of 64.2 years (range, 37 to 78 years). Mediastinal biopsies were attempted in 2 patients by the cardiothoracic surgeons, but were technically unsuccessful due to severe venous congestion. Computed tomography (CT) scans of all patients were done at a mean of 1.9 days (range, 0 to 5 days) after admission and showed evidence of an irregular superior mediastinal mass with encasement of the BC vein and the SVC, indicating malignant SVC obstruction. Superior vena cavograms of all patients were done at a mean of 8.5 days (range, 1 to 30 days) after admission and showed SVC obstruction (0 Stanford type I, 4 type II, 6 type III and 1 type IV).¹⁴ Ultrasound of the internal jugular veins was performed in all patients immediately following the superior vena cavogram and all showed widely patent right and left internal jugular veins. SVC stenting was performed at a mean of 9.6 days (range, 3 to 30 days) after presentation, using Wallstent (Boston Scientific, Minneapolis, MN, USA) in 10 patients and Memotherm stent (Bard angiomed, Wachhausstraße, Germany) in 1 patient. The patient, who had SVC stenting performed 30 days after presentation, had received empirical radiation therapy at a dose of 28 Gy before stenting, but the post-radiotherapy response was poor. Pressure gradient, duration of the procedure, peri-procedural morbidity and mortality and general well-being of the patients were retrospectively reviewed.

Pre-stenting Work-up

Apart from basic pre-angiography preparation, the following investigations were recommended:

1. CT scan of the thorax to determine the nature of the obstruction, length of the stenosis, degree of SVC compression and diameter of the SVC. CT scan is particularly useful in the measurement of SVC diameter and length of the stenosis as an entirely occluded SVC will not be opacified in a superior vena cavogram.
2. Superior vena cavogram (Fig. 1) to map out the vascular anatomy and, together with the CT scan, to estimate the SVC diameter and length of the SVC obstruction. Superior vena cavogram was performed using digital subtraction angiography (DSA) technique, 40 to 50 cc dilute (1:1 dilution) water-soluble contrast medium, 10 cc/sec, 1 frame/sec for the whole run, via 18-gauge angio-catheters at both antecubital veins and a Y-adaptor connected to the injector.

3. Ultrasound of both internal jugular veins as an adjunctive measure to ensure both veins are patent, which is important in unilateral BC-SVC stenting.

SVC Stenting Technique

Informed consent was obtained from each patient. The angiographic procedure was performed via femoral approach under local anaesthesia and continuous monitoring by electrocardiogram, blood pressure, heart rate and oxygen saturation. An adhesive tape with radio-opaque calibrations was placed at the anterior chest wall or, alternatively, a ruler with radio-opaque calibrations was placed at the back of the patient at the right mid-clavicular line. Adalat 5 to 10 mg was given sublingually just before the procedure to prevent venous spasm. The size of the vascular sheath varied from French 10 to 12, depending on the size of the stent, which was obtained from the pre-stenting CT scan and venogram. A French 5 or 6 JB 1 or H1 catheter (Cook, Bloomington, IL, USA) was used. The pressures in the inferior vena cava, right atrium and SVC across the BC-SVC stenosis were recorded. Before traversing the BC-SVC venous stenosis using 0.035-inch hydrophilic, angled guidewire (Terumo, Tokyo, Japan), 4000 to 5000 IU heparin was given intravenously. After traversing the stenosis, the pressure in the right or left BC vein (depending on which side was chosen for stenting) was then measured. At this point, a superior vena cavogram (Fig. 2) was obtained in frontal projection, which provided sufficient information for stenting. The length of the stenosis and that of the stent were both determined by the guidewire withdrawal technique (with the catheter in place, the tip of the guidewire is positioned at the BC vein where the cephalic portion of the stent will be placed). A vascular clamp was applied to the guidewire at the luer-lock end of the catheter. Under fluoroscopic guidance, the guidewire was withdrawn slowly until it reached the optimum position at the SVC where the caudal portion of the stent should be positioned. Another vascular clamp was then applied to the guidewire at the luer-lock end of the catheter. The length of the stent is the length between the two vascular clamps, which can be measured by a sterile ruler. The diameters of the BC vein and SVC were obtained from the pre-stenting CT scan and venograms.

A 0.035 260 cm extra stiff Amplatz guidewire (Cook, Bloomington, IL, USA) was then employed for transluminal dilatation and stenting. A 10- to 14-mm balloon was used to pre-dilate the stenosis, depending on the size of the SVC and stent. We used either the Wallstent endoprosthesis or Memotherm stent, depending on their availability. The stents were deployed across either the right BC vein or left BC vein, even though the confluence of the SVC was involved by the tumour, to ensure that the orifice of the internal jugular vein was not covered by the stent. Once the

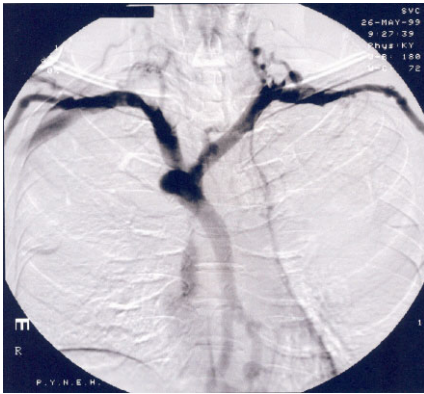


Fig. 1. Superior vena cavogram of Stanford type III obstruction shows SVC obstruction with reversal of flow in the markedly hypertrophied azygos vein.



Fig. 4. Post-stenting superior vena cavogram shows the stent in a satisfactory position and good contrast flow from the right internal jugular vein to the SVC and right atrium.

stent was deployed, it was further dilated using an appropriate-sized balloon to accelerate stent expansion. When using more than 1 stent, deployment of the caudal stent followed by the cephalic stent is recommended. This allows full expansion of the usually smaller-diameter cephalic stent. In addition, when using 2 stents, there should be appropriate (at least 2.0 cm) overlap of the stents, especially Wallstents, because of stent retraction after deployment (Fig. 3).

Post-stenting venogram (Fig. 4) was performed to ensure the success of stenting by demonstrating stent patency and position. The pressure gradient across the SVC stenosis was subsequently measured.



Fig. 2. Superior vena cavogram with the catheter in situ. This allows measurement of the pressure gradient across the stenosis, length of the stenosis and, therefore, length of the stent.



Fig. 3. When 2 stents were used, the larger caudal stent (20 mm) was deployed first, followed by the smaller cephalic stent (18 mm), with appropriate overlap between the stents.

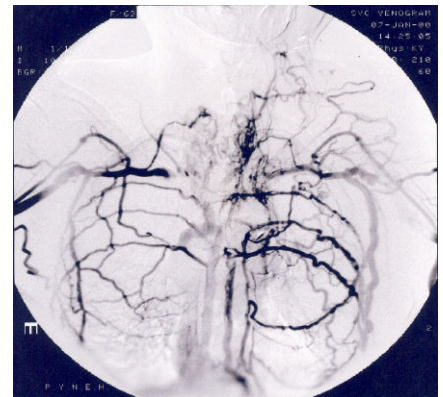


Fig. 5. Stanford type IV obstruction shows extensive mediastinal and intercostal collaterals with venous return of the upper extremities and chest to the inferior vena cava back to the right atrium.

Upon completion of the procedure, manual compression was applied at the puncture site for haemostasis. Bed rest was recommended for 6 hours, whilst keeping the leg with the puncture site straight for the same period of time. Plavix (Clopidogrel, Sanofi) 75 mg orally was prescribed routinely for 8 weeks after the procedure to allow endothelialisation of the stent.

Results

SVC stenting was technically successful in all 11 patients, 10 across the right BC-SVC and 1 across the left BC-SVC. Wallstent endoprosthesis was used in 10 patients and Memotherm stent was used in 1 patient (because the appropriate-sized Wallstent was not available at the time of stenting). Depending on the length of the available stents,

we placed 1 Wallstent in 6 patients, 2 Wallstents in 4 patients and 1 Memotherm stent in 1 patient; the sizes ranged from 12 to 20 mm in transverse diameter. The entire procedure was completed at a mean duration of 115 minutes (range, 75 to 225 minutes) with good angiographic and pressure results. SVC stenting was technically successful in all 11 patients. There was no peri-procedural morbidity or mortality. Pressure gradients were measured in 10 patients. Of these, the pressure gradients across the BC vein and SVC stenoses decreased at a mean of 26 mm Hg (range, 15 to 36 mm Hg) before stenting to a mean of 2.1 mm Hg (range, 0 to 7 mm Hg) after stenting. Immediate symptomatic relief of SVC syndrome was achieved in 10 patients who had received prompt work-up and stenting 3 to 18 days after presentation. Two patients, who had unsuccessful mediastinal biopsy attempts before SVC stenting, had successful and uneventful mediastinal biopsies. Malignant SVC obstruction was proven histologically in 9 patients: 7 with carcinoma of lung, 1 with thymic carcinoma and 1 with metastatic nasopharyngeal carcinoma. Biopsy results were equivocal in 1 patient and inadequate in another patient who refused further biopsy attempts.

All patients received radiotherapy with or without adjuvant chemotherapy after stenting. One patient died of disseminated malignancy 2 months after stenting, 1 died at 3 months, 1 died at 6 months and 1 died at 9 months. Four patients were still alive at the time of this study. The stents of the 2 patients who had the longest survival were patent on follow-up CT scan 7 and 8 months, respectively, after stenting. Two patients were transferred to a convalescence hospital 10 days and 60 days, respectively, after stenting and their present status could not be traced. One patient who received work-up and stenting 30 days after presentation remained dyspnoeic and died of pneumonia 7 days after the procedure. The cause of death of this patient was not related to the stenting procedure.

Routine follow-up chest radiograph, CT scan or venogram was not routinely performed to avoid patient discomfort and anxiety, as the quality of life of these pre-terminal patients is of the utmost priority. However, there was no recurrence of SVC obstruction. Migration, fracture or collapse of the stents was absent in follow-up post-stenting chest radiograph or CT scan.

Discussion

The traditional treatment for malignant SVC obstruction is either radiation therapy or chemotherapy. Endovascular SVC stent therapy is a well-recognised, safe and concise alternative procedure for SVC obstruction. SVC stenting is less invasive and risky than bypass surgery and is also less toxic than chemotherapy and radiotherapy. Studies using self-expandable Gianturco Z stent,^{4,6} balloon-expandable Palmaz stent^{7,8} and self-expandable Wallstent⁹⁻¹³ have been

reported.

In our series, the superior vena cavogram of all 11 patients who had severe acute/subacute onset of symptomatic SVC obstruction demonstrated Stanford types II, III and IV obstruction.¹⁴ Four other patients (1 Stanford type I and 3 type IV) who were referred for SVC stenting had no substantial clinical signs and symptoms of SVC obstruction on the day of stenting were not stented. In addition, 3 (Stanford type IV) of these 4 non-stented patients had extensive thrombosis of the right internal jugular vein and developed numerous mediastinal and intercostal collaterals (Fig. 5). The chronic onset of SVC obstruction allowed adequate time for the development of collaterals and, therefore, accounted for the absence of venous congestion at the upper half of the body.

When stenosis of the SVC involves the confluence of the central veins, it is debatable whether 1 or both BC veins should be stented. Gaines et al¹⁵ described that when both BC veins are occluded, it is sufficient to restore patency to only 1 of the veins to provide symptomatic relief, even when patients presented with bilateral upper extremity oedema. Irving et al¹⁶ stated that the decision to stent 1 or both BC veins will depend on the patient's symptoms. If bilateral upper extremity oedema is present, they advocate bilateral BC vein stenting. If bilateral upper extremity oedema is absent, unilateral stenting is recommended. In our series, the entire procedure required a mean duration of 115 minutes (range, 75 to 225 minutes) which is comparable to Hennequin et al's series.⁹ Needless to say, the deployment of 2 stents required a longer duration than the placement of 1 stent. Jackson and Brooks¹⁷ and Rosch et al¹⁵ reported cases of extensive thrombotic occlusion when they attempted to place bilateral BC vein stents secondary to a prolonged procedure time. In Hennequin et al's series,⁹ the bilateral femoral approach was recommended to deploy 2 stents across the right and left BC veins and the SVC in Y-configuration. Kee et al¹² also described a patient with parallel kissing Wallstents placed across the BC veins and the SVC required additional deployment of Palmaz stents in the lumina of the Wallstents to maintain stent patency. However, in our series, if both internal jugular veins were patent, 1 stent with appropriate length or 2 short stents with appropriate overlap would be good enough for decompression, even though the confluence of both BC veins was involved. Unilateral BC-SVC stenting is, therefore, not only less expensive, but also avoids bilateral femoral punctures for simultaneous deployment of 2 stents at the confluence of the 2 BC veins.⁵ We usually choose the right BC vein because the right internal jugular vein and the SVC are aligned in an almost straight line and is, therefore, technically easier for stenting. Hennequin et al⁹ used the double venous access technique, which allows opacification of the BC vein, to guide the deployment of the stent. We

used a tape with radio-opaque calibration placed on the right anterior chest wall or a ruler with radio-opaque calibration at the back of the patient along the right mid-clavicular line, together with a frozen image of the venogram for reference in stent placement.

Kishi et al¹⁰ established a criterion that pressure peripheral to the SVC stenosis <22 mm Hg indicated a less critical SVC syndrome. Hence, they did not perform stent placement in a patient with a pressure below this level. We did measure the pressure gradient across the SVC stenosis, which was to document the haemodynamic improvement after stenting. However, with regards to stent placement in our population, the indication for palliative SVC stenting should be made by the presence of distressful clinical symptoms, not by the pressure measurements, pressure gradient or Stanford venographic classification.¹⁴ The Stanford classification of SVC obstruction¹⁴ provides useful adjunctive information on the degree of SVC obstruction. Hennequin et al⁹ recommended 2 projections in the superior vena cavogram to classify the type of Stanford SVC obstruction.¹⁴ We believe that, with the help of the CT scan, single frontal projection for the superior vena cavogram is sufficient to estimate the degree of SVC obstruction.

According to Hennequin et al,⁹ when using several stents, the cephalic stent was placed first, followed by the caudal stent. On the contrary, we recommend placing the caudal stent first and then the cephalic stent. This is because the SVC, and subsequently the stent, usually has a larger diameter than the BC vein. This will allow full and better expansion of both stents. Though the long-term prognosis of Wallstent in SVC obstruction is uncertain, there are several advantages: a) flexibility, especially in curved vessel; b) small wire size and self-expansibility and, therefore, low occlusion rate;² and c) overexpansion and embedding the metal stent struts away from the circumference of the lumen allow rapid re-endothelialisation.⁹ Wallstent has 3 disadvantages. Firstly, it is susceptible to retraction after placement. Therefore, an appropriate length of the stent should be chosen to cover the entire lesion. In addition, there should be an appropriate (at least 2.0 cm) overlap if 2 Wallstents are employed. Secondly, the wires at both ends of the stent are more susceptible to balloon perforation. Finally, it has less radial strength than the Palmaz stent.

In conclusion, metallic SVC stenting is a rapid, safe and effective measure to treat acute/subacute onset of symptomatic malignant SVC obstruction. When both internal jugular veins are patent, unilateral BC-SVC stenting is often sufficient even though the venous confluence is

involved. Prompt pre-stenting work-up and stenting are recommended to improve the quality of life and to prevent potential fatal complications of SVC syndrome.

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