Stenting of superior vena caval obstruction

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Introductory article

Superior vena caval obstruction managed by the Gianturco Z stent

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Twenty patients with superior vena caval obstruction (SVCO) due to malignancy were managed using the Gianturco Z stent. Three patients had adjunctive thrombolysis. The primary clinical success was 90% (18/20 patients). Thirteen patients were free of SVCO to death or follow-up without re-intervention (primary patency=65%). Three patients had re-intervention for recurrent symptoms, two successfully (secondary long-term patency=75%). Stenting of the SVC is a valuable, under-used technique for the symptomatic relief of superior vena caval obstruction. (Clin Radiol 1994;49:202-8)

In the introductory article, Gaines *et al* describe their experience with the Gianturco Z self-expanding metallic endoprosthesis (William Cook Europe, Bjaeverskov, Denmark) for the relief of malignant superior vena caval (SVC) obstruction in 20 patients.¹ During the previous year, Dyet *et al* published their results of SVC stenting in 17 patients with the same condition, although they used the Wallstent endovascular prosthesis (Schneider, Bülach, Switzerland).² In this earlier study 15 of the patients had been treated previously with radiotherapy or chemotherapy without sustained relief and six had had thrombolysis before stenting, and it is worth while considering these two papers together.

Initial attempts at endovascular treatment of SVC obstruction relied on simple balloon angioplasty but, whilst this was occasionally successful in benign disease, recurrence rates were very high due to the inability of the central veins to resist compression by surrounding tumour, fibrosis, or inflammatory tissue. Since the first reported successful placement of an intravascular stent for the treatment of malignant SVC obstruction in 1986³ there have been several published series and case reports⁴⁻¹³ documenting the value of this technique in the management of malignant strictures of the SVC and/or the brachiocephalic veins, and the papers by Gaines *et al* and Dyet *et al* are useful contributions to this literature. Despite this, a recent review on the treatment of SVC obstruction¹⁴ appears to dismiss SVC stenting with a single reference to a report describing the use of Gianturco stents in two patients.

The papers of Gaines *et al* and Dyet *et al* lend weight to the argument for this form of therapy and raise

questions about the possible use of stents as a first line treatment in patients with malignant SVC obstruction.

Background

PATHOGENESIS OF SVC OBSTRUCTION

Obstruction of the SVC occurs as a complication of primary intrathoracic malignancy in approximately 3-8% of patients.^{15,16} Invasion of the mediastinum by bronchogenic carcinoma is the most common cause, accounting for 70-80% of cases, with most of the remainder being due to lymphoma, mesothelioma, or secondary deposits from an extrathoracic primary.^{14,17,18}

Whilst only a small percentage of patients present with life-threatening SVC obstruction,¹⁹⁻²¹ symptoms are often distressing and include facial and upper limb oedema (which may be very severe), headache, dyspnoea, dysphagia, and visual disturbance. Most patients have advanced malignant disease and an average life expectancy of 3-10 months.^{18,20-22} The severity of symptoms depends upon the degree of SVC narrowing and the speed with which it occurs. Malignant disease often progresses rapidly and SVC obstruction is likely to occur before there has been time for the enlargement of collateral veins, whilst benign causes often produce more gradual narrowing of the central veins. Venous thrombosis may, however, complicate both benign and malignant disease and in these patients severe symptoms often develop rapidly.

Some authors have attempted to correlate the severity of symptoms with venographic findings²³ or SVC pressure.⁴ Whilst the venographic appearances are important

when it comes to choosing the best course of treatment (surgery, angioplasty, stent insertion, thrombolysis), in most patients these grading systems are of little practical use.

TREATMENT OF MALIGNANT SVC OBSTRUCTION

Radiotherapy

Radiotherapy is well established as the first line treatment for malignant SVC obstruction. Treatment is aimed at relieving venous compression by reducing tumour bulk and current methods employ initial high dose fractions for up to five days. Further radiotherapy is then tailored to the individual patient. The response to radiotherapy is usually rapid but may be delayed for 2–3 weeks and most patients will experience some improvement.^{21,24} Symptomatic relief is reported as being complete, however, in only 15–23% and partial in 50% of patients with bronchogenic carcinoma, although the results are much better in lymphoma, with a complete response in 65–75% and a partial response in 25–30% of patients.²¹ Recurrent SVC obstruction following radiotherapy occurs in 10–32%.^{16,21,22} Radiotherapy is generally well tolerated, with dysphagia being the most common complaint.

Chemotherapy

Lymphoma and small cell lung carcinoma are sensitive to both chemotherapy and radiotherapy. In 37 patients with small cell carcinoma complicated by obstruction of the SVC complete relief of symptoms was demonstrated in 57% and substantial relief in a further 27% with chemotherapy alone.²² No improvement in symptoms or survival was seen in patients who underwent additional radiotherapy. Recurrent SVC obstruction occurred in 30%.

Surgery

Surgical bypass of the SVC is a major operation requiring a thoracotomy and is best avoided in most patients with malignant disease who have a short life expectancy. There are several papers describing the useful palliation achieved in carefully selected patients using this technique,^{23,25,26} but there must be little doubt nowadays that stenting would be the preferred procedure in the first instance.

It is interesting to note, however, that six of the 20 patients treated by Gaines *et al* had undergone previous surgery for their SVC obstruction. In most patients this consisted of tumour debulking and some relief was obtained in all patients (personal communication, P Gaines), but the length and degree of symptom relief is not mentioned.

Practical aspects of stent insertion

STENT TYPE

A variety of different stents has been developed as a result of immense interest in the use of these devices for both vascular and non-vascular (for example, biliary, oesophageal, bronchial) indications (fig 1). Gaines *et al* used the Gianturco stent, which consists of a stainless steel wire bent into a zigzag configuration. These are supplied as single or double stents, the latter consisting

of two single stents joined together by a wire strut. The design of this stent is the reason for one of its primary failures – namely, its tendency to migrate out of short, tight strictures. For this reason the authors suggest the use of the double Gianturco stent in such patients. These are also less than ideal as the join between the two stents tends to settle at the stricture, resulting in marked funnelling of the mid portion of the stent or separation of the two stent elements on either side of the stricture. The latter occurred in one of the patients in this series with resultant stent occlusion at nine days. Whilst some modification of the Gianturco stent is possible in order to overcome these problems,²⁷ the experience of Dyet *et al* and others^{11,13} (including the present authors) with the Wallstent endoprosthesis, which consists of a tube of woven stainless steel mesh, shows this stent to have a number of advantages. These include easy deployment across tight strictures, a smaller sheath size of 9 Fr (compared with 11–14 Fr sheath size required for Gianturco stents), their availability in a variety of different lengths, and ease of insertion around bends. The last of these is particularly important when the right or left brachiocephalic veins require stenting. In addition, the meshwork is fairly tightly woven and one would therefore expect tumour ingrowth to be less of a problem than with the open design of the Gianturco stent. Gaines *et al* comment that “other types of stents ... are not yet ideal because of a limitation on stent diameter”. The 16 mm diameter Wallstent has, however, been shown by the Dyet group to be perfectly suitable for treatment of SVC obstruction and is preferred by most centres in the UK for this specific indication, including the centre from which the Gaines paper originates (personal communication, P Gaines).

Figure 1 Treatment of SVC obstruction and right main bronchial stenosis due to a bronchogenic carcinoma with Wallstents. Right main bronchial and SVC stents in situ. (Image courtesy of Professor A Adam, St Thomas' and Guy's Hospitals, London.)

Other endoprosthesis types currently available include the Strecker stent (Boston Scientific), which is made of knitted tantalum, and the Palmaz stent (Johnson and Johnson), which is an etched steel tube. Both are balloon expandable, not self-expanding.

THROMBOLYSIS

One of the patients reported by Gaines *et al* and six of those reported by Dyet *et al* required thrombolytic therapy before initial stent insertion because of the presence of subclavian and/or SVC thrombus. Both streptokinase¹ and tissue plasminogen activator² were used, and thrombolysis was reported as being successful and uncomplicated although the length of time required for complete lysis was not given for each patient. Two further patients reported by Gaines *et al* and one reported by Dyet *et al* underwent thrombolysis after stent insertion, one immediately, one four months, and the other six months later. Two of these procedures were complicated by bleeding, one being a self-limiting haemoptysis¹ and the other a haemoptysis followed by a fatal intracerebral haemorrhage.² Dyet's group also mentions five patients who were rejected because of extensive venous thrombosis. We are not told, but it is implied, that thrombolysis was not attempted in these patients.

Central venous thrombosis is therefore not a contraindication to stent placement. Even extensive thrombosis may be cleared by local infusion of low dose thrombolytic therapy,^{28,29} and it is our opinion that no patient should be excluded from a trial of thrombolysis, regardless of the degree of thrombus present, unless there is a definite contraindication to lytic therapy such as a recent cerebral infarction or very recent surgery. Nor should the length of the history exclude a patient from this treatment; thrombus which has been present for several weeks or months may be cleared in some individuals.

Thrombolysis is usually best achieved by inserting 5 Fr catheters into both arms, usually via an antecubital fossa or axillary vein approach, and manipulating their tips into the thrombus. Streptokinase (5000 units/hour) or tissue plasminogen activator (0.5 units/hour) is then infused through each catheter directly into the thrombus and the patient is returned to the ward. Repeat venograms are performed at six-hourly or eight-hourly intervals to assess progress, and the catheters are advanced into the more central veins if satisfactory lysis is seen. Once the underlying occlusive or stenotic lesion is demonstrated, stent insertion should be performed, usually via a femoral approach. It is important that the infusion of the lytic agent is continued during femoral catheterisation and stent insertion as further thrombus may develop extremely rapidly above a central venous stenosis because of stasis. It is unusual, if a severe SVC stenosis is present, for complete clearance of thrombus to occur without restoration of an adequate flow and, in some cases, a moderate amount of thrombus will still be present when the underlying stenosis is identified. Many interventionists would still proceed with stent insertion at this time as clinically significant pulmonary emboli appear to be rare. Thrombolytic therapy should be continued after stent placement until there is complete clearance of the venous lumen.

Mechanical thrombectomy devices may occasionally prove useful in those patients who do not respond to thrombolysis³⁰ or in those in whom lytic therapy is contraindicated. In certain individuals, and in particular those with life threatening SVC obstruction due to extensive thrombosis, these devices may produce more rapid thrombus clearance than is possible with thrombolytic agents.

ANTICOAGULATION

There is no clear consensus on the need for anticoagulation following stent insertion. Gaines *et al* routinely fully heparinised their patients for five days following the procedure. They do not appear to have used antiplatelet agents. Of the five patients in their series who developed recurrent symptoms, one who was left with a significant stenosis after stent insertion thrombosed after just nine days. The authors mention that anticoagulation might have been useful in this patient until full stent expansion had occurred. Recurrent symptoms in three of the remaining four patients were due to growth of tumour either into or over the stent. The cause of the final patient's recurrent symptoms was not known.

Dyet *et al* gave all of their patients 5000 units of heparin intravenously at the time of stent insertion and continued with a dose of 7500 units subcutaneously every six hours for the next two days. Aspirin (300 mg/day) was then prescribed for the next three months. Warfarin was prescribed for three months to those patients in whom complete SVC occlusion had been present and those in whom thrombolysis had been necessary. Two of their patients developed recurrent symptoms due to stent thrombosis, one at two days and the other at four months. Both of these patients had undergone thrombolysis at the time of their original stent insertion, and both had had their anticoagulation treatment discontinued shortly before thrombotic re-occlusion occurred.

Other authors are equally divided in their use of anticoagulation and antiplatelet agents. Kishi *et al*⁴ gave all their patients 1 g of aspirin intravenously for seven days after stent insertion and continued with 3 g orally for a further seven days. They had no thrombotic stent occlusions in their six patients on follow up. Rösch *et al*⁶ administered intravenous heparin during and for 3–4 days after stent insertion and then continued with warfarin indefinitely in those with malignant disease. One of their 22 treated patients returned at nine months with reocclusion due to a combination of tumour ingrowth and thrombosis shortly after discontinuing oral anticoagulation. Irving *et al*⁷ did not give any anticoagulants to their patients, 17 of whom had malignant SVC obstruction. None of these patients returned with recurrent symptoms. Watkinson and Hansell¹³ administered heparin during the procedure and for 72 hours afterwards and then discharged their patients on 75 mg aspirin. None of their five patients experienced recurrence of symptoms.

No firm conclusion can be drawn from these results. There is, however, no evidence that anticoagulation with heparin or warfarin is necessary in patients in whom there is good blood flow through the stent(s) at the end of the procedure. Our policy in patients who have undergone an uncomplicated procedure and in

whom there is either no or only a small residual stenosis is to give aspirin (300 mg/day) before the procedure, continued indefinitely afterwards at a lower dose of 75 mg; 5000 units of heparin are given during stent insertion. Systemic administration of heparin and, subsequently, warfarin for three months is reserved for those patients who require thrombolytic therapy and for those in whom there is a significant residual venous stenosis with some impairment of venous drainage. Ideally, a venogram should be performed at three months to exclude a residual stenosis, tumour invasion, or non-occlusive thrombus before ceasing anticoagulants.

STENT LENGTH

Of the five patients with recurrent symptoms, Gaines *et al* described two in whom this was due to compression of the SVC by tumour above or below the stent. One of these patients was successfully treated by insertion of another endoprosthesis. Similar problems of tumour overgrowth and early stent occlusion have been encountered in patients treated with metallic stents for malignant bile duct obstruction, and these have been partly overcome by placement of stents across a longer segment of normal bile duct above and below the malignant stricture. This technique, if applied to venous stenting in patients with SVC obstruction, might be expected to reduce the incidence of tumour overgrowth and is probably the reason for the fact that Dyet *et al* did not encounter this complication in their series. They treated disease confined to the SVC with a single 16 mm diameter, 6 cm long stent, but were more aggressive in the six patients in whom there was involvement of the brachiocephalic veins. In these patients two 10 mm diameter Wallstents (8 or 9 cm in length) were inserted into the brachiocephalic veins with their lower ends adjacent to one another within the SVC. In most of the patients treated by Gaines *et al* stenting was confined to the SVC and right brachiocephalic vein, even when left brachiocephalic vein disease was present.

Although it is generally easier to satisfactorily position the Wallstent than the Gianturco stent, care has to be taken with shortening after its deployment. Surprisingly, this is not mentioned as being a problem in the paper by Dyet *et al*. The 16 mm diameter Wallstent is available in a variety of lengths, the longest of which will be 9 cm when confined by a 14 mm vessel, 7.8 cm when confined by a 15 mm vessel, and 4.5 cm if full expansion to 16 mm is allowed. The stent used by Dyet *et al* is described as being 6 cm in length. This measurement probably applies to the stent, which is 6.1 cm long in a 14 mm vessel, 5.2 cm in a 15 mm vessel, and 3 cm in a 16 mm vessel. There is the possibility, therefore, that shortening of the stent will occur after placement with the risk of recurrent occlusion due to uncovering of the strictured segment, a complication which has been reported.³¹ It is important to keep this in mind when inserting these stents. Wallstents of 20 and 22 mm maximum diameter (4, 7, and 10 cm lengths) are also available, although these require placement of an 11 Fr sheath. Stents of 16 mm diameter appear to produce satisfactory results in most patients with SVC obstruction, and these large diameter endoprostheses have found their greatest application in the treatment of malignant oesophageal strictures.

SHOULD ONE OR BOTH BRACHIOCEPHALIC VEINS BE STENTED?

Gaines *et al* state that when "both brachiocephalic veins are occluded it is sufficient to restore patency in only one vein to effect symptomatic relief". As mentioned above, Dyet *et al* restored patency in both brachiocephalic veins in six of their patients with bilateral involvement. It might seem obvious that the latter course of action should be preferred, but this is not always the case. Even in patients with bilateral arm swelling, complete symptomatic relief may be obtained by relief of occlusion on one side only. This is presumably because of the development of collaterals across the midline. Dyet *et al* found that placement of bilateral stents extended the average procedural time by 25 minutes and, in some patients, the procedure may be excessively prolonged due to attempts to cross a severe stenosis of one brachiocephalic vein when the contralateral vein is easily catheterised. It is important to try to keep the procedural time short as thrombus formation may occur above the SVC stenosis during excessive catheter manipulation. Rösch *et al*⁶ describe one patient, and we have seen another, who developed extensive thrombotic occlusion of both brachiocephalic veins during a prolonged procedure involving bilateral stent insertion. Lysis was successfully performed in both.

It is now our policy to attempt stent insertion of both brachiocephalic veins with Wallstents in all patients with bilateral disease. If any difficulty is experienced in catheterising one side owing to more advanced disease, however, then unilateral stenting is performed.

IS BALLOON DILATATION NECESSARY?

Gaines *et al* do not mention balloon angioplasty of the SVC stenosis in any of their patients. In the invited commentary by Professor Dondelinger, following this paper, however, he mentions that balloon expansion after stent insertion "is useful in accelerating expansion, and in correcting eccentric alignment of multiple stents". Dyet *et al* used a 12 or 14 mm diameter balloon in 12 patients following stent insertion; five did not need dilatation as the radial force of the stent was sufficient to relieve the obstruction.

Predilatation may be useful in some patients, particularly those who have short, very tight stenoses. The difficulty in placing the Gianturco stent across such lesions has already been mentioned; if some dilatation is achieved before stent placement then accurate positioning of the endoprosthesis may be simpler.

COMPLICATIONS OF STENT PLACEMENT

No immediate complications directly attributable to stent insertion (other than unsatisfactory position as already discussed) were reported in either of the papers being reviewed. One patient in each series had complications related to thrombolysis. One further patient reported by Dyet *et al* had a haemoptysis five days after commencing warfarin.

Migration of Gianturco Z stents into the right ventricle (from the inferior vena cava)³ and pulmonary artery³² have been reported, but in both cases there were no clinical sequelae. Stent fracture is also a pos-

sibility,⁸ and is one of the reasons why careful consideration should be given to their use in patients with benign disease and longer life expectancy.

AT WHAT STAGE SHOULD SVC STENTING BE OFFERED?

There can be little doubt that stenting must be the procedure of choice in continued or recurrent SVC obstruction following conventional treatment with radiotherapy or chemotherapy. It is a little more difficult to decide whether or not all patients with SVC obstruction should be offered endoprosthesis insertion as a first line treatment. The arguments in favour of this include the simplicity of the procedure in most patients, the rapid relief of symptoms, which is obviously important in patients with limited life expectancy, and the fact that the stent does not interfere in any way with

subsequent chemotherapy or radiotherapy. The argument against early stenting is the cost (about £1000).

It is our present policy to reserve early stenting for patients with very severe symptoms who are likely to fare badly during the time taken to respond to radiotherapy or chemotherapy.

Benign SVC obstruction

The papers by Gaines *et al* and Dyet *et al* both restrict themselves to malignant SVC obstruction. It is worth mentioning, however, that venous stenting may occasionally be of use in patients with benign disease,^{33 34} although it is probably wise to avoid this form of treatment until other techniques, such as balloon dilatation,³⁵ have failed (fig 2). What is more, SVC stenting will have to prove itself to be as good as

Figure 2 Balloon angioplasty of SVC stenosis due to permanent pacemaker. (A) Current right sided dual lead permanent pacemaker and two left sided leads from a previous pacemaker in situ. (B) Right arm venogram showing multiple collateral veins around the right shoulder and a stenosis of the superior vena cava with some prestenotic dilatation. (C) Insertion of catheter via the right femoral vein across the SVC stenosis. A left anterior oblique projection showing a web-like stenosis of the SVC. (D) Two 10 mm balloons inflated simultaneously across the stenosis. (E) Repeat venogram after dilatation showing disappearance of the web.

LEARNING POINTS

- * Stenting of the superior vena cava (SVC) provides rapid relief of symptoms in most individuals with SVC obstruction.
- * Its use should be confined to patients with malignant SVC obstruction who have failed to respond to conventional treatment, or who require urgent relief of symptoms.
- * The Wallstent has generally superseded the Gianturco stent.

surgical bypass techniques in the long term before it becomes accepted as the treatment of first choice.

Current surgical techniques aim at bypassing the stenosis using a conduit made from spiral saphenous vein or polytetrafluoroethylene (PTFE). Doty *et al*³⁶ treated nine patients with benign SVC obstruction using spiral saphenous vein grafts extending from the left innominate or internal jugular vein to the right atrial appendage. Seven of these patients remained symptom-free 1–15 years (mean seven years) after surgery. Wiselink *et al*³² reported significant symptomatic relief in seven of eight patients at one year and in five of six patients at two years following surgical bypass of innominate and SVC stenoses using PTFE.

The long term follow up of stent insertion in benign disease is limited at present. In patients with haemodialysis fistulae, Zollikofer *et al*¹¹ have reported primary patency in all four isolated brachiocephalic vein stenoses treated with Wallstents at 3–39 months (mean 18 months). They have also reported primary patency at four and five years in two iatrogenic iliac vein stenoses which were also stented.

Conclusion

Stenting of the SVC provides excellent palliation of symptoms in patients with malignant SVC obstruction, and should be combined with thrombolysis therapy in patients with thrombosis unless there is a definite contraindication to this form of treatment.

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