Treatment of superior vena cava obstruction secondary to pacemaker wires with balloon venoplasty and insertion of metallic stents

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Aims Pacemaker wires can result in stenosis of the superior vena cava and other central veins. The aim of this study is to demonstrate the safety and effectiveness of treating stenoses of the superior vena cava (SVC) and central veins with balloon venoplasty and metallic stent insertion in the presence of cardiac pacemaker wires.

Methods and Results Three patients were referred to the department after developing symptomatic SVC obstruction following implantation of a cardiac pacemaker several years earlier. They were examined with duplex ultrasound and venography, which revealed significant stenoses of the central veins. These patients subsequently underwent endovascular treatment which involved balloon dilation and stent insertion. The treatment was successful in all three patients, without any complications. Long-term patency of up to 4 years is recorded. No pacemaker function dysfunction was encountered.

Conclusion SVC stenting is safe and effective in patients who develop the SVC obstruction after cardiac pacemaker insertion.


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Key Words: Cardiac pacemaker, superior vena cava stenosis, balloon venoplasty, venous stenting.

Introduction

Cardiac pacemakers are inserted to control symptomatic bradycardia, such as that seen with heart block or sick sinus rhythm. Although local complications, including thrombosis and stenosis within the central venous system, occur in up to 30% of patients with pacemakers, symptomatic superior vena cava obstruction is, fortunately, uncommon[1]. Several factors may increase the occurrence of venous thrombosis related to a pacemaker. The presence of more than one lead has been associated with a higher likelihood of superior vena cava obstruction[2,3]. Retention of a severed lead or previous lead infection have also been implicated as potential etiologic factors[4]. Little information is available on the effect of stent placement over pacemaker wires in the superior vena cava, of which the largest series consists of four patients[5–7]. We report our experience with treating three patients with superior vena cava obstruction caused by pacemaker wires. These patients were successfully treated with balloon venoplasty and stenting of the superior vena cava.

Materials and Methods

Between February 1994 and August 2000, three patients underwent endovascular treatment of the superior vena cava to treat symptomatic obstruction related to the presence of pacemakers. The data were collected prospectively and are summarized in Table 1.

Two patients had intravenous heparin during the procedure but no anticoagulants were used in one, who had a bleeding diathesis of unknown cause.

Case 1

A 63-year-old woman presented with facial swelling and engorged veins. Six years previously she had had a dual chamber DDD (ICHD) (dual chambers, dual mode of action; triggering and inhibition)[8] pacemaker...
for problems of sino-atrial and atrio-ventricular node block. Pertinent past medical history included hypertension, a severe bleeding diathesis of unknown cause and worsening atrial fibrillation. The propensity to bleed was investigated extensively but no laboratory abnormalities were found and its cause remains unknown.

Clinical examination was in keeping with superior vena cava obstruction. A bilateral arm venogram confirmed SVC obstruction, with severe stenosis at the origin of the superior vena cava and the left innominate and right subclavian veins (Fig. 1(a)). There were numerous collateral veins in the neck.

In view of her propensity to bleed, she was started on tranexamic acid and aprotinin immediately before the procedure on an empirical basis. Access was obtained via the right groin. The stenosis in the SVC was dilated with a 12 mm-diameter, 4 cm-long balloon (Ultra-thin Diamond, Boston Scientific Inc, Natick, Mass., U.S.A.) (Fig. 1(b)). The stenoses of the left brachiocephalic and right subclavian veins were dilated with a 10 mm-diameter, 4 cm-long balloon (the right subclavian vein was stenosed following previous pacemaker insertion from the right side). Following venoplasty there was re-establishment of flow within the superior vena cava (Fig. 1(c)), and collaterals on the right side stopped filling; small collaterals were still evident on the left (Fig. 1(d)). As there was substantial improvement of venous return from the head, neck and upper limbs following the venoplasty we did not proceed to stent placement.

The symptoms of superior vena cava obstruction began to improve almost immediately and she continues to be free 18 months after the procedure. There have been no untoward effects on the function of the cardiac pacemaker.

Case 2

A 78-year-old female retired physician had an AAI (atrium chamber paced and sensed, response mode inhibited) pacemaker inserted via the right subclavian vein 6 years ago, to treat sick sinus syndrome. Three years later she developed superior vena cava obstruction, which manifested itself with facial edema and a feeling of congestion in the head and neck. Computer tomography showed stenoses of the superior vena cava and the origin of the right subclavian vein, which was confirmed on venogram (Figure 2(a)). Venoplasty with 12 mm balloons produced poor immediate result. Therefore, two Gianturco Z stents, each 30 mm in diameter and 5 cm long (William Cook Europe A/S) were inserted (Figure 2(b)), extending from the right innominate vein to the superior vena cava (Figure 2(c)). Her symptoms improved markedly and there were no untoward effects on her cardiac pacing. Warfarin was administered for 6 months after the procedure. She continues to enjoy good health at 4 years after the procedure and was especially pleased to be able to resume her game of golf.

Case 3

A 35-year-old woman had previous radiofrequency ablation for re-entry supra-ventricular tachycardia. A dual chamber DDD pacemaker was subsequently inserted from the right subclavian route to treat the arrhythmia.

Four years after insertion of the pacemaker she developed significant clinical features of superior vena cava obstruction, including facial swelling, and had an uncomfortable sensation of ‘congestion’ in the head and neck. Contrast-enhanced computer tomography of the thoracic inlet confirmed superior vena cava obstruction and shunting into small collateral veins in the neck.

Venography via a right femoral vein approach demonstrated severe stenoses of the superior vena cava and of the origins of both innominate veins. These were dilated with 12 mm and 16 mm balloons but the tissues immediately recoiled to their previous position. Therefore, two Gianturco Z stents (William Cook Europe A/S), each 20 mm in diameter and 5 cm long, were inserted, extending from the right internal jugular vein into the superior vena cava.

Table 1  Patient data

<table>
<thead>
<tr>
<th>Presenting age</th>
<th>Sex</th>
<th>Pacer type</th>
<th>Route of pacemaker insertion</th>
<th>Duration to SVC obstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>63</td>
<td>F</td>
<td>DDD</td>
<td>(L) subclavian</td>
</tr>
<tr>
<td>Patient 2</td>
<td>78</td>
<td>F</td>
<td>AAI</td>
<td>(R) subclavian</td>
</tr>
<tr>
<td>Patient 3</td>
<td>35</td>
<td>F</td>
<td>DDD</td>
<td>(R) subclavian</td>
</tr>
</tbody>
</table>

Figure 1  (a) 63-year-old woman with DDD cardiac pacemaker inserted 6 years ago, now presenting with facial swelling and upper limb venous congestion on exertion. The venogram shows severe stenosis of the proximal SVC and left brachiocephalic vein. (b) Dilation of the narrowing with a 12 mm × 4 mm balloon. (c) Post venoplasty study shows improvement of flow into the SVC, although there is a mild residual stenosis. (d) Post venoplasty study of left brachiocephalic stenosis showing free flow across the previous obstruction and significant reduction in the collateral flow.
Within 2 days the facial swelling resolved. Warfarin and aspirin were administered for 4 months after the procedure. The patient remains free of symptoms 2 years after the procedure. The function of the cardiac pacemaker has not been affected.

Figure 2  (a) 78-year-old woman who developed symptomatic SVC obstruction after AAI cardiac pacemaker was inserted 3 years earlier. This catheter directed venogram shows severe stenosis of the proximal SVC and filling of multiple collaterals at the thoracic inlet. (b) Post stenting radiograph of the same patient shows a Gianturco stent extending from the right internal jugular vein to the SVC. (c) Digital subtraction radiograph shows free flow across the SVC stenosis that was stented. The collaterals are also conspicuous by their absence.

Results
The procedure was technically successful in all cases, with no subsequent stent migration, fracture, collapse or occlusion. Testing of the pacemaker confirmed normal
function after stent placement in all patients. All patients experienced rapid relief from the symptoms of superior vena cava obstruction, and remained well with normal pacemaker function at a mean follow-up of 30 months. (range, 18–48 months) There were no complications related to the procedure.

### Discussion

Obstruction to the venous outflow from the head and neck can result in severe morbidity. Patients can present with facial congestion and swelling and engorged and distended upper limb veins. With severe obstruction, there can be difficulty in lying down and breathing, disturbing sleep. These symptoms and signs are known as the Superior Vena Cava Obstruction syndrome. This is usually caused by malignant disease, such as bronchial carcinoma or lymphoma, but can be related to mediastinal fibrosis caused by radiotherapy, tuberculosis, or collagen vascular disease.

In these patients with superior vena cava obstruction caused by malignant tumors, radiotherapy and/or chemotherapy are the most common first-line methods of treatment. However, recent publications have shown that balloon venoplasty and stenting, which may be augmented by catheter related thrombolysis, are useful alternatives[9]. The results of stent insertion are excellent, as there is high percentage of technical success and rapid relief of symptoms. These techniques can be combined with chemotherapy for the treatment of the malignant disease. Stenting is also indicated where there are recurrent or unresolved symptoms after maximal radiotherapy.

In contrast, treatment for benign causes of superior vena cava obstruction is often protracted, punctuated by multiple episodes of recurrences. These causes include arterio-venous shunt or central lines placed for haemodialysis; or other iatrogenically introduced devices, such as central lines, particularly those for long-term drug therapy, or cardiac pacing wires. Infection along central venous catheters and cardiac pacemaker leads is a well-known predisposing factor. Venous angioplasty and stenting in patients with arterio-venous shunts are often repeated, with cumulative patency approaching 80% at 2 years[10,11].

In cases related to cardiac pacing wires, removal of the device is not only often undesirable, in view of the cardiac arrhythmia, it is also often impossible and may not relieve the symptoms. The leads, which are insulated by silicon, are covered by endothelium and become incorporated into the vascular wall[12]. The pacing wires can also become incorporated into the vascular walls and heart chambers, making removal both difficult and sometimes dangerous. Thrombosis can occur along these wires leading to stenoses and occlusions of the great veins[13]. Trauma to the vessel wall during insertion, infection and dual chamber systems are thought to be predisposing factors[14].

Data regarding treatment options are limited, in view of the low incidence of superior vena cava obstruction after insertion of a cardiac pacemaker. Surgical treatment involves the insertion of a bypass graft between the left innominate or jugular vein and the right atrial appendage using an autologous or Dacron graft[15,16]. This operation is performed only in patients with benign disease, in whom the life expectancy is relatively long; it is a very invasive and difficult option, which should be avoided if possible.

Reluctance to use venoplasty and stenting in these patients with superior vena cava obstruction caused by pacing wires is related to concerns that the balloon might dislodge the wires, or that pressure by the metallic stent on the wires may lead to malfunction of the pacemaker. As it has been shown that the pacing leads become incorporated to the venous wall, there is no direct contact of the venoplasty balloon or stent with it. This series has shown that in the short and medium term, there is no disruption to the pacing wires, and that venoplasty and stenting can be used safely in these patients.

In the two patients stented in this article, we chose the Gianturco Z stents over other types of endoprostheses with a larger number of metallic struts, such as the Wallstent, because it is generally believed that a smaller number of stent struts in the Gianturco endoprostheses reduces the risk of thrombosis[17].

### Conclusion

Superior vena cava obstruction is a recognized, fortunately rare, complication pacemaker implantation. This study and other small series, have shown that balloon venoplasty and stenting can be safely performed in the presence of pacemaker leads.

### References


