Efficacy of Coronary Venoplasty for Left Ventricular Lead Implantation

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Background  Optimal target vein selection for the pacing lead results in a better outcome, but left ventricular (LV) variability limits this selection. The aim of the present study was to investigate the efficacy of coronary venoplasty for insertion of a LV lead.

Methods and Results  Transvenous LV lead placement was attempted in 208 consecutive patients from November 2002 to January 2007, with success in 206 patients (99%). Retrospective analysis of the cardiac resynchronization therapy system implantation showed that 4 of the 206 patients (1.9%) required coronary venoplasty for insertion of the pacing lead implant. Using coronary balloon angioplasty catheters of 2.5 mm (2 patients), 3.0 mm (1 patient) and 4.0 mm (1 patient), each target vein was dilated. Of 4 patients, stenoses in 3 were dilated by balloon angioplasty only. However, focal stenosis of 1 patient was not able to be dilated due to severe stenosis. Therefore, part of the lesion was sharpened by rotational atherectomy and the stenosis was successfully dilated. The LV pacing lead could then be inserted and no complications occurred.

Conclusion  Venoplasty for stenosis was effective in allowing deployment of a LV lead into a target vein in some patients. The safety and complications of the procedure remain unclear.

Key Words: Cardiac resynchronization therapy; Coronary vein stenosis; Left ventricular lead; Venoplasty

Cardiac resynchronization therapy (CRT) has been shown to improve quality of life, class of heart failure, exercise tolerance (maximum oxygen consumption), 6-minute walking distance, and left ventricular (LV) ejection fraction in patients with heart failure.1–2 However, it is difficult to identify potential non-responders to CRT in whom hemodynamics does not improve after surgery. Preoperative evaluation using echocardiography and other modalities has been investigated, but significant preoperative differentiation between responders and non-responders has not been achieved.

Placing the LV lead in a location giving a large contractile delay is ideal and positions that are lateral to posterolateral positions are considered appropriate since improvement in left cardiac function is higher when the LV lead is implanted in the lateral or posterolateral vein, compared to implantation in the anterior wall side.1 If insertion by the implanted in the anterior wall side.4 If insertion by the implanted in the lateral or posterolateral vein, compared to implantation in the anterior wall side,3.0 mm (1 patient) and 4.0 mm (1 patient), each target vein was dilated. Of 4 patients, stenoses in 3 were dilated by balloon angioplasty only. However, focal stenosis of 1 patient was not able to be dilated due to severe stenosis. Therefore, part of the lesion was sharpened by rotational atherectomy and the stenosis was successfully dilated. The LV pacing lead could then be inserted and no complications occurred.

Conclusion  Venoplasty for stenosis was effective in allowing deployment of a LV lead into a target vein in some patients. The safety and complications of the procedure remain unclear.

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Patients

Of 208 consecutive patients who underwent intravenous

CRT between November 2002 and January 2007, the procedure was successful in 206 patients (99%). The reasons for the 2 unsuccessful cases were anatomical difficulty in LV lead insertion, and inability to place a lead due to diaphragm reflex to stimulation, respectively. A myocardial lead was inserted via the epicardium in cardiac surgery in the first case, and oral drug treatment was continued in the second case. When insertion of an LV lead is difficult because of stenosis, there are several conditions that need to be fulfilled before “venoplasty” should be considered: (1) if there is no adequate site to insert an LV lead except the vein, (2) if surgical treatment is too difficult, and (3) if informed consent for venoplasty has been given by the patient. In the present study, 4 (1.94%) of 206 cases satisfied all conditions. Venoplasty was required for LV lead insertion into the coronary vein in 4 cases (Table 1). Passage of the LV lead was not possible due to coronary vein stenosis in 3 cases. In the 1 case that involved LV lead re-insertion, the coronary vein was obstructed due to a previous insertion.

Implantation Procedure

Three types of LV lead (Medtronic Attain 2187 4194 and 4193; Medtronic Inc, Minneapolis, MN, USA) were used. Preoperative coronary venography was carried out in all patients. Images were acquired in 3 directions (left anterior oblique 20°, right anterior oblique 20°, and anteroposterior views) and the position for lead placement was determined based on evaluation of the coronary vein distribution. A guide sheath was inserted into the coronary sinus for retrograde coronary venography following confirmation of the coronary vein distribution. The decision that which LV lead was used was made by the surgeon with reference to the diameter and tortuosity of the target vein. Written informed consent was given by all patients before the procedure.
Venoplasty for LV Lead Implantation

Venoplasty Procedure

A guidewire for the coronary artery of 0.014 inches in diameter was inserted into the lesion, which was dilated using a high-pressure balloon. The vascular diameter was estimated visually from the inserted catheter diameter and an appropriate balloon size was selected. Balloon pressure was increased until the stenosis was overcome and then maintained for 30–60 s after the indentation disappeared before deflation. This procedure was repeated if dilatation was insufficient, with an increase in the balloon size if dilation was still insufficient after a repeated attempt.

Results

Case 1

The patient had undergone coronary arterial bypass and aortic valve replacement. An Amplatz type (AL1) guide catheter was used and the lateral vein branching from the midcardiac vein was successfully targeted using a 0.014-inch guidewire (Run-through NS®, Terumo, Japan). Venoplasty was carried out because the over-the-wire (OTW)-type LV lead (Medtronic Attain 4194) did not pass through the target vein due to stenosis (Fig 1A). The vein was dilated using a pressure-resistant balloon catheter with a diameter of 2.5 mm (Kongou®, Terumo) (Fig 1B). The indentation disappeared at 18 atmospheres (atm), after which passage of the lead became possible and the lead was successfully placed (Fig 1C).

Case 2

The patient had undergone CRT 1 year before the current procedure, but the lead was removed because of wound infection and the patient admitted for repeat surgery. The coronary posterolateral vein, in which a LV lead had previously been placed, was selected as the target vein, but venography showed that this branch was obstructed (Fig 2A). A 0.014-inch guide wire (Run-through NS®, Terumo) was passed through the obstructed region, fol-

Table 1 Characteristics of Patients Who Required Coronary Venoplasty for Insertion of a Pacing Lead Implant

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Rhythm</th>
<th>Diagnosis</th>
<th>LVEF (%)</th>
<th>LVEDd (mm)</th>
<th>QRS morphology</th>
<th>QRS duration (ms)</th>
<th>Previous intervention</th>
<th>Pacing threshold (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>M</td>
<td>Sinus</td>
<td>DCM</td>
<td>23</td>
<td>66.1</td>
<td>CLBBB</td>
<td>158</td>
<td>CABG, AVR</td>
<td>1.1</td>
</tr>
<tr>
<td>2</td>
<td>86</td>
<td>F</td>
<td>Sinus</td>
<td>DCM</td>
<td>30</td>
<td>44.9</td>
<td>CLBBB</td>
<td>144</td>
<td>–</td>
<td>5.3</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>M</td>
<td>Sinus</td>
<td>ICM, OMI</td>
<td>31</td>
<td>57.8</td>
<td>CLBBB</td>
<td>212</td>
<td>CABG, MAP</td>
<td>3.5</td>
</tr>
<tr>
<td>4</td>
<td>78</td>
<td>M</td>
<td>Sinus</td>
<td>ICM</td>
<td>18</td>
<td>64.6</td>
<td>CLBBB</td>
<td>188</td>
<td>PCI</td>
<td>2.0</td>
</tr>
</tbody>
</table>

LVEF, left ventricular ejection fraction; LVEDd, left ventricular end-diastolic diameter; DCM, dilated cardiomyopathy; CLBBB, complete left bundle branch block; CABG, coronary artery bypass graft surgery; AVR, aortic valve replacement; ICM, ischemic cardiomyopathy; OMI, old myocardial infarction; MAP, mitral annuloplasty; PCI, percutaneous coronary intervention.

Fig 1. Case 1. (A) Posterolateral target vein with focal stenosis. (B) Balloon angioplasty (2.5×20.0 mm) of the stenosis lesion. (C) Successful lead implantation after dilatation.

Fig 2. Case 2. (A) The coronary posterolateral vein, in which a left ventricular lead had previously been placed, was occluded. (B) Balloon angioplasty (4.0×20.0 mm) of the occlusive lesion. (C) Although lead implantation was successful after dilatation, the pacing threshold was very high and the lead was not placed there.
followed by dilatation using a 4.0 mm diameter balloon (Kongou®, Terumo) (Fig. 2B). Blood flow was improved after dilatation (Fig. 2C), but the pacing threshold increased to a level higher than that in the previous implantation. Thus, re-placement was considered inappropriate and the lead was placed in another region.

Case 3

No apparent stenosis was noted in the target vein on pre-operative coronary venography in case 3 (Fig. 3A). Insertion of an OTW-type LV pacing lead (Medtronic Attain 4193) into the lateral vein was attempted, but the lead did not pass through the vein. Venous stenosis was suspected and venoplasty was carried out. The vein was dilated with a 3.0-mm balloon (Kongou®, Terumo), but ring stenoses formed at 2 sites and could not be dilated (Figs. 3B, C). The balloon ruptured when the pressure was increased to 20 atm. The Attain 4193 was placed in a region proximal to the stenosis in the lateral vein near the branching site, but it had entered the coronary sinus by the following day. Repeat surgery was carried out 1 week later. After passing the guidewire (Run-through NS®, Terumo) and a 1.5-mm OTW balloon (Ryujin OTW®, Terumo) through the vein, the wire was replaced with a guidewire exclusively for passage (Rotawire™ floppy, Boston Scientific, MA, USA) and rotational coronary vein angioplasty (Rotablator®, Boston Scientific) was
carried out using a burr size of 1.5 mm (Fig 3D). The vein became dilatable with a 3.0-mm balloon (Kongou®, Terumo) (Figs.3E,F), with disappearance of the indentation that had caused the previous balloon to rupture. Subsequently, an OTW-type LV lead (Medtronic Attain 4193) was successfully inserted.

Case 4

In case 4, the lateral vein was selected as the target vein and venography showed that this vein was approachable via 2 blood vessels: the upper and lower veins (Fig 4A). The vein descending from the great cardiac vein was highly torturous and the guidewire would not pass through this vein; therefore, the ascending vein was selected. However, this vein was still highly tortuous after passing of the guidewire (Run-through NS®, Terumo), and the wire was replaced by a support-type guidewire (IRON MAN®, Guidant, Santa Clara, CA, USA) using a microcatheter (Finecross®, Terumo). Despite this approach, the LV lead was still unable to pass through the vein because of the stenosis (Fig 4B); therefore, the vein was dilated using a 2.5-mm balloon (Kongou®, Terumo) (Fig 4C) and the LV lead (Attain 4193) was then inserted successfully (Fig 4D).

Discussion

Stenosis of the coronary vein is relatively rare, but an increasing number of cases are accumulating in the published reports. Balloon angioplasty for coronary vein stenosis and successful insertion of a LV lead without complication has been reported in a small number of cases. Difficulty with insertion was not anticipated based on coronary venography in any of the 4 cases reported here, suggesting that preoperative coronary venography alone may be insufficient for indication of venoplasty.

The response to CRT varies depending on the LV lead insertion site and therefore this site should be carefully selected. However, the coronary venous distribution is markedly diverse and the branching angle also varies, leading to some situations that are unsuitable for implantation of current pacing leads. In cases when LV lead insertion using the standard procedure is difficult, we have attempted insertion at our facility using the following methods. The guide catheter is replaced by one with a strong backup; and another guidewire is inserted by a support-type wire and another guidewire is inserted into the target vein using a 5-Fr inner catheter. The guide wire is then replaced by a support-type wire and another guidewire is inserted for use in the buddy-wire technique.

Venoplasty should be considered in cases in which insertion is difficult using the above techniques and no other appropriate insertion site for the pacing lead is available. Clear criteria for indication of venoplasty have not been established, but cases in which cardiac tamponade is likely to develop, such as those after thoracotomy, may be appropriate. For other cases, it may be better to dilate the vein using a balloon that is 25% narrower than the vascular diameter; the use of a vascular-sized balloon may not be appropriate because passage of a LV lead through the vein is the objective.

Although the procedure was successfully completed in all 4 cases, complications such as rupture, perforation, dissection and thrombosis are possible.

The following points should be made regarding safety: (1) our facility is a core hospital for circulatory disorders in the community, and therefore we have abundant experience with the procedures described above; (2) the physician carrying out CRT is not only skilled in CRT implantation, but is also a skilled interventionist who is routinely engaged in percutaneous coronary intervention and is skilled in guidewire and balloon procedures; and (3) the physician holds regular conferences with the Cardiac Surgery Department and carries out the procedure with the support of the Surgery Department. Under such optimal conditions, we believe that venoplasty is a useful choice for cases in which stenoses cause difficulty in LV lead insertion. An accumulation of cases is required to investigate the indications and safety of this procedure.

References