Coronary Vein Balloon Angioplasty for Left Ventricular Pacemaker Lead Implantation

Bert Hansky, MD,* Barbara Lamp, MD,† Kazutomo Minami, MD,* Johannes Heintze, MD,† Leon Krater, MD,‡ Dieter Horstkotte, MD,† Reiner Koerfer, MD,* Jürgen Vogt, MD†

Bad Oeynhausen, Germany

OBJECTIVES

Retrospective analysis of five cases of coronary vein balloon angioplasty performed to allow insertion of left ventricular pacing leads.

BACKGROUND

Coronary vein stenoses or an insufficient vessel caliber can preclude transvenous placement of coronary vein leads.

METHODS

We compared our total patient population (n = 218), in whom we implanted coronary vein leads, to those five patients who required coronary vein angioplasty to allow lead placement. Standard over-the-wire coronary artery balloon angioplasty catheters were used to dilate the vessel to 2.5 mm (n = 3) or 3.5 mm (n = 2).

RESULTS

Transvenous lead placement succeeds in >99% of patients. Four cases of target vein stenoses and one case of a vein of insufficient caliber were successfully treated by balloon angioplasty. There were no complications.

CONCLUSIONS

Coronary vein angioplasty is an effective and safe technique to permit transvenous left ventricular pacing lead insertion in cases of target vein stenoses or insufficient target vein caliber. (J Am Coll Cardiol 2002;40:2144–9) © 2002 by the American College of Cardiology Foundation

Promising results with cardiac resynchronization (1–3) and significant variations in coronary venous anatomy necessitated the development of special left ventricular (LV) pacing leads. Transvenous lead placement avoids direct exposure of the heart and is much less stressful to patients, compared with conventional surgical implantation of epicardial leads (4,5). Optimal target vein selection is important to achieve the best results. Other indications for coronary vein leads include pacemaker indications after prosthetic tricuspid valve replacement (4,6) or other heart operations.

In addition to inadvertent phrenic nerve stimulation, anatomic variations of the coronary venous system present the biggest challenge (4,7). Up to three veins—highly variable in caliber and course—drain the posterolateral myocardium (7).

We summarize our experience with five patients in whom LV pacing lead implantation was only possible after coronary vein balloon angioplasty. To our knowledge, this approach has not been described in the literature.

Patient population. In 210 patients, we implanted seven different types of coronary vein leads (made by Medtronic Inc. [Minneapolis, Minnesota] Guidant Corp. [St. Paul, Minnesota], and St. Jude Medical [Sylmar, California]) for cardiac resynchronization. Eight additional patients received LV pacing systems for indications other than heart failure. In only two other patients (0.91%), we had to resort to open epicardial lead implantation. All patients requiring cardiac resynchronization therapy underwent preoperative testing and coronary vein angiography to determine their response to pacing, as well as the optimal lead position (8). In four patients (1.83%), we found significantly stenosed posterolateral veins. In one patient, the target vein was too small to admit the lead. In these patients, we chose target vein balloon angioplasty to avoid epicardial lead placement.

Patient characteristics are summarized in Table 1. Patient nos. 1 to 4 had indications for both implantable cardioverter-defibrillator (ICD) and cardiac resynchronization therapy. Informed, written consent was obtained from all patients.

Patient 1. Coronary vein lead (Medtronic Attain 2187) displacement necessitated revision two months after implantation of a biventricular ICD. Subsequently, septic thrombus at the ICD lead prompted complete removal of the system. Three months later, a new biventricular ICD (Medtronic InSync ICD) was implanted. The coronary vein lead was advanced into the same posterolateral vein as before (Fig. 1A). Refractory phrenic nerve stimulation necessitated an additional revision after 11 months. Coronary vein angiography showed adhesions along the coronary venous course of the lead and narrowing of the proximal section of the target vein (Fig. 1B). After extraction of the old lead, a coronary wire (Guidant ACS Hi-Torque Balance middleweight, 0.014-in. [0.035-cm]) was advanced through the affected vein segment (Fig. 1C), but placement of the over-the-wire (OTW) lead (Medtronic OTW 4193) did not succeed until the stenosis had been dilated with a standard 3.5-mm balloon (Cordis Europass) (Figs. 1D to 1E). Phrenic nerve stimulation forced us to accept a more
proximal lead position, despite a rather high pacing threshold. The patient eventually received a transplant. On histologic examination, the coronary sinus and posterolateral cardiac vein showed a zone of fibrosis with occasional proliferation of angioblasts around the pacemaker lead.

PATIENT 2. Coronary vein angiography demonstrated that the posterolateral target vein formed an acute angle with the coronary sinus and showed several stenoses within its arching proximal segment. The mid and distal vein sections measured 3 to 4 mm and were free of additional stenoses (Fig. 2A). A guide wire (Guidant ACS Hi-Torque BMW, 0.014-in.) was easily inserted into the distal vein segment, but the lead could not be advanced beyond the narrowing. After balloon dilation (Cordis Europass, 2.5 mm) (Figs. 2B to 2C), the lead (Medtronic OTW 4193) was easily delivered into the mid third of the vein (Fig. 2D). A rather high pacing threshold in this position was accepted because of phrenic nerve stimulation in any other peripheral location.

PATIENT 3. The guide catheter was easily maneuvered into the coronary sinus ostium, but the coronary wire (Guidant ACS Hi-Torque BMW, 0.014-in.) could not be positioned in the tortuous posterolateral target vein until the vein had been super-selectively cannulated with a 4F catheter (Cordis Infiniti angiographic catheter). A short stenosis at the confluence and the coronary sinus was not passable by the OTW lead. It was only after dilation of this stenosis (Cordis Europass 2.5 and 3.5 mm) that the lead (Medtronic OTW 4193) was easily advanced.

PATIENT 4. The coronary sinus was easily cannulated, and a coronary wire (Guidant ACS Hi-Torque BMW, 0.014-in.) could be advanced without problems. Initially, placement of an OTW lead failed because of a stenosis of the posterolateral target vein (Fig. 3A). The narrow venous segment was therefore dilated with a balloon catheter (Cordis Europass, 2.5 mm) (Fig. 3B). Subsequently, the lead (Medtronic OTW 4193) was easily positioned in the mid section of the vein.

PATIENT 5. While implanting a cardiac resynchronization system, a preshaped coronary vein lead (Medtronic Attain 2187) could not be passed into the posterolateral vein, which was small and tortuous. Although positioning a "side wire lead" (Medtronic Attain 4191) was successful, it could not be left in place because of phrenic nerve stimulation and a poor pacing threshold. A preshaped lead (Medtronic Attain 2187) was therefore implanted into the middle cardiac vein. Two years later, a lack of hemodynamic improvement prompted us to revise the lead. The original posterolateral target vein was found to be occluded. A coronary wire (Guidant ACS Hi-Torque BMW, 0.014-in.) was advanced into another smaller and more distal posterolateral vein. Tortuosity and small caliber prevented positioning of the Medtronic Attain 4193 OTW lead. The vein was therefore dilated with a balloon (Cordis Europass, 2.5 mm) (Figs. 4A to 4C), eventually achieving a stable lead position.

**Method of coronary vein balloon angioplasty.** As in our standard technique of transvenous lead implantation, a guide catheter was positioned in the coronary sinus for coronary vein angiography, which delineates the anatomy of the target vein and visualizes any stenoses or insufficient vessel size. Lumen diameters were estimated in comparison to known catheter dimensions. As none of our patients had alternate target veins permitting pacing with identical hemodynamic benefits, we attempted to place OTW leads. In four patients, the coronary wire (Guidant ACS Hi-Torque BMW, 0.014-in.) was easily advanced into the target vein. In one patient, coronary wire placement did not succeed until the target vein ostium had been super-selectively cannulated with a 4F diagnostic catheter (Cordis Infiniti angiographic catheter). Initially, stenoses or an insufficient vessel caliber precluded lead (Medtronic Attain 4193 OTW) advancement, prompting us to proceed with incremental dilation of the narrowed segment until the lead would pass. Three to five different segments of the stenosed section of the vessel and locations distal and proximal to the stenosis were dilated with a semi-compliant 2.5-mm OTW balloon angioplasty catheter (Cordis Europass) inflated to 8

<table>
<thead>
<tr>
<th>Table 1. Patient Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient No.</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Note: All electrocardiograms showed a left bundle branch block pattern.

CABG = coronary artery bypass graft surgery; DCM = dilated cardiomyopathy; ICM = ischemic cardiomyopathy; LVEDD = left ventricular end-diastolic diameter; PTCA = percutaneous transluminal coronary angioplasty; s/p MI = status post-myocardial infarction; TMR = transmyocardial laser revascularization.
Figure 1. Patient no. 1. (A) Posterolateral target vein before initial lead implantation. (B) In the same vessel, intraluminal adhesions and stenoses secondary to the lead falsely suggest an extraluminal course of the lead. (C) After lead extraction. (D) Balloon angioplasty of narrowed segment. (E) Intraluminal adhesions continue to be visible, even after balloon dilation of the central stenosis.
to 10 bar for 60 s. In three of five patients, the lead was then easily advanced. In the remaining two patients, angioplasty had to be repeated with a 3.5-mm balloon. Control angiography was always performed, demonstrating a sufficient caliber of the previously stenosed segment, with smooth contours and no recoil phenomenon or signs of dissection (Fig. 2C).

RESULTS

In our population, only five patients (2.29%) had stenoses or an insufficient caliber of proximal venous segments. Initially, such findings and the lack of alternate target veins precluded coronary vein lead implantation, despite the OTW technique. Standard coronary artery balloon angioplasty catheters permitted adequate dilation. The caliber increase persisted long enough to place leads in all five patients. No recoil phenomenon was seen. The vessels were dilated to 2.5 mm, and in two cases to 3.5 mm. There were no complications such as dissection or perforation. All leads remained in a stable position. Intraoperative pacing thresholds (Table 2) were similar to those of routine cases. Pacing thresholds remained

Figure 2. Patient no. 2. (A) Posterolateral target vein with spontaneous proximal stenosis (<2 mm). (B) Balloon angioplasty of the narrowed venous segment. (C) Angioplasty result. (D) Successful lead placement after dilation of the narrowed segment.
stable, and LV pacing was effective throughout the follow-up period (Table 2).

DISCUSSION

Thickness, diameter, stiffness, and implantation technique vary between commercially available coronary vein leads. Based on coronary vein angiography, the optimal lead with the most suitable mechanical properties can be selected on an individual basis (4,5).

Because the target veins show significant anatomic variations, none of the current leads is equally suited for all situations. Because only the thicker, preshaped leads (Medtronic Attain 2187, St. Jude Medical Aescula, and St. Jude Medical Bi Aescula) are sufficiently stiff for stable positioning in large-caliber veins, it is especially the OTW coronary vein leads (Medtronic OTW 4193, Guidant Easytrak) that can be successfully implanted in smaller and tortuous veins (4,5).

Postoperative pacing thresholds after target vein balloon angioplasty did not increase beyond the intraoperative values in any of these patients. We conclude that this type of angioplasty does not lead to venous wall injuries that cause deterioration of electrical properties.

Presently, coronary vein stenoses are rare (4 [1.83%] of 218 patients). Previous coronary artery bypass graft procedures, scarring after myocardial infarction, and previous implantation of a coronary vein lead are possible etiologies. We may be faced with more cases in the very near future.

Stenoses and small-caliber veins can be successfully dilated with standard coronary angioplasty catheters. Individually tailored incremental OTW dilation to 2.5 or 3.5 mm was used in five patients and did not result in any intraoperative or postoperative complications. Nevertheless, caution is advised. At this time, this novel procedure should only be performed in centers with extensive experience with transvenous LV leads and percutaneous transluminal coronary angioplasty. Cardiac surgical backup is needed.

Conclusions. Transvenous lead implantation is the method of choice in cardiac resynchronization therapy. Among 218 patients, we observed only four cases (1.83%) of localized target vein stenosis and one case of insufficient caliber of the posterolateral vein, precluding standard transvenous placement of a coronary vein lead. Previous myocardial infarctions (n = 2), status post-bypass surgery (n = 2), and intravascular changes after a previous coronary vein lead (n = 1) were causative. Balloon angioplasty allowed successful lead placement in all cases. No complications were observed. In our hands, coronary vein angioplasty proved straightforward. After dilation, the OTW leads were implanted quickly and safely.

Table 2. Pacing Threshold at Implantation and After One and Three Months

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Implantation (V)</th>
<th>One Month (V)</th>
<th>Three Months (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.5</td>
<td>&lt;2.0 (0.3 ms at 2.0 V)</td>
<td>&lt;2.0 (0.3 ms at 2.0 V)</td>
</tr>
<tr>
<td>2</td>
<td>3.5</td>
<td>&lt;4.0 (0.4 ms at 4.0 V)</td>
<td>&lt;4.0 (0.4 ms at 4.0 V)</td>
</tr>
<tr>
<td>3</td>
<td>0.8</td>
<td>&lt;1.0 (0.2 ms at 1.0 V)</td>
<td>&lt;1.0 (0.2 ms at 1.0 V)</td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
<td>&lt;1.0 (0.3 ms at 1.0 V)</td>
<td>&lt;1.0 (0.3 ms at 1.0 V)</td>
</tr>
<tr>
<td>5</td>
<td>0.7</td>
<td>&lt;1.0 (0.3 ms at 1.0 V)</td>
<td>&lt;1.0 (0.3 ms at 1.0 V)</td>
</tr>
</tbody>
</table>

Figure 3. Patient no. 4. (A) Mid section of the lateral target vein narrowed to <2.0 mm (arrow). (B) Angioplasty of the narrow segment (Cordis Europass, 2.5 mm).
REFERENCES


Figure 4. Patient no. 5. (A) Small, tortuous lateral target vein. (B) Coronary vein balloon angioplasty (Cordis Europass, 2.5 mm). (C) Successfully implanted lead (Medtronic OTW 4193).