Major dissection of the coronary sinus and its tributaries during lead implantation for biventricular stimulation: angiographic follow-up

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Abstract Dissection of the coronary sinus during lead implantation for biventricular pacemaker implantation in patients with advanced heart failure is a serious complication that has occasionally been reported. We report on the clinical outcome and angiographic follow-up in a series of 7 patients with acute major dissection from 103 consecutive attempts (incidence 6.8%).

Serial echocardiography was performed in all patients and all underwent follow-up angiography 2–3 months after the procedure. In 1 patient, pericardial extravasation was seen during retrograde venography. Clinical follow-up was uneventful except for one other patient who complained of prolonged chest discomfort for several hours after the procedure. In none of the patients were there signs of pericardial effusion or tamponade demonstrated on echocardiography. Venograms during the procedure and after follow-up were analysed using a quantitative coronary angiography system (CAAS II). Parameters included minimal luminal diameter, diameter stenosis, minimal cross-sectional area and an estimation of the reference diameter. There were no significant differences in all analysed parameters, although in 1 patient a small partial dissection was present. Thus, although dissection of the coronary sinus following lead implantation for biventricular stimulation is not an uncommon complication, it is usually well tolerated. Long-term angiographic follow-up demonstrated no significant vessel damage or vessel remodeling.

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Introduction

Several studies have recently provided evidence that biventricular stimulation may improve haemodynamics as well as exercise tolerance and quality of life in patients with refractory congestive heart
failure and marked intra-ventricular conduction delays [1,2]. The technique of the procedure, however, is challenging and cannulation of the coronary sinus and subsequent manipulation within its tributaries remain difficult despite substantial improvements in equipment. Dissection of the coronary sinus has occasionally been reported and is one of the major complications of this procedure [3–5].

We report on the clinical outcome in a consecutive series of patients with dissection of the coronary sinus following lead implantation including long-term angiographic follow-up.

Material and methods

From January 1998 to December 2001, 103 attempts at lead implantation using the coronary sinus were undertaken in patients with advanced congestive heart failure selected for biventricular pacemaker implantation. All patients were in New York Heart Association (NYHA) class III–IV despite extensive medical therapy. In addition, all patients had intra-ventricular conduction delays (QRS duration ≥ 140 ms) and a left ventricular ejection fraction ≤ 35%. Coronary sinus cannulation was performed using specifically designed coronary sinus catheters (Medtronic LDS 6216 and Biotronik SCOUT). All procedures were performed by 2 experienced operators. After introduction of the guiding catheter in the os of the coronary sinus, a test injection was performed to verify its position. A guidewire (Terumo Radifocus M 0.035) was advanced to a distal portion of the tributaries of the coronary sinus and the guiding catheter was advanced to a position in the mid-portion of the coronary sinus. Subsequently, the guidewire was withdrawn and a balloon catheter was introduced. An additional test injection was given before balloon inflation to prevent inflation in a side branch. Finally, retrograde venography was performed in all patients during balloon occlusion. Left ventricular pacing leads (Medtronic 2879, 2187 or 2188 and Biotronik Corox LV-S) were advanced to the target vessel using contrast injection through the guiding catheter. If a dissection was suspected by extravasation of contrast, the pacing lead was withdrawn and balloon occlusive venography was repeated using multiple (orthogonal) projections including the RAO 30° and LAO 60° projections. A major dissection was defined as a dissection equal to or exceeding the luminal diameter of the dissected vessel. In patients with a major dissection of the coronary sinus, the procedure was terminated and echocardiography was performed immediately after the procedure and 24 h later to detect pericardial effusion. In addition, balloon occlusive venography was performed 2–3 months after the procedure through the femoral approach using an Amlpatz catheter. Venography was performed using multiple projections including the RAO 30° and LAO 60° and angulated views and quantitative analysis was performed off-line (Phillips QCA-CAAS II) [6]. The absolute diameter of the vessel (in mm) was determined using a contrast free guiding catheter as a calibration device [7]. Using the diameter function, the luminal diameter at the site of the lesion was measured (minimal luminal diameter; MLD) and a computer-derived estimation of an interpolated reference vessel diameter (RD) at the site of the lesion was determined. Minimal cross-sectional area (MCSA) was calculated from the value of minimal luminal diameter obtained from the edge detection analysis. The projections used in the follow-up venogram and in the venogram during implantation were identical. All patients consented to the study which was approved by the Human Research Medical Ethics Committee.

All data are expressed as mean ± SD. The serial changes in angiographic parameters were analysed by means of variance analysis and Neuman–Keuls test. A p value of < 0.05 was considered statistically significant.

Results

During 103 attempts, 7 patients (6.8%) had angiographic signs of a major coronary sinus dissection. In 6 patients the dissection was apparent close to or at the position of the balloon during the initial inflation. All dissections occurred within the first 40 mm from the os of the coronary sinus (QCA). In 1 patient, pericardial extravasation was observed after contrast injection. In no other patients were clinical signs or symptoms of tamponade observed and follow-up was without clinical events. One patient complained of sustained chest discomfort for several hours after the procedure. No patient presented with pericardial effusion on sequential echocardiography after the procedure, including the patient with pericardial extravasation on angiography. Dissection of the coronary sinus or its tributaries was caused by manipulation of the guiding catheter or the pacing lead in all instances.

Angiographic follow-up was obtained in all patients. There were no significant differences in any of the analysed parameters between the first and second angiographic study, although minimal luminal diameter and luminal diameter stenosis tended to decrease on the second venogram (Table 1). In
Table 1  Patient characteristics and angiographic parameters of the coronary sinus during initial retrograde venography and after follow-up

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age</th>
<th>MLD (mm)</th>
<th>DS (%)</th>
<th>REF (mm)</th>
<th>MCSA (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt  1</td>
<td>M</td>
<td>66</td>
<td>6.4/6.2</td>
<td>6/9</td>
<td>6.8/6.7</td>
<td>1/4</td>
</tr>
<tr>
<td>Pt  2</td>
<td>M</td>
<td>73</td>
<td>6.6/5.1</td>
<td>10/26</td>
<td>6.9/6.8</td>
<td>29/41</td>
</tr>
<tr>
<td>Pt  3</td>
<td>M</td>
<td>43</td>
<td>7.7/7.6</td>
<td>2/4</td>
<td>7.8/7.7</td>
<td>5/6</td>
</tr>
<tr>
<td>Pt  4</td>
<td>F</td>
<td>54</td>
<td>5.1/4.9</td>
<td>13/9</td>
<td>6.0/6.0</td>
<td>28/25</td>
</tr>
<tr>
<td>Pt  5</td>
<td>F</td>
<td>61</td>
<td>6.1/6.1</td>
<td>5/8</td>
<td>6.5/6.7</td>
<td>10/10</td>
</tr>
<tr>
<td>Pt  6</td>
<td>M</td>
<td>55</td>
<td>5.0/5.1</td>
<td>23/26</td>
<td>6.7/6.7</td>
<td>41/43</td>
</tr>
<tr>
<td>Pt  7</td>
<td>M</td>
<td>79</td>
<td>6.9/6.9</td>
<td>15/17</td>
<td>8.0/8.1</td>
<td>24/28</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>62 ± 12</td>
<td>6.3 ± 0.9/6.0 ± 1</td>
<td>11 ± 7/14 ± 9</td>
<td>7.0 ± 0.7/7.0 ± 0.7</td>
<td>20 ± 15/22 ± 16</td>
<td></td>
</tr>
</tbody>
</table>

MLD, minimal luminal diameter; DS, diameter stenosis; REF, reference diameter; MCSA, minimal cross-sectional area; Pt, patient.

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Figure 1  Retrograde venography before implantation (1), at the time of dissection (2) and after follow-up (3). At the time of dissection, slow retrograde flow is visible in the mid-portion of the coronary sinus with occlusion of the (postero-lateral) side branch.
1 patient, the follow-up angiogram (45 days after the procedure) showed a persistent intra-luminal defect suggestive of a minimal dissection (Fig. 1). If this patient was excluded from the final analysis, all analysed angiographic parameters were identical between the 2 angiograms (data not shown).

Discussion

The present study demonstrates that coronary sinus dissection (Fig. 2) following manipulations during lead implantation for biventricular pacing is not an uncommon complication. However, this complication is usually well tolerated and clinical follow-up was uneventful in all cases. Angiographic follow-up showed no signs of developing stenosis or persistent dissection at the site of initial dissection, except for 1 patient with relatively early follow-up, suggesting that the intimal flap will stabilise within several weeks. The lack of clinical signs after potentially flow limiting dissection of the coronary sinus and its tributaries is probably also related to the extensive collateral anastomoses with the cardiac veins [8]. Potential mechanisms associated with coronary sinus dissections include inappropriate cannulation of a side branch and the presence of intravascular obstructions (e.g. valve or myocardial bridge). In addition an aggressive introduction

Figure 2  Proximal coronary sinus dissection with minimal retrograde flow at the time of implantation (1) showing normal findings at follow-up (2).
of a guiding catheter to obtain sufficient back-up support should be avoided. Finally, an unusual coronary sinus anatomy or extensive manipulation to reach a distal lead position in a tortuous target vessel may be responsible for coronary sinus dissections. Although dissection and perforation of the coronary sinus has been reported as case report data on the incidence of this complication are limited [3–5, 9]. Gras and colleagues [9] reported a low incidence of coronary sinus perforation of <1% which is in accordance with our experience. Walker et al. [5] presented a case report of a patient with coronary sinus dissection during lead removal with subsequent insertion of a coronary sinus lead. In the recently reported MIRACLE trial, coronary sinus dissection was observed in 4.4% of all patients, with perforation in 2.1% [10]. In our study no attempts were made to re-cross the site of the dissection and the procedure was terminated. Since follow-up demonstrated a normal aspect of the coronary sinus after 2–3 months in almost all patients, this approach seems appropriate to minimise the risk of perforation. In our series, 4 patients underwent successful implantation 3 months after the first procedure. In the remaining group, 2 patients were referred for heart transplantation and 1 patient refused a second attempt.

Dissection of the coronary sinus was not related to abnormal angulation or the diameter of the vessel. Mean reference diameter of the coronary sinus was 6.23 ± 0.72 mm which is in accordance with previous reports [11]. In all cases the dissection was made during manipulation of the guiding catheter in order to have sufficient guiding support to advance the lead. In 3 patients the dissection also involved a major side branch, resulting in a total occlusion or slow retrograde flow during venography. In the majority of cases the site of the dissection was located close to or at the site of the initial balloon inflation, suggesting that the inflation might have induced minimal endothelial damage associated with impaired wall vessel resistance to subsequent manipulation. This might be related to the relatively rigid design of these first-generation catheters. Specific adaptations should be considered for an improved design facilitating non-traumatic cannulation of the os of the coronary sinus as currently used in guiding catheters (“soft-tip” design) for performing percutaneous coronary interventions. In addition, we have developed a technique without balloon inflation using the balloon catheter only to perform a sub-selective injection near the take off of the target vessel to prevent accidental vessel damage. If visualisation of the target vessel is still not satisfactory, incremental balloon inflation should be performed with a balloon/vessel ratio < 1.

In conclusion, procedure-related dissection of the coronary sinus during lead implantation for biventricular stimulation is not an uncommon complication encountered in 6.8% in the present consecutive series. This complication is, however, usually well tolerated and is not associated with long-term stenosis or intimal vessel damage. Future research should focus on the development of more non-traumatic catheters.

References