Over a 5 year period at three centers, 53 patients under­
went percutaneous transluminal angioplasty of a right
coronary artery ostial stenosis. The procedure was suc­
cessful in 42 patients (79%) and unsuccessful in 11, of
whom 5 (9.4%) required emergency coronary artery
bypass grafting because of abrupt closure. The right
coronary ostial lesion had distinctive technical require­
ments to achieve success, including high pressure balloon
inflation (10 ± 4 atm) and the need for unconventional
right coronary guide catheters.

Technical factors that account for increased difficulty
in these patients include: 1) problems with guide catheter
impaction and ostial trauma; 2) inability to inflate the
balloon with adequate guide catheter support; and 3)
need for increased intracoronary manipulation. The ste­
neses were quite discrete (4 ± 5 mm) and calcified in
the majority (40) of the 53 patients. Long-term follow­
up (mean 12.5 months, range 4 to 60) of these patients
demonstrated clinical recurrence of angina in 20 patients
(48%) and angiographically proved restenosis in 16 (38%).
Repeat coronary angioplasty was successful in three of
six patients for relief of symptoms for over 6 months.

In conclusion, angioplasty of the right coronary ostial
lesion compared with nonostial dilation leads to 1) a
suboptimal early success rate; 2) an apparent high risk
of emergency bypass surgery; and 3) a high restenosis
rate. Careful assessment of the patient with this lesion
and improved technology appear to be warranted.

(J Am Coll Cardiol 1987;9:1214–8)

Right coronary artery ostial stenosis is an unusual mani­
festation of symptomatic coronary artery disease, occurring in
1% of patients with angiographically defined disease (1).
Management of a patient with this anatomy and refractory
symptoms includes the alternatives of percutaneous trans­
luminal coronary angioplasty (PTCA) or surgical revascular­
ization. Coronary angioplasty of the right ostial stenosis
may be technically difficult, owing to the need to inflate the
balloon at a point where the guiding catheter engages the
artery. Further, with guide catheter intubation, trauma to
the diseased intima may lead to dissection and abrupt closure
of the vessel. As with the left coronary artery ostial lesion
(2), there may be increased risk of acute complications and
a higher rate of restenosis compared with angioplasty of
nonostial lesions. The present study was undertaken to eval­
uate the role of coronary angioplasty of the right coronary
ostial lesion and to define the procedural success and com­
plication rate and angiographic and long-term clinical out­
comes.

Methods

Patients. Between June 1981 and July 1986, all patients
who underwent coronary angioplasty of a right coronary
artery ostial stenosis at three centers (Emory University,
San Francisco Heart Institute and University of Michigan)
were included in this series. For the purpose of this study,
the significant lesion was 50% stenotic and involved the coro­
nary ostium (within 0.3 cm of the orifice of the right coro­
nary artery). Patients with other right or left coronary artery
lesions were included in the series, provided angioplasty of
the right coronary ostium was attempted. All patients underwent coronary angioplasty on an elective basis. None of the patients had previous aortic valve replacement, known syphilitic cardiovascular disease or Takayasu’s arteritis, which have been associated with right coronary artery ostial stenosis (3). Six patients were shown to have polygenic hypercholesterolemia, but not the homozygous familial form (4), which has been correlated with a right coronary ostial lesion. One patient had an isolated right coronary ostial lesion that may have related to mediastinal radiotherapy for Hodgkin’s disease. In Table 1, the demographic and relevant clinical data for the patients are summarized.

**Techniques.** Of the 53 patients studied, 49 had coronary angioplasty performed by way of the femoral approach and 4 by way of the brachial approach. All patients received aspirin, 325 mg, and dipyridamole, 75 mg, on the night before the procedure and 10,000 U of heparin at its initiation. In all patients, an over the wire dilation catheter system was utilized. The equipment that was successful in dilating the ostial stenosis is presented in Table 2. Transstenotic gradients were measured and recorded whenever possible. To successfully dilate the stenosis, it was often necessary to partially inflate the balloon in the ostium and gently back out the guide catheter. The use of non-Judkins type guide catheters, which led to less selective engagement in some cases, precluded the need for this maneuver.

**Definitions.** Angioplasty success was defined as a residual diameter stenosis of <50% after dilation and a transstenotic gradient of <15 mm Hg when available. Patients who required urgent coronary artery bypass surgery were considered as having had unsuccessful angioplasty. Intimal dissection and restenosis were defined in accordance with the National Heart, Lung, and Blood Institute PTCA Registry definitions (4,5). Mean diameter stenosis was determined by measuring the lesion in two or three different angiographic views before and after dilation using electronic calipers.

**Follow-up.** All but two patients were followed up for at least 6 months (mean 10.5 months, range 3 to 39). Anginal status, results of exercise studies and the need for repeat coronary angioplasty or subsequent coronary artery bypass surgery were ascertained. Repeat angiography was performed in 22 of the 42 patients who had initial success. The mean time to angiographic follow-up was 4.1 ± 1.5 months.

**Results**

**Immediate results.** Data summarizing the morphologic and angiographic characteristics of the right coronary ostial lesion before and after angioplasty in the 53 patients are presented in Table 3. The right coronary artery was dom-

---

### Table 1. Clinical Characteristics of 53 Patients

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>66 ± 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>M, 13 F</td>
</tr>
<tr>
<td>Duration of angina (yr)</td>
<td>1.3 ± 1.5</td>
</tr>
<tr>
<td>Class of angina (no. of patients)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>7</td>
</tr>
<tr>
<td>II</td>
<td>40</td>
</tr>
<tr>
<td>III</td>
<td>13</td>
</tr>
<tr>
<td>IV</td>
<td>11</td>
</tr>
<tr>
<td>Risk factors (no. of patients)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>4</td>
</tr>
<tr>
<td>Hypertension</td>
<td>24</td>
</tr>
<tr>
<td>Hypercholesterolemia*</td>
<td>6</td>
</tr>
<tr>
<td>Smoking</td>
<td>20</td>
</tr>
<tr>
<td>Multivessel disease† (no. of patients)</td>
<td>16</td>
</tr>
</tbody>
</table>

*Hypercholesterolemia was defined as >300 mg/dl at the time of admission for coronary angioplasty. †Multivessel disease was defined as >50% stenosis in another main epicardial artery. Coronary angioplasty of another vessel was attempted in 11 of these 16 patients. F = female; M = male.

---

### Table 2. Technical Factors in Successful Right Coronary Artery Ostial Angioplasty

<table>
<thead>
<tr>
<th>1) Guide Catheters Successfully Employed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>FR 4</td>
</tr>
<tr>
<td>FR 3.5</td>
</tr>
<tr>
<td>FR 5</td>
</tr>
<tr>
<td>Sidewinder</td>
</tr>
<tr>
<td>Amplatz</td>
</tr>
<tr>
<td>Cobra</td>
</tr>
<tr>
<td>Arani</td>
</tr>
<tr>
<td>Multipurpose</td>
</tr>
<tr>
<td>Brachial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Balloon Inflation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal atmosphere (bar)</td>
</tr>
<tr>
<td>(no. of patients)</td>
</tr>
<tr>
<td>No. of inflations</td>
</tr>
<tr>
<td>Maximal duration (seconds)</td>
</tr>
</tbody>
</table>

*All of these guide catheters are commercially available. FR = femoral right.
inominate in 50 patients and codominant in three. Technical success, as defined previously, was achieved in 42 patients (79%). In Figure 1, cineangiograms of a technical success are presented. In those patients with technical success, the lesion was reduced from $73.7 \pm 16$ to $33.5 \pm 26\%$ stenosis, with the transstenotic gradient reduced from $51.7 \pm 20$ to $11.8 \pm 8$ mm Hg (measured in 36 patients). Twenty-two patients underwent coronary angioplasty of additional lesions, including 12 of other right coronary lesions, 8 of the left anterior descending artery and 2 of the left circumflex artery. The inflation pressure, duration and frequency data are presented in Table 2. Five patients (9.4%) required urgent coronary artery bypass surgery due to a propagated intimal dissection with (two patients) or without (three pa-

**Figure 1.** Successful dilation of right coronary artery ostial stenosis. **A,** Left anterior oblique view of discrete, high grade ostial lesion. **B,** Attempt at dilation of this lesion was not successful when the balloon was inflated within the guide catheter. **C,** With backing out of the guide catheter and proper seating of the dilation catheter, full balloon inflation was achieved. **D,** Relief of the ostial stenosis, as demonstrated here, was associated with a reduction in the translesional gradient from 74 to 10 mm Hg.
Table 4. Clinical Outcomes of 53 Patients

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute success</td>
<td>42 (79%)</td>
</tr>
<tr>
<td>Recurrence of angina</td>
<td>20 (48%)</td>
</tr>
<tr>
<td>Restenosis</td>
<td>16 (38%)</td>
</tr>
<tr>
<td>Emergency CABG</td>
<td>5 (9.4%)</td>
</tr>
<tr>
<td>Repeat angioplasty</td>
<td>6 (11%)</td>
</tr>
<tr>
<td>Elective CABG</td>
<td>8 (15%)</td>
</tr>
<tr>
<td>Long-term success</td>
<td>25 (47%)</td>
</tr>
</tbody>
</table>

CABG = coronary artery bypass grafting

patients) abrupt closure of the vessel. In three of these five patients, enzymatic and electrocardiographic data demonstrated a myocardial infarction.

Follow-up. Of the 42 patients with initial success, 20 developed recurrent angina (48%) and angiographic restenosis was confirmed in 16 of these patients (Table 4). In the other four patients who did not undergo repeat angiography, exercise testing was positive for an ischemic response; in three of these four patients, thallium scintigraphy demonstrated a reversible inferior perfusion defect whereas the fourth patient had only electrocardiographic criteria for ischemia. Repeat coronary angioplasty was performed in six patients in this series, and restenosis occurred again in three patients. Elective coronary artery bypass grafting has been performed in eight patients. Thus, a total of 13 (25%) of 53 patients in this series underwent elective or emergency bypass surgery. The remaining six patients with recurrent symptoms were treated medically.

Discussion

The present study demonstrated a relatively high acute complication rate, high incidence of recurrence of stenosis and several distinct technical factors associated with coronary angioplasty of the right coronary ostial stenosis.

Acute complications. Angioplasty of the right coronary ostial lesion resulted in a 9.4% incidence rate of emergency surgery. This compares with an emergency coronary bypass rate of <3.5% for elective angioplasty at each of the three centers participating in this study. The apparent increased rate of abrupt closure, necessitating urgent surgical revascularization, is probably related to the unfavorable location of this lesion. First, guide catheter cannulation of the artery in these patients may induce intimal trauma even before the guide wire or dilation catheter is introduced. This clearly occurred in one patient in the series (Fig. 2) and may have set up procedural complications in several other cases. Second, to dilate the right ostial lesion, the guide catheter must be partially removed from the artery. This may be accomplished by balloon inflation allowing for some anchoring effect of the dilation catheter, while the guide catheter is gently pulled back (Fig. 1). Such intraloesional and intracoronary manipulations may be responsible for increased risk of intimal dissection. Third, the proximal location of this lesion inherently engenders a larger territory of ischemia in the event of abrupt closure. If coronary blood flow is

Figure 2. Complication of coronary angioplasty of a right ostial lesion. A, In this left anterior oblique view, a 90% isolated, discrete ostial stenosis is demonstrated. B, Before the dilation catheter was advanced into the artery, a guide catheter contrast injection demonstrates closure of the vessel with contrast staining of the stenosis, representing intimal dissection. Abrupt closure could not be managed with balloon dilation and the patient required emergency surgery after developing profound ischemia, hypotension and atrioventricular block. In this case, guide catheter trauma was the likely mechanism for the ostial dissection.
interrupted, inferior, posterolateral and right ventricular ischemia may be precipitated. Right coronary artery ischemia may be extensive and life threatening. This was seen in two patients in the current study who had a large, dominant right coronary and had abrupt closure.

Recurrent of stenosis in the series was rather high (48%) and nearly twice as high as that reported in previous large studies of restenosis (6,7). Without complete follow-up angiographic data, however, the exact rate of restenosis in this series has not been determined. The apparent high restenosis rate may be explained by multiple factors: 1) involvement of the aortic wall, as with the left main, renal and other ostial/aortic lesions that have been demonstrated to be predisposed for restenosis (3,8); 2) increased shear forces associated with an orifice location; 3) increased intimal trauma associated with the procedure, as discussed here, which may lead to more rigorous platelet aggregation; and 4) the difficulty in “cracking” and fully dilating some right coronary ostial lesions because of very extensive calcification.

**Technical factors.** The 79% primary success rate in these patients is less than the three center cumulative success rate (between 1981 and 1986) of >90% for nonostial single vessel coronary angioplasty in more than 4,000 patients. In the current study, primary and long-term success was achieved in 25 (47%) of the 53 patients. Whereas this success rate is lower than that experienced with nonostial coronary angioplasty, it demonstrates that the procedure can technically be accomplished and lead to clinical improvement in a significant proportion of patients. Several technical factors associated with success were identified:

First, high pressure inflations, 9.8 ± 4 atm, were generally required to fully dilate the lesion. In 21 patients, inflation to ≥12 atm was used to achieve full balloon inflation. This inflation pressure was required to reduce the translesional gradient to < 15 mm Hg or reduce the residual diameter stenosis to < 50%, or both. Such a high pressure requirement may have been anticipated because of the extensive calcification found in the majority of our patients. Calcification may account for increased “hardness” of the lesion and heightened difficulty in stretching the underlying media and adventitia, a proposed mechanism for balloon angioplasty (9). A high pressure balloon material, polyethylene terephthalate, which is able to withstand up to 20 bars, is now commercially available and may facilitate dilation of this type of lesion.

Second, the right coronary ostial lesion is usually quite discrete. In this series, the average length was only 4 mm. To minimize trauma to the nondiseased, perilesional intima and need for manipulation of the guide catheter, a short balloon (12 mm, for example) may be ideal for such lesions. Although short balloons were not available during the current study, our recent experience with them in discrete lesion angioplasty has been encouraging.

Third, guide catheter selection is an important consideration in dilating the right ostial stenosis. In nearly half the patients, a conventional Judkins guide catheter could not be used and several alternative catheter designs, including the Amplatz, multipurpose, cobra, sidewinder and Arani were used (10). Proper attention to the takeoff of the right coronary artery, anatomy of the aortic root and right sinus of Valsalva are all important in selecting the appropriate guide catheter. Correct catheter placement may be difficult and deep cannulation of the ostium should be avoided. Lack of selective cannulation to avoid catheter impaction and trauma may, however, lessen the ability to cross a high grade lesion with the balloon.

**Conclusion.** The present study demonstrates that angioplasty of the right coronary ostial lesion produces disappointing results. In patients with multivessel coronary artery disease, coronary artery bypass surgery, particularly with bilateral internal mammary artery grafting (11), may be the procedure of choice. In those patients with isolated right coronary ostial stenosis, angioplasty may be considered but its potential acute and long-term complications must be carefully weighed.

**References**