Does Length or Eccentricity of Coronary Stenoses Influence the Outcome of Transluminal Dilatation?

BERNHARD MEIER, M.D., ANDREAS R. GRUENTZIG, M.D., JAY HOLLMAN, M.D., THOMAS ISCHINGER, M.D., AND JAMES M. BRADFORD, PH.D.

SUMMARY In 526 patients undergoing a first percutaneous transluminal coronary angioplasty (PTCA) of a single native vessel, we studied the influence of length and eccentricity of the lesion on complications and primary success. Long stenoses (≥ 5 mm, n = 153) did not differ from short stenoses (≤ 4 mm, n = 265) in terms of overall complications or gain in lumen diameter and distal pressure. Eccentric stenoses (n = 155) showed a lower rate of primary success than concentric stenoses (n = 338) (80% vs 89%, p < 0.05). Inability to cross the stenosis was the main reason for failure. Stenoses that were long and eccentric (n = 51) had the highest incidence of complications (24%) and stenoses that were short and concentric (n = 177) the lowest (12%, p < 0.05). However, the average outcome expressed by gain in lumen diameter and distal pressure was equal in both groups and is obviously more dependent on technical factors than on anatomy. Nevertheless, length and, particularly, eccentricity of a lesion constitute risk factors for PTCA. They may be overcome by technical skill and sophisticated equipment, such as steerable catheters.

PERCUTANEOUS transluminal coronary angioplasty (PTCA) has gained an indisputable place in the treatment of coronary artery disease.1-4 The selection of patients to be treated with PTCA is a demanding art and influences the safety and success of the technique. In this report, we address the influence of two morphologic attributes—length and eccentricity of the lesions—on the incidence of complications and primary success of PTCA.

Patients

Before PTCA at Emory University Hospital, the history, symptoms, preoperative test results and angigraphic data (number, location, tightness, length and eccentricity of the lesions) of each patient are routinely recorded on a questionnaire, and the data are subsequently entered into a computer.

All available data of the 526 patients undergoing PTCA of a single native vessel between November 1980 and February 1982 were used for this study. Redilatations of the same vessel were excluded. Three pairs of groups were formed according to the morphology of the stenoses: long vs short, eccentric vs concentric, and long and eccentric vs short and concentric. Each patient could only be part of one group of each pair. The age range was 28–80 years. Age and sex distribution were comparable in all groups (table 1), as were the distribution of the stenoses within the coronary vasculature and the initial degree of stenosis (table 2).

Methods

Percent diameter reduction was used to express the degree of stenosis. The length of the stenosis was measured from where the tapering began to where the widening ended (fig. 1). For the more recent evaluations, a computerized caliper was used to facilitate measurements (A2D CineMetric Viewer and Prodelic 1101 Programmable Digital Caliper). The projection revealing the longest aspect of the stenosis was used. The results were corrected for magnification using the diameter of the catheter as standard and rounded off to the nearest millimeter. The mean length of all stenoses was 4.6 mm (range 1–20 mm). Stenoses of 5 mm or more constituted the group of long stenoses (n = 153); those of 4 mm or less constituted the group of short stenoses (n = 265). The criterion for eccentricity (n = 155) was that the stenotic lumen appeared to lie within one half of the supposedly normal lumen in at least one projection (fig. 2). All other stenoses were considered concentric (n = 338). The group of long and eccentric stenoses (n = 51) and the group of short and concentric stenoses (n = 177) were formed accordingly. All assessments were done by the same two angiographers, usually as a joint venture.

Statistical analysis was done with the chi-square test. A p value greater than 0.05 was considered not significant.

Results

Length

Of the 153 patients with long stenoses, 25 (16%) had one or more of the complications listed in table 3, compared with 38 of the 265 patients (14%) with short stenoses (NS). Successful dilatation (reduction of pressure gradient by > 20 mm Hg) was achieved in 141 (92%) of long and 231 (87%) of short stenoses (NS). The failures were due to inability to reach the stenosis in three (2%) and nine (3%), inability to cross the lesion in four (3%) and 19 (7%), and inability to reduce the pressure gradient by > 20 mm Hg despite balloon inflation in five (3%) and six (2%), respectively (NS). The mean reduction of the degree of stenosis was 44 ± 18% (± SD) in long and 41 ± 20% in short stenoses (NS). The pressure gradient was reduced by 73 ± 19% of its initial value in long and 71 ± 21% in short stenoses (NS).

Eccentricity

Of the 155 patients with eccentric stenoses, 32 (21%) had one or more complications (table 3) compared with 47 of the 338 patients (14%) with concen-
tric stenoses (NS). Successful dilatation was achieved in 124 (80%) of eccentric and 300 (89%) of concentric stenoses ($p < 0.05$). The failures were due to inability to reach the stenosis in six (4%) and 10 (3%) (NS), inability to cross the lesion in 20 (13%) and 18 (5%) ($p < 0.05$), and inability to reduce the pressure gradient by $> 20$ mm Hg despite balloon inflation in five (3%) and 10 (3%), respectively (NS). The mean reduction of the degree of stenosis was $39 \pm 21\%$ in eccentric and $43 \pm 19\%$ in concentric stenoses (NS). The pressure gradient was reduced by $69 \pm 22\%$ of its initial value in eccentric and $72 \pm 21\%$ in concentric stenoses (NS).

### Combination of Length and Eccentricity

Of the 51 patients who had long and eccentric stenoses, 12 (24%) had one or more complications, compared with 21 of the 177 patients (12%) with short and concentric stenoses ($p < 0.05$). Successful dilatation was achieved in 45 (88%) of long and eccentric and 161 (91%) of short and concentric stenoses (NS). The failures were due to inability to reach the stenosis in one (2%) and five (3%), inability to cross the lesion in two (4%) and six (3%), and inability to reduce the pressure gradient by $> 20$ mm Hg despite balloon inflation in three (6%) and five (3%), respectively (NS). The mean reduction of the degree of stenosis was $42 \pm 18\%$ in long and eccentric and $43 \pm 19\%$ in short and concentric stenoses (NS). The pressure gradient was reduced by $72 \pm 23\%$ of its initial value in long and eccentric and $72 \pm 21\%$ in short and concentric stenoses (NS).

### Discussion

As the indications for PTCA change, it seems appropriate to concentrate on properties of lesions that do not represent a contraindication to PTCA but are likely to render the procedure more difficult, more risky, and less successful. The importance of the site of the stenosis has been stressed repeatedly. The importance of the tightness of the stenosis was emphasized by Cowley and co-workers, who showed a significantly higher success rate in patients with stenoses $< 90\%$ than in patients with stenoses $\geq 90\%$. In this report, we studied length and eccentricity of the lesion. Site and severity of the stenosis are unlikely to bias our results because these factors were similarly distributed in the studied groups (table 2).

The length of the stenosis alone did not have an adverse effect on the overall incidence of complications (table 3) or on the primary success expressed by reduction of diameter narrowing or pressure gradient, which is in keeping with the findings of the National Health, Lung, and Blood Institute PTCA registry. Eccentricity, however, was coupled with an increased incidence of immediate complications, of which coronary dissection and the need for emergency bypass surgery were the most prominent (table 3). The primary success rate for PTCA of eccentric stenoses was

### Table 2. Distribution of Site and Severity of the Stenosis

<table>
<thead>
<tr>
<th>Morphology of stenosis</th>
<th>No. of pts</th>
<th>LM (%)</th>
<th>LAD (%)</th>
<th>LCx (%)</th>
<th>RCA (%)</th>
<th>D (mean ± sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td>153</td>
<td>0%</td>
<td>72%</td>
<td>2%</td>
<td>26%</td>
<td>72 ± 13%</td>
</tr>
<tr>
<td>Short</td>
<td>265</td>
<td>1%</td>
<td>69%</td>
<td>8%</td>
<td>22%</td>
<td>71 ± 15%</td>
</tr>
<tr>
<td>Eccentric</td>
<td>155</td>
<td>1%</td>
<td>64%</td>
<td>3%</td>
<td>32%</td>
<td>72 ± 14%</td>
</tr>
<tr>
<td>Concentric</td>
<td>338</td>
<td>1%</td>
<td>70%</td>
<td>8%</td>
<td>21%</td>
<td>73 ± 15%</td>
</tr>
<tr>
<td>Long and eccentric</td>
<td>51</td>
<td>0%</td>
<td>57%</td>
<td>0%</td>
<td>43%</td>
<td>72 ± 12%</td>
</tr>
<tr>
<td>Short and eccentric</td>
<td>177</td>
<td>1%</td>
<td>68%</td>
<td>10%</td>
<td>21%</td>
<td>72 ± 15%</td>
</tr>
</tbody>
</table>

Abbreviations: LM = left main coronary artery; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; RCA = right coronary artery; D = initial degree of stenosis (diameter reduction).
lower than that for concentric stenoses (80% vs 89%, \( p < 0.05 \)), which confirms a former report. This difference was predominantly due to a greater incidence of inability to cross the stenosis (13% vs 5%, \( p < 0.05 \)). However, the average reduction of diameter narrowing and pressure gradient was not significantly different in these two groups. This finding may be attributed to a greater effort put into difficult cases by the operator and explains why eccentricity is a negligible variable according to the National Heart, Lung, and Blood Institute PTCA registry.

Long and eccentric stenoses have the highest incidence of complications (24%) and short and concentric stenoses have the lowest (12%) \( (p < 0.05) \). The length seems to be responsible only for an increased frequency of iatrogenic side-branch occlusion, probably because of an increased frequency of side-branch involvement.

In conclusion, not only the site and the severity of a stenosis, but also the eccentricity and to a lesser degree the length of the lesion have a significant negative impact on the immediate outcome of PTCA. The highest incidence of complications occurs with stenoses that are both long and eccentric. However, the risk is still tolerable and the gain in luminal diameter and distal pressure is not significantly less with long and eccentric stenoses than with short and concentric ones. Yet, long and, especially, eccentric stenoses require more alertness, skill and time of the operator, as well as sophisticated equipment, such as steerable catheters. PTCA of long and eccentric stenoses should only be attempted if extensive experience has been acquired.

### References


### Table 3. Complications in the Different Groups

<table>
<thead>
<tr>
<th>Complications</th>
<th>L (153)</th>
<th>S (265)</th>
<th>E (155)</th>
<th>C (338)</th>
<th>L+E (51)</th>
<th>S+C (177)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary dissection</td>
<td>16%</td>
<td>14%</td>
<td>21%</td>
<td>14%</td>
<td>24% *</td>
<td>12%</td>
</tr>
<tr>
<td>Bypass surgery necessary within 24 hours</td>
<td>5%</td>
<td>7%</td>
<td>9%</td>
<td>6%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Arrhythmia requiring cardioversion</td>
<td>2%</td>
<td>0.5%</td>
<td>1%</td>
<td>0.5%</td>
<td>2%</td>
<td>—</td>
</tr>
<tr>
<td>Unresolved spasm</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Occlusion of side branch</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>Myocardial infarct by ECG</td>
<td>2%</td>
<td>1%</td>
<td>0.5%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Blood loss requiring transfusion</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Other complications</td>
<td>5%</td>
<td>3%</td>
<td>4%</td>
<td>4%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Deaths</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Numbers in parentheses represent number of patients.

\( *p < 0.05 \).

Abbreviations: L = long; S = short; E = eccentric; C = concentric.
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B Meier, A R Gruentzig, J Hollman, T Ischinger and J M Bradford

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