Quantitative Angiographic Comparison of Elastic Recoil After Coronary Excimer Laser-Assisted Balloon Angioplasty and Balloon Angioplasty Alone

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Objectives. Coronary lumen changes during and after excimer laser-assisted balloon angioplasty were measured by quantitative coronary angiography, and the results were compared with the effects of balloon angioplasty alone.

Background. Reduction of atherosclerotic tissue mass by laser ablation in the treatment of coronary artery disease may be more effective in enlarging the lumen than balloon angioplasty alone.

Methods. A series of 57 consecutive coronary lesions successfully treated by xenon chloride excimer laser-assisted balloon angioplasty were individually matched with 57 coronary artery lesions successfully treated by balloon angioplasty alone. The following variables were measured by quantitative coronary analysis: 1) ablation by laser, 2) stretch by balloon dilation, 3) elastic recoil, and 4) acute gain.

Results. Matching by stenosis location, reference diameter and minimal lumen diameter resulted in two comparable groups of 57 lesions with identical baseline stenosis characteristics. Minimal lumen diameter before excimer laser-assisted balloon angioplasty and balloon angioplasty alone were (mean ± SD) 0.73 ± 0.44 and 0.74 ± 0.43 mm, respectively. Laser ablation significantly improved minimal lumen diameter by 0.56 ± 0.44 mm before adjunctive balloon dilation. In both treatment groups, similarly-sized balloon catheters (2.59 ± 0.35 and 2.56 ± 0.40 mm, respectively) were used. After laser-assisted balloon angioplasty, elastic recoil was 0.84 ± 0.30 mm (32% of balloon size), which was identical to that after balloon angioplasty alone, namely, 0.82 ± 0.32 mm (32%). Consequently, both interventions resulted in similar acute gains of 1.02 ± 0.52 and 1.00 ± 0.56 mm, respectively. Minimal lumen diameter after intervention was equal in both groups: 1.75 ± 0.35 and 1.75 ± 0.34 mm, respectively. The statistical power of this study in which a 25% difference in elastic recoil (0.2 mm) between groups was considered clinically important was 95%.

Conclusions. In matched groups of successfully treated coronary lesions, xenon chloride excimer laser ablation did not reduce immediate elastic recoil after adjunctive balloon dilation or improve the final angiographic outcome compared with balloon angioplasty alone using similarly-sized balloon catheters.

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cases (to debulk and dilate), it is hypothesized that reduction of atherosclerotic tissue mass by laser ablation with or without adjunctive balloon dilation may be more effective in enlarging lumen diameter than balloon angioplasty alone. Laser angioplasty may favorably modify plastic and elastic properties of the vessel wall, thereby facilitating balloon dilation (23). Also, tissue removal by laser ablation may cause a reduction in the extent of vessel stretching during subsequent balloon dilation, resulting in less elastic recoil and preserved lumen dimensions after balloon deflation. This study was undertaken to determine whether atherosclerotic plaque removal by excimer laser ablation before balloon dilation reduces elastic recoil and improves the immediate outcome compared with balloon coronary angioplasty alone as assessed by quantitative angiography.

Methods

Patients. For the purpose of this study, a consecutive series of 53 patients with 59 native coronary artery lesions successfully treated by excimer laser angioplasty and adjunctive balloon dilation was accumulated. This cohort of patients represents almost a fourth of the patients treated with the excimer laser at our institution until now and reflects our experience with the device after completion of a learning curve. All patients had symptomatic coronary artery disease or objective evidence of myocardial ischemia, or both. The group included 13 patients with 13 chronic total coronary artery occlusions. A successful treatment was defined as procedural success (a residual diameter stenosis <50% at the end of the intervention) without major complications (death, myocardial infarction, coronary artery bypass grafting) during the hospital period. Two patients who underwent successful excimer laser-assisted balloon angioplasty for a chronic total coronary occlusion could not be matched according to the angiographic criteria described later. The study group, therefore, consisted of 51 patients with 57 lesions successfully treated by excimer laser-assisted balloon angioplasty and was individually matched with a group of patients undergoing successful balloon angioplasty as the single treatment. The clinical and quantitative angiographic details of the groups are described in Table 1.

Laser procedure. The laser system consisted of a xenon chloride excimer laser (Advanced Interventional Systems, Inc.) emitting light pulses at a wavelength of 308 nm with a pulse duration of ~200 ns and a repetition rate of 20 Hz. Over-the-wire laser catheters 1.3, 1.6, and 2.0 mm in diameter with a concentric multifiber arrangement around a central guide wire lumen were used in 46 patients (52 lesions), and a directional 1.8-mm diameter laser catheter with eccentric multiliber design was used in 5 patients (5 lesions). Laser fluence at the catheter tip was set at levels ranging from 45 to 65 mJ/mm². For anticoagulation, aspirin and heparin were given intravenously, keeping the activated clotting time >400 s for the duration of the procedure, with additional doses of 5000 U of heparin. The laser catheter was advanced through a standard 9F coronary angioplasty guide catheter (Schneider, Inc.) and directed over a 0.014- or 0.018-in (0.36 to 0.46 mm) guide wire until its tip was just proximal to the lesion. After flushing with saline solution to remove any intracoronary contrast medium, the laser was activated for 2 to 3 s, and the fiberoptic catheter was passed two to three times in the same or another direction (controlled by rotation of the device around the guide wire by a torque-control knob) followed by balloon angioplasty. Before and after the laser procedure or balloon dilation, or both, angiography was performed in multiple projections after intracoronary administration of nitroglycerin to reduce vasomotor tone.

Quantitative coronary angiography. All cineangiograms were analyzed using the computer-based Cardiovascular Angiography Analysis System (CASS), which has been previously described and validated (26-28). This system permits an objective and reproducible quantification of coronary artery...
diameter and reference diameter between the two identical were individually matched according to minimal lumen diam-
of 57 successfully treated excimer laser-assisted balloon angio-
ence not exceeding 0.2 mm is within the precision of our CAAS (twice the variability; 95% confidence limits). Also, a differ-
lesions must be within the range of twice the variability of the
angiographic dimensions occurring during excimer laser-assisted balloon angioplasty. These were 1) ablation (minimal lumen diameter after laser ablation minus minimal lumen diameter before laser ablation); 2) stretch (mean balloon diameter minus minimal lumen diameter before balloon dilation); 3) elastic recoil (mean balloon diameter minus minimal lumen diameter after balloon dilation), and 4) acute gain (minimal lumen diameter after minus minimal lumen diameter before intervention). All four variables were also calculated in units of area (mm²) and normalized for interpolated reference diameter and reference area, respectively, to correct for vessel size. To obtain the mean balloon diameter, the largest balloon at maximal inflation was measured in a nonforeshortened projection: balloon area and balloon/artery ratios were then calculated.

Statistical analysis. All values obtained from quantitative angiographic analysis and derived variables are expressed as mean value ± 1 SD. Differences between the two groups and within each group were assessed by two-factor repeated-measures analysis of variance. The Bonferroni correction was applied for multiple comparisons. Linear regression analysis was performed by the least-squares method to calculate correlation and slopes. To compare the linear regressions for the two treatment groups, multiple regression analysis was performed introducing the type of intervention as a separate (dummy) variable. A p value < 0.05 was considered to indicate a significant difference.

Results

Matching. Baseline clinical and quantitative angiographic characteristics of the excimer laser-assisted balloon angioplasty group and the balloon angioplasty-only group are listed in Table 1. No differences in gender, age or anginal status were observed. Matching for angiographic variables was considered adequate because distribution of stenosis location as well as minimal lumen and reference diameter measurements were not significantly different in both groups: 0.73 ± 0.44 and 2.66 ± 0.44 mm for the excimer laser-assisted balloon angio-
plasty group and 0.74 ± 0.43 and 7.67 ± 0.44 mm for the balloon angioplasty group, respectively. Other lesion variables (diameter stenosis, minimal lumen cross-sectional area, reference area, area stenosis, plaque area and number of total occlusions) also did not differ significantly between groups, with the sole exception of lesion length, which was 7.9 ± 3.4 mm in the excimer laser-assisted balloon angioplasty group and 6.3 ± 2.9 mm in the balloon angioplasty group (p = 0.02) (Table 1). Qualitative descriptors of lesion morphology derived from visual analysis of coronary angiograms included the presence of a branch point in the stenotic segment (46% in the excimer laser-assisted balloon angioplasty group vs. 53% in the balloon angioplasty group), lesion calcification (15% vs. 11%, respectively) and relation of the lesion to a coronary bend (17% vs. 7%, respectively), which were not significantly different between groups. However, the frequency of qualitative characteristics in the treatment groups may be different, but it would require a much larger sample size to exclude such a difference with a high statistical power. Thus, this matching technique resulted in the selection of two patient groups with similar clinical and preprocedural stenosis variables.

Procedural results. The immediate efficacy of excimer laser-assisted balloon angioplasty and balloon angioplasty alone as assessed by quantitative angiography is shown in Table 2 and Figure 1. Both interventions resulted in a significant improvement in minimal lumen diameter, from 0.73 ± 0.44 to 1.75 ± 0.35 mm (p < 0.001) and from 0.74 ± 0.43 to 1.75 ± 0.34 mm (p < 0.001), respectively. Accordingly, diameter stenosis was reduced from 72 ± 16% to 36 ± 9% (p < 0.001) and from 72 ± 16% to 34 ± 9% (p < 0.001), respectively. Despite a significant initial improvement in minimal lumen diameter from 0.73 ± 0.44 to 1.50 ± 0.28 mm (p < 0.001) in the excimer laser-assisted balloon angioplasty group by laser ablation, the final angiographic outcome did not differ between the two treatment groups.

Ablation, stretch, recoil and gain. Results of quantitative angiographic analysis of the extent of laser ablation, mean balloon size at maximal inflation, vessel stretching during balloon inflation, immediate elastic recoil after balloon deflation and acute gain for the two treatment groups are summarized in Table 3 and Figure 2. In Table 3, values are expressed in absolute terms, that is, in units for diameter (mm) and area (mm²), as well as in relative terms (i.e., normalized for reference diameter and reference area to correct for vessel size). Figure 2 shows a graphic representation of the results in absolute millimeters. Despite a significant initial improvement in lumen dimensions by excimer laser ablation causing a reduction in vessel stretching during subsequent balloon dilation, elastic recoil after balloon deflation did not differ between treatment groups, resulting in a similar acute gain from preintervention to postintervention. Similar-sized balloon catheters were used in both groups. On average, 32% of the theoretically achievable lumen diameter (i.e., balloon diameter) and 53% of the maximal achievable cross-sectional area (i.e., balloon cross-sectional area) is lost shortly after balloon deflation, whether balloon dilation is preceded by excimer laser ablation or not. When a mean difference in recoil of 25% between groups is considered clinically important (0.2 mm, i.e., the precision of the quantitative analysis system [28]), the statistical power of this investigation reaches a level of 95%. When a 25% mean difference in acute gain between groups (0.25 mm) is considered, the power is 75%.

Relation among extent of laser ablation, balloon size, vessel stretch and elastic recoil. In the balloon angioplasty group, where balloon dilation was performed as the single treatment, a linear correlation could be documented between vessel stretching during balloon dilation and subsequent elastic recoil (Fig. 3, top), as previously described [12–16]. A similar relation was found in the excimer laser-assisted balloon angioplasty group (Fig. 3, middle), where balloon dilation was preceded by excimer laser ablation. Comparison of these two relations by means of multiple regression analysis showed no significant difference (p = 0.25). No relation was observed between the extent of laser tissue ablation (debulking) and the amount of elastic recoil after adjunctive balloon dilation in the excimer laser angioplasty.

### Table 2. Comparative Quantitative Angiographic Analysis of the Immediate Results of Excimer Laser-Assisted Balloon Angioplasty and Balloon Angioplasty Alone in 57 Coronary Lesions

<table>
<thead>
<tr>
<th></th>
<th>EL-BA</th>
<th>BA</th>
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<tbody>
<tr>
<td>Minimal lumen diameter (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>0.73 ± 0.44</td>
<td>0.74 ± 0.43</td>
</tr>
<tr>
<td>Postlaser</td>
<td>1.30 ± 0.28</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>1.75 ± 0.35</td>
<td>1.75 ± 0.34</td>
</tr>
<tr>
<td>Reference diameter (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>2.66 ± 0.44</td>
<td>2.67 ± 0.44</td>
</tr>
<tr>
<td>Postlaser</td>
<td>2.69 ± 0.46</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>2.77 ± 0.50</td>
<td>2.67 ± 0.45</td>
</tr>
<tr>
<td>Diameter stenosis (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>72 ± 16</td>
<td>72 ± 16</td>
</tr>
<tr>
<td>Postlaser</td>
<td>53 ± 10</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>36 ± 9</td>
<td>34 ± 9</td>
</tr>
<tr>
<td>Minimal lumen cross-sectional area (mm²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>0.57 ± 0.47</td>
<td>0.58 ± 0.45</td>
</tr>
<tr>
<td>Postlaser</td>
<td>1.38 ± 0.60</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>2.50 ± 1.03</td>
<td>2.48 ± 1.03</td>
</tr>
<tr>
<td>Reference area (mm²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>5.70 ± 1.88</td>
<td>5.73 ± 1.92</td>
</tr>
<tr>
<td>Postlaser</td>
<td>5.84 ± 1.99</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>6.22 ± 2.72</td>
<td>5.75 ± 2.03</td>
</tr>
<tr>
<td>Area stenosis (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>90 ± 8</td>
<td>90 ± 8</td>
</tr>
<tr>
<td>Postlaser</td>
<td>75 ± 10</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>59 ± 12</td>
<td>56 ± 12*</td>
</tr>
<tr>
<td>Lesion length (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>7.9 ± 3.4</td>
<td>6.3 ± 2.9</td>
</tr>
<tr>
<td>Postlaser</td>
<td>8.0 ± 3.3</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>7.7 ± 3.0</td>
<td>5.9 ± 2.2</td>
</tr>
<tr>
<td>Plaque area (mm²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>9.8 ± 4.7</td>
<td>7.6 ± 5.8</td>
</tr>
<tr>
<td>Postlaser</td>
<td>8.0 ± 4.9</td>
<td>—</td>
</tr>
<tr>
<td>Postballoon</td>
<td>5.6 ± 2.9</td>
<td>4.1 ± 2.4*</td>
</tr>
</tbody>
</table>

*p < 0.01 within groups. (Preprocedural (Pre) data are for non-total occlusions only (n = 46 in both groups). Data presented are mean value ± SD. Other abbreviations as in Table 1.
Figure 1. Cumulative frequency curves illustrating the immediate changes in minimal lumen diameter (MLD) induced by excimer laser-assisted balloon angioplasty (EL-BA) and balloon angioplasty alone (BA) as assessed by quantitative coronary angiography. PRE = before intervention; PL = after laser ablation; POST = after balloon dilation.

Figure 2. Graphic representation of immediate effects of excimer laser-assisted balloon angioplasty (EL-BA) and balloon angioplasty alone (BA), along with derived quantitative angiographic variables, expressed in absolute millimeters. For definition of terms, see text. Despite significant reduction in vessel stretching during balloon dilation after laser ablation, elastic recoil in the excimer laser-assisted balloon angioplasty group after balloon deflation is similar to that after balloon angioplasty alone, resulting in a similar acute gain in both treatment groups. *p < 0.0001. Other abbreviations as in Figure 1.

Table 3. Absolute and Relative Changes in Minimal Lumen Diameter and Minimal Lumen Cross-Sectional Area Caused by Excimer Laser Ablation or Balloon Dilation, or Both, in the Two Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Ablation</th>
<th>Balloon</th>
<th>Stretch</th>
<th>Recoil</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs (mm)</td>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-BA</td>
<td>0.56 ± 0.44</td>
<td>0.59 ± 0.35</td>
<td>1.29 ± 0.40</td>
<td>0.84 ± 0.30</td>
<td>1.02 ± 0.52</td>
</tr>
<tr>
<td>BA</td>
<td>—</td>
<td>2.50 ± 0.40</td>
<td>1.81 ± 0.59</td>
<td>0.82 ± 0.32</td>
<td>1.00 ± 0.56</td>
</tr>
<tr>
<td>p value</td>
<td>—</td>
<td>0.69</td>
<td>&lt;0.0001</td>
<td>0.65</td>
<td>0.87</td>
</tr>
<tr>
<td>Normalized for RD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-BA</td>
<td>0.22 ± 0.18</td>
<td>0.98 ± 0.16</td>
<td>0.49 ± 0.16</td>
<td>0.32 ± 0.13</td>
<td>0.39 ± 0.20</td>
</tr>
<tr>
<td>BA</td>
<td>—</td>
<td>0.97 ± 0.14</td>
<td>0.69 ± 0.23</td>
<td>0.31 ± 0.13</td>
<td>0.36 ± 0.21</td>
</tr>
<tr>
<td>p value</td>
<td>—</td>
<td>0.81</td>
<td>&lt;0.0001</td>
<td>0.92</td>
<td>0.84</td>
</tr>
<tr>
<td>Absolute area (mm²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-BA</td>
<td>0.81 ± 0.06</td>
<td>5.30 ± 1.43</td>
<td>3.98 ± 1.41</td>
<td>2.86 ± 1.10</td>
<td>1.92 ± 0.95</td>
</tr>
<tr>
<td>BA</td>
<td>—</td>
<td>5.27 ± 1.77</td>
<td>4.69 ± 1.82</td>
<td>2.79 ± 1.37</td>
<td>1.90 ± 1.11</td>
</tr>
<tr>
<td>p value</td>
<td>—</td>
<td>0.78</td>
<td>0.02</td>
<td>0.76</td>
<td>0.91</td>
</tr>
<tr>
<td>Normalized for RA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL-BA</td>
<td>0.13 ± 0.14</td>
<td>0.92 ± 0.27</td>
<td>0.74 ± 0.30</td>
<td>0.51 ± 0.24</td>
<td>0.35 ± 0.19</td>
</tr>
<tr>
<td>BA</td>
<td>—</td>
<td>0.90 ± 0.36</td>
<td>0.86 ± 0.30</td>
<td>0.52 ± 0.25</td>
<td>0.34 ± 0.18</td>
</tr>
<tr>
<td>p value</td>
<td>—</td>
<td>0.43</td>
<td>0.03</td>
<td>0.87</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Data presented are mean value ± SD, unless otherwise indicated. RA = reference area; RD = reference diameter; other abbreviations as in Table 1.

Discussion

New techniques. In the past 10 years, a variety of novel techniques and devices have been introduced for the percutaneous treatment of coronary artery disease (11) in an attempt...
ELASTIC RECOIL AFTER ANGIOPLASTY

Figure 3. Relation between vessel stretching and elastic recoil after balloon angioplasty alone (BA) (top) and excimer laser-assisted balloon angioplasty (EL-BA) (middle) and the relation between extent of laser ablation and elastic recoil after adjunctive balloon dilation in the excimer laser-assisted balloon angioplasty group (bottom). Crossed circles represent procedural data, where excimer laser ablation was associated with deterioration of cross-sectional lumen area. Extent of laser ablation, vessel stretching and elastic recoil have been normalized for reference area (RA) to correct for vessel size. Solid lines represent calculated lines of regression.

Figure 4. Relation between minimal lumen diameter (MLD) after balloon dilation and mean balloon diameter during inflation in balloon angioplasty alone (BA) (top) and excimer laser-assisted balloon angioplasty (EL-BA) (bottom). Dashed lines connect data points, where minimal lumen diameter after balloon dilation would equal mean balloon diameter, and elastic recoil would be zero. Solid lines represent the calculated lines of regression.

to further improve primary success and to reduce acute complication and long-term restenosis rates associated with balloon coronary angioplasty. Current interventional techniques can be separated into two main categories on the basis of their effects on coronary lumen shape or obstruction: 1) remodeling, as with balloon dilation (1–11) and endoluminal stenting (16); and 2) removal of plaque tissue, as in laser angioplasty (17–19) and rotational (30) and directional (31–35) atherectomy. Comparative angiographic studies on the immediate efficacy of coronary atherectomy and balloon angioplasty in matched patients showed that atherectomy produced larger postprocedural lumen diameters (31–35) and less immediate elastic recoil than balloon angioplasty performed with similar-sized catheters (35). By physically removing obstructive atherosclerotic tissue from the arterial lumen, the result of directional atherectomy appears to depend less on plaque compression and stretching of the vascular wall than balloon dilation (7–11). Thus, debulking of plaque tissue by atherectomy may well be responsible for the observed reduction in elastic recoil causing a greater improvement in coronary lumen dimensions (i.e., acute gain), as in balloon angioplasty. In contrast to coronary stenting (16) and directional atherectomy (35), the present investigation did not demonstrate any benefit of atherosclerotic tissue ablation by excimer laser irradiation.
waves (37) in the arterial wall that result in multiple layers of dissection, causing the artery to "puff up," described by Abela as vapor bubbles is accompanied by the generation of shock waves within the tissue, causing tissue elevation. The damage as attributed to microsecond vapor bubble expansion and imploding vapor bubbles on the arterial segment caused by dilatory ("Dotter") effect of excimer laser angioplasty rather than true debulking (i.e., tissue removal using current available laser catheter technology).

**Future directions:** Modifications in procedural protocol and laser catheter design may improve the immediate results of excimer laser angioplasty. To increase the efficiency of ablation, fluence levels emitted from the catheter have been increased from ~40 mJ/mm² in initial laser procedures to maximum fluences of 65 mJ/mm², which is well above the ablation threshold of fibrous atherosclerotic plaque (47). Moreover, incorporation of more (hundreds) and smaller (50-μm diameter) optical fibers has improved catheter flexibility and reduced the so-called dead space, that is, the nonfiber cross-sectional area at the catheter tip. A reduction in dead space may reduce the mechanical dilating or "Dottering" effect of a laser catheter when a more active area of fibroplastics at the tip of the catheter is available for laser ablation. A recent development potentially eliminating dead space almost completely is the design of a modified multifiber laser catheter with a lensed tip that delivers a homogeneous donut-shaped light beam (48). Perpendicular irradiation of segments of fresh porcine aorta in forced contact with the modified catheter and immersed in a saline bath or blood field produced single smooth craters with sharp crater wall edges and no damage to surrounding endothelium (48). To reduce mechanical effects and acoustic trauma caused by rapid bubble expansion and collapse and accompanying shock waves, laser catheter systems are in development that activate separate fiber sections, so that not all fibers in the catheter are activated simultaneously but in a sequence of small fiber sections (49,50). Also, excimer laser irradiation in a saline medium has been shown in vitro and in vivo to reduce the magnitude of bubble formation and shock waves compared with laser-tissue interaction in a blood field (37,51). These techniques may reduce the incidence of significant dissections and shock wave-related trauma resulting from excimer laser angioplasty while the efficiency of tissue ablation is maintained.

**Limitations:** This study has several limitations. First, it is based on relatively early experience with excimer laser angioplasty. Careful patient selection, experience and future modifications in catheter design and treatment protocol may improve immediate results. Second, matching of groups was based on lesion characteristics (minimal lumen diameter,
reference diameter) that define elastic recoil in response to a given intervention. However, lesions were matched using pre-procedural angiographic variables only by an independent analyst who was unaware of treatment outcome. Third, a comparative study of coronary lumen dimensions after excimer laser-assisted balloon dilation versus balloon dilation alone by quantitative angiography represents an indirect manner of investigating the mechanism of excimer laser angioplasty. A more direct assessment of the effects of excimer laser ablation on the vessel wall would be distensibility measurements by producing balloon pressure–diameter curves for each lesion undergoing angioplasty, as proposed by Hjemdahl-Monsen et al. (14). A lesion (pre)treated by excimer laser angioplasty may be more distensible and easier to dilate than an untreated one, especially a heavily calcified stenosis (23). Another methodologic limitation may be the measurement of mean balloon diameter at maximal inflation instead of minimal balloon diameter because the inflated balloon is not uniform along its entire length. This may have resulted in some variation in the calculated stretch, elastic recoil and balloon/artery ratios, as previously pointed out by Hermans et al. (52). Also, with a sample size of 57 lesions in each group, a difference in elastic recoil of 25% (0.2 mm) can be detected with a statistical power of 95%. A difference in recoil of <0.2 mm may be of no clinical significance, but it cannot be excluded on the basis of the current data. Finally, this is a retrospective, observational study limited to a subset of patients who underwent successful excimer laser-assisted balloon angioplasty or balloon angioplasty alone. Although the two groups are well matched for several angiographic variables, procedural and patient variables (other than age, gender and angina class) are not included in the analysis. The efficacy of all intracoronary interventions will be limited by the problem of restenosis, which necessitates careful and complete angiographic follow-up. A controlled, prospective randomized trial in which patient and lesion characteristics are balanced is currently under way in the Netherlands (Amsterdam-Rotterdam [AMRO] trial) to assess the immediate and long-term efficacy of excimer laser and balloon angioplasty in the treatment of long (>10 mm) coronary lesions (53).

Conclusions. In a matched group of successfully treated coronary artery lesions, scenon chloride excimer laser ablation followed by adjunctive balloon dilation did not reduce acute elastic recoil or improve the final angiographic outcome compared with balloon angioplasty alone performed with similarsized balloon catheters.

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