Editorial Comment

Coronary Arteriographic Analysis and Angiographic Morphology*

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Which angiographic variables should be evaluated on a coronary arteriogram? The number of vessels with significant obstruction (usually defined as a ≥50% reduction in luminal diameter) (1,2) and the location and degree of these narrowings (3,4) have been shown to correlate with the clinical presentation and the risk of future myocardial infarction or sudden death. Recently, qualitative assessment of the shape of a coronary lesion has also provided important data (5-7). Analysis of the contour of a coronary lesion, noting in orthogonal views its symmetry and the irregularity of its borders, has afforded information about clinical presentation not contained in an analysis limited to the degree of coronary obstruction. Specifically, coronary morphology discriminated between stable and unstable angina when percent stenosis was similar (5).

Evaluation and interpretation of coronary morphology. Although the evaluation of coronary morphology is subjective, and therefore dependent on individual interpretation, we have found that it is reproducible. Optimally, morphology should be analyzed only from high quality cinearteriograms. All lesions should be evaluated in views that minimize vessel overlap and foreshortening. Three- to fivefold magnification of still frames and cine pictures is preferable. Utilizing this type of analysis, we have identified the type II eccentric lesion, which is an asymmetric stenosis in the form of a convex intraluminal obstruction with overhanging edges or irregular and often hazy borders, or both. This lesion was both sensitive and specific for detecting the acute coronary syndromes of unstable angina (5), non-Q wave infarction (6) and acute or recent transmural infarction (7) in which the angioma-producing or infarct-related artery was narrowed by ≥70% but <100%. As suggested by the work of Levin and Fallon (8) and by angioscopic images (9), such lesions represent plaque disruption with thrombus formation. These angiographic findings in unstable angina have been confirmed by other investigators, although some have referred to a similar appearing lesion as one with a complex morphology (10), a "T" lesion (11) or, in other cases, an intracoronary thrombus (12). Because there is no agreement as to what constitutes an intracoronary thrombus when there is <100% coronary occlusion, we prefer to restrict this term to single or multiple filling defects located proximal or distal to a severe coronary stenosis. Otherwise, we would classify the lesion according to its coronary morphology. Occasionally concentric (rather than eccentric) lesions may contain ulcerations, irregular borders, overhanging edges or associated thrombi. Therefore, it might be more appropriate to refer to all of these lesions as complex or type II lesions rather than as type II eccentric lesions.

Prognostic implications: present study. There is little information on the prognostic importance of complex lesions in unstable angina or myocardial infarction. In some studies (13,14) with small numbers of patients, a complex lesion or intracoronary thrombus occurred more commonly than did a noncomplex lesion in patients with unstable angina refractory to medical therapy. In this issue of the Journal, Ellis et al. (15) report on the prognostic importance of lesion irregularity in a cohort of patients from the Coronary Artery Surgery Study (CASS) registry who predominantly had a diagnosis of stable angina. Angiograms from 118 patients with one or more stenoses of the left anterior descending artery who developed anterior myocardial infarction during a 3 year follow-up period were matched on the basis of arteriographic anatomy and disease with angiograms from 141 patients who did not develop myocardial infarction.

The major results of this study were the following: 1) Lesion roughness, defined as either border irregularity or a "sawtooth" appearance of a lesion, ranked second in importance to quantitative measurement of percent stenosis as a predictor of risk of anterior myocardial infarction during a 3 year follow-up interval. 2) Roughness appeared to be a better predictor of transmural than of nontransmural myocardial infarction. 3) Roughness rather than eccentricity was the major factor imparting prognostic importance to complex plaques or type II lesions. Furthermore, on the basis of their data, Ellis et al. (15) suggested that lesion irregularity should be considered in clinical decision making because it possibly represents endothelial disruption that may promote thrombus formation with subsequent myocardial infarction. Additionally, their data indicate that moderate left anterior descending artery stenosis (50% to 69%) with a roughened appearance may well be associated with such a high incidence of infarction with medical therapy that one should consider more invasive strategies like coronary angioplasty.
This is the first study to analyze lesion contour as a variable for the subsequent development of myocardial infarction. Whether this irregularity represents intimal disruption (one cannot visualize the endothelium angiographically) is unclear at present. Because the risk of infarction within 1 year of angiography in their study was related to lesion irregularity as well as to the presence of a stenosis in a vessel bend or at a branch point, it is possible that these anatomic findings may predispose to turbulent blood flow or increased shear stresses rather than the irregularity indicating intimal disruption. Over time, turbulence or increased shear stress may contribute to plaque disruption with thrombus formation. Prospective verification of these findings will be necessary to confirm these findings. In particular, the risk of subsequent infarction in patients with a moderate lesion with irregular borders should be carefully assessed in future studies. However, these data support angiographic studies indicating that mild to moderate plaques are often the site of subsequent myocardial infarction (16,17). Occlusion of these moderate plaques is more likely to result in transmural than in nontransmural infarction (16), a finding that is consistent with the data of Ellis et al. (15).

Methodologic considerations. Whereas these data are indeed provocative, I have two concerns about the methodology used: 1) The study represents a retrospective subgroup analysis from CASS. This in itself has definite statistical limitations. Furthermore, because the analysis of morphology is subjective, only the highest quality cine films with angulated views should be categorized. It is difficult to assure that this high quality was maintained on films analyzed retrospectively, especially films from the 1970s.

2) The angiographic site of arterial occlusion was unknown because angiography was not repeated. Because mild to moderate lesions may progress and lead to myocardial infarction, it cannot be assumed that the most severe or most irregular stenoses were necessarily responsible for myocardial infarction. Even the actual artery responsible for anterior infarction is difficult to pinpoint because an occlusion of the left anterior descending artery or a large diagonal branch might be responsible for anterior precordial changes on the electrocardiogram. Although Ellis et al. (15) correctly point out that studies that relied on repeat angiographic assessment after myocardial infarction chose a selected group of patients, repeat angiography is necessary in most cases to determine the culprit lesion.

Conclusions. The role of lesion irregularity in clinical decision making, especially in patients with stable angina, requires further analysis. If the findings of Ellis et al. (15) can be corroborated by serial angiographic studies of high quality that properly assess morphology and the site of coronary occlusion, they may well modify how we recommend therapy on the basis of coronary arteriographic findings.

Finally, it has been shown that quantitative analysis of the anatomic severity of a coronary stenosis is more reproducible and correlates better with functional measurements of stenosis severity than does a subjective approach to diameter stenosis (18,19). Thus, in the future, a more objective approach to the analysis of coronary morphology may be developed whereby lesions can be precisely reconstructed by utilizing techniques for automatic edge detection.

References
