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Shortcomings of coronary angiography

(SEPTEMBER 1999)

TO THE EDITOR: I enjoyed reading Dr. Nissen's excellent article on the shortcomings of coronary angiography and their implications in clinical practice in the September issue of the *Cleveland Clinic Journal of Medicine*.[1] To the reasons enumerated by Dr. Nissen why angiography does not measure coronary artery disease accurately, I wish to add another.

As Dr. Nissen mentioned, coronary angiography provides a two-dimensional silhouette of a three-dimensional structure. Actually, it gives a one-dimensional measurement of a two-dimensional structure. In other words, what the angiographer sees on the angiogram is the diameter of the vessel, not the cross-sectional area of the vessel lumen: $A = \pi r^2$, where A is the luminal area of the vessel, π equals 22/7, and r is the radius of the vessel. Thus, a 50% narrowing of the vessel diameter on the angiogram corresponds to a 75% reduction of the luminal area of the coronary artery, and a 75% narrowing of the vessel diameter corresponds to a 95% reduction of the luminal area (**FIGURE 1**). Consequently coronary angiography always underestimates the severity of the coronary artery obstructive disease.

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Coronary angiography always underestimates the severity of coronary obstruction

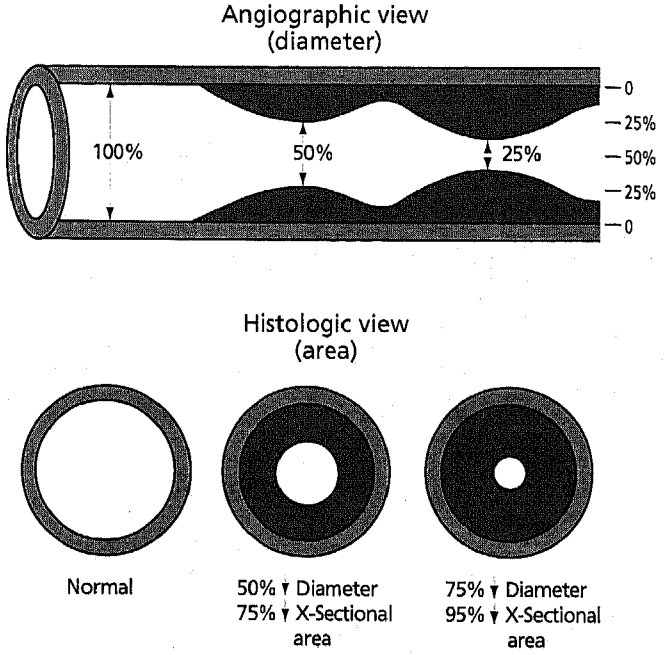

FIGURE 1. Diagrammatic representation of the relation between longitudinal narrowing (diameter reduction) as seen on coronary angiography and cross-sectional area reduction as seen on histologic examination of a coronary artery. A coronary arterial segment with a 50% longitudinal width narrowing has a 75% reduction in cross-sectional area; a 75% reduction in longitudinal width corresponds to a 95% reduction in cross-sectional area.

FROM ARNETT EN, ISNER JM, REDWOOD DR, KENT KM, BAKER WP, ACKERSTEIN H, ROBERTS WC. CORONARY ARTERY NARROWING IN CORONARY HEART DISEASE: COMPARISON OF CINEANGIOGRAPHIC AND NECROPSY FINDINGS. ANN INTERN MED 1979; 91:350–356; REPRODUCED WITH PERMISSION.

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1. **Nissen SE.** Shortcomings of coronary angiography and their implications in clinical practice. Cleve Clin J Med 1999; 66:479–485.

TO THE EDITOR: Dr. Nissen's article on "Shortcomings of coronary angiography and their implications in clinical practice"[1] was interesting and correctly pointed out the physiologic limitations of angiography. However, **FIGURE 4** in that article represents coronary flow reserve data from the dog model published approximately 10 years ago. This data is not for human coronary arteries, which is represented by a quadratic function (**FIGURE 2**). This was work published by my group in the October 1994 issue of *Angiology*.[2,3] The specific flow reserve equation is now published in the *Textbook of Angiology*.[4]

Dr. Nissen is correct that "a small difference in stenosis can make a big difference in symptoms," and the visual interpretation of percent diameter stenosis is frequently misrepresented by angiographers, as we note in two other publications.[5,6]

I believe it would be beneficial both for the author and your reading audience to be aware of these papers and their findings.

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2. **Fleming RM, Harrington GM, Gibbs HR, Swafford J.** Quantitative coronary arteriography and its assessment of atherosclerosis. Part I. Examining the independent variables. Angiology 1994; 45:829–834.
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6. **Fleming RM, Fleming DM, Gaede R.** Training physicians and health care providers to accurately read coronary arteriograms. A training program. Angiology 1996; 47:349–359.

Coronary flow reserve begins to decline at a percent stenosis of 15%–20%

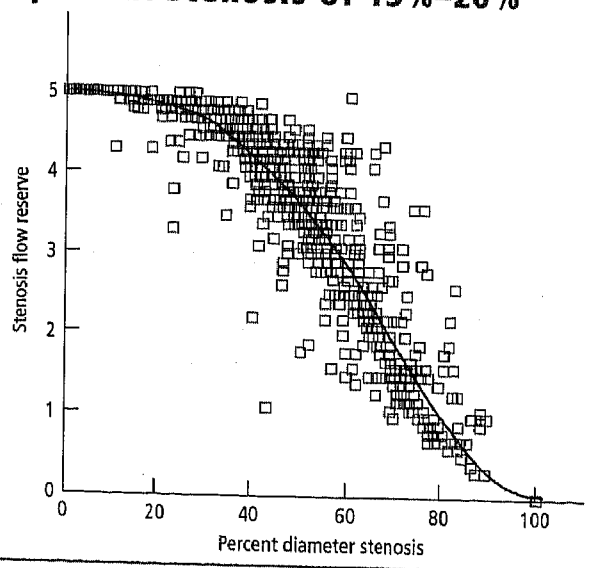

FIGURE 2. Comparison of percent diameter stenosis with stenosis flow reserve in 1,040 coronary artery lesions in humans.

FROM FLEMING RM, HARRINGTON GM, GIBBS HR, SWAFFORD J. QUANTITATIVE CORONARY ARTERIOGRAPHY AND ITS ASSESSMENT OF ATHEROSCLEROSIS. PART I. EXAMINING THE INDEPENDENT VARIABLES. ANGIOLOGY 1994; 45:829–834.