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.

TSUNG O. CHENG, MD
Professor of Medicine
The George Washington University Medical Center
Washington, DC

Coronary angiography always underestimates the severity of coronary obstruction

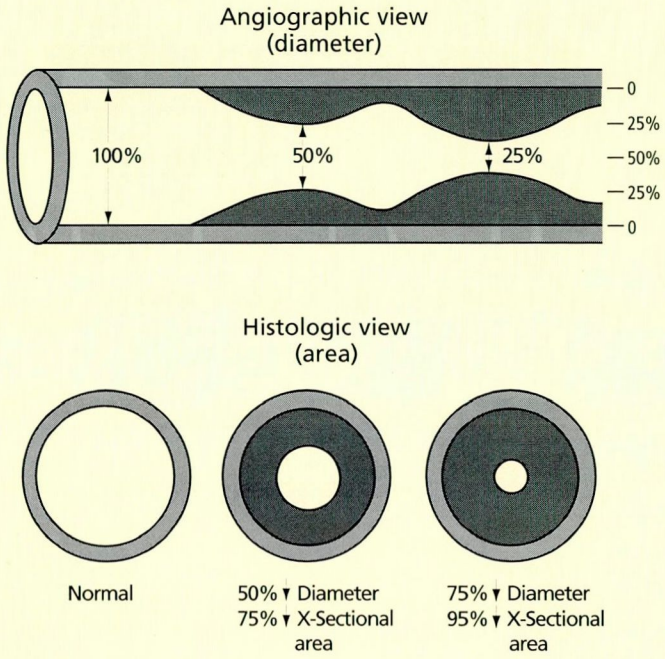


FIGURE 1. Diagrammatic representation of the relation between longitudinal narrowing (diameter reduction) as seen on coronary angiography and cross-sectional area reduction as seen on histologic examination of a coronary artery. A coronary arterial segment with a 50% longitudinal width narrowing has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

REFERENCES

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.

RICHARD M. FLEMING, MD
Fleming Heart and Health Institute
Omaha, Nebraska

REFERENCES

1. **Nissen SE.** Shortcomings of coronary angiography and their implications in clinical practice. Cleve Clin J Med 1999; 66:479–485.
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.
3. **Fleming RM, Harrington GM.** Quantitative coronary arteriography and its assessment of atherosclerosis. Part II. Calculating stenosis flow reserve from percent diameter stenosis. Angiology 1994; 45:835–840.
4. **Fleming RM.** Atherosclerosis; Understanding the relationship between coronary artery disease and stenosis flow reserve. In: Chang JB, editor. Textbook of Angiology. New York: Springer-Verlag, 2000:381–387.
5. **Fleming RM, Kirkeeide RL, Smalling RW, Gould KL.** Patterns in visual interpretation of coronary arteriograms as detected by quantitative coronary angiography. JACC 1991; 18:945–951.
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%

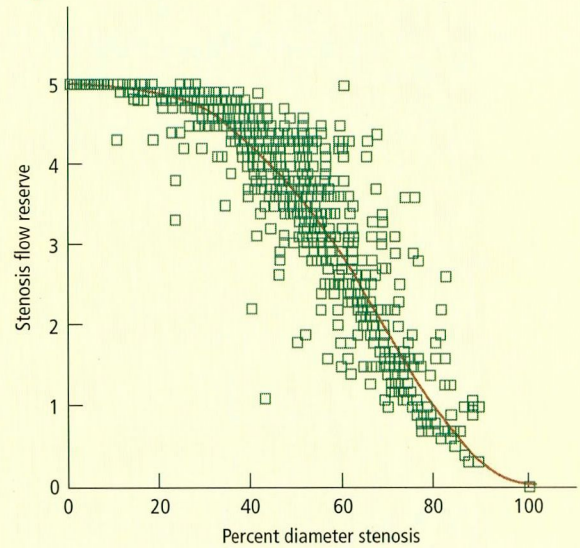


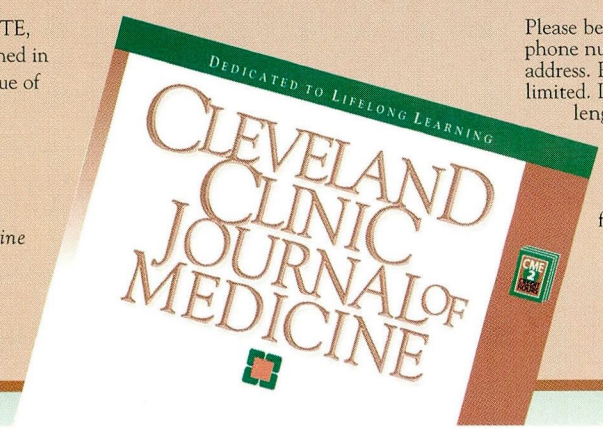
FIGURE 2. Comparison of percent diameter stenosis with stenosis flow reserve in 1,040 coronary artery lesions in humans.

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.

We Welcome Your Letters

WE ENCOURAGE YOU TO WRITE, either to respond to an article published in the *Journal* or to address a clinical issue of importance to you. You may submit letters by mail, fax, or e-mail.

MAILING ADDRESS
Letters to the Editor
Cleveland Clinic Journal of Medicine
9500 Euclid Ave., NA32
Cleveland, OH 44195
FAX 216.444.9385
E-MAIL ccjm@ccf.org



Please be sure to include your full address, phone number, fax number, and e-mail address. Please write concisely, as space is limited. Letters may be edited for style and length. We cannot return materials sent. Submission of a letter constitutes permission for the *Cleveland Clinic Journal of Medicine* to publish it in various editions and forms.

The HOPE study

(APRIL 2000)

TO THE EDITOR: While the mechanism of reducing cardiac events by ACE inhibitors is still unclear as mentioned by Hoogwerf and Young in their excellent review of the HOPE trial[1] and by the main investigators, the answer to this question will never be simple.

Current understanding of the cellular mechanism of atherogenesis provides us with invaluable information about the role of ACE inhibitors that can partially answer the question raised by the HOPE trial.

The activation of the cellular suicide pathway leading to apoptosis of the coronary endothelial cells possibly through activation of the transmembrane protein Fas/APO 1 is a key event in the development of atherosclerotic lesions.[2,3]

Dimmler et al[4] reported induction of apoptosis in human endothelial cells by using angiotensin II. Further evidence suggests that the activation of the vascular renin-angiotensin system following endothelial dysfunction/injury plays an important role in the pathogenesis of vascular remodeling and atherosclerosis.

We were able to prove that ACE inhibitors can inhibit apoptosis induced by Fas/APO 1 in a different cell line,[5,6] and blockade of angiotensin receptors was shown to prevent angiotensin II-induced apoptosis in human endothelial cells.[4]

The TREND study[7] was another landmark study that showed that ACE inhibition with quinapril improved endothelial dysfunction in patients who were normotensive and who did not have severe hyperlipidemia or evidence of heart failure.

I believe that ACE inhibitors play a pivotal role in preventing atherosclerosis and in plaque stability through inhibition of endothelial cell apoptosis. Further studies are needed in this area.

RAED BARGOUT, MD
Oak Park, IL

REFERENCES

1. **Hoogwerf BJ, Young JB.** Ramipril lowered cardiovascular risk, but vitamin E did not. Cleve Clin J Med 2000; 67:287-293.
2. **Cai W, Devaux B, Schaper W, Schaper J.** The role of Fas/APO1 and apoptosis in the development of human atherosclerotic lesions. Atherosclerosis 1997; 131:177-186.
3. **Dimmeler S, Hermann C, Zeiher AM.** Apoptosis of endothelial cells. Contribution to the pathophysiology of atherosclerosis? Eur Cytokine Netw 1998; 9(4):697-698.
4. **Dimmeler S, Rippmann V, Weiland U, Haendeler J, Zeiher AM.** Angiotensin II induces apoptosis of human endothelial cells. Protective effect of nitric oxide. Circ Res 1997; 81(6):970-976.
5. **Uhal BD, Gidea C, Bargout R, et al.** Captopril inhibits apoptosis in human lung epithelial cells: apotential antifibrotic mechanism. Am J Physiol 1998; 275: L1013-1017.
6. **Wang R, Zagariya A, Ang E, Ibarra-Sunga O, Uhal BD.** Fas-induced apoptosis of alveolar epithelial cells requires ANG II generation receptor interaction. Am J Physiol 1999; 277: L1245-1250.
7. **Mancini GB, Henry GC, Macaya C, et al.** Angiotensin-converting enzyme inhibition with quinapril improves endothelial vasomotor dysfunction in patients with coronary artery disease. Circulation 1996; 94:258-265.