

3. Hamsten A. Hemostatic function and coronary artery disease. *N Engl J Med* 1995;332:677-678.
4. Loscalzo J. The relation between atherosclerosis and thrombosis. *Circulation* 1995;86:III95-99.
5. Fowkes FGR, Lee AJ, Lowe GDO, Riemersma RA, Housley E. Inter-relationships of plasma fibrinogen, low density lipoprotein cholesterol, cigarette smoking and the prevalence of cardiovascular disease. *J Cardiovasc Risk* 1996;3:307-312.
6. Ma J, Hennekens CH, Ridker PM, Stampfer MJ. A prospective study of fibrinogen and risk of myocardial infarction in the Physicians Health Study. *J Am Coll Cardiol* 1999;33:1347-1352.
7. Ross R. The pathogenesis of atherosclerosis—an update. *N Engl J Med* 1986;314:488-500.
8. Celermajer DS, Sorensen KE, Gooch VM, Spiegelhalter DS, Miller OI, Sullivan ID, Lloyd JK, Deanfield JE. Non-invasive detection of endothelial dysfunction in children and adults at risk of atherosclerosis. *Lancet* 1992;340:1111-1115.
9. Fagiotto A, Ross R, Harker L. Studies of hypercholesterolemia in the non-human primate. I: changes that lead to fatty streak formation. *Arteriosclerosis* 1984;4:323-340.
10. Fish RD, Nabel EG, Selwyn AP, Ludmer P. Responses of coronary arteries of cardiac transplant patients to acetylcholine. *J Clin Invest* 1988;81:21-31.
11. Ernst E, Koenig W. Fibrinogen and cardiovascular risk. *Vasc Med* 1997;2:115-125.
12. Kannel WB. Contributions of the Framingham study to the conquest of coronary artery disease. *Am J Cardiol* 1988;62:1109-1112.
13. Connelly JB, Cooper JA, Meade TW. Strenuous exercise, plasma fibrinogen, and factor VII activity. *Br Heart J* 1992;67:351-354.
14. Stratton JR, Chandler WL, Schwartz RS, Cerqueira MD, Levy WC, Khan SE, Larson VG, Cain KC, Beard JC, Abrass IB. Effects of physical conditioning on fibrinolytic variables and fibrinogen in young and old healthy adults. *Circulation* 1991;83:1692-1697.
15. Haglund O, Mehta JL, Saldeen T. Effects of fish oil on some parameters of fibrinolysis and lipoprotein(a) in healthy subjects. *Am J Cardiol* 1994;15:189-192.
16. Calles-Escandon J, Ballor D, Harvey-Berino J, Ades P, Tracy R, Sobel B. Amelioration of the inhibition of fibrinolysis in elderly, obese subjects by moderate energy intake restriction. *Am J Clin Nutr* 1996;64:7-11.

## Practice Guidelines for Electron Beam Tomography: A Report of the Society of Atherosclerosis Imaging

Harvey S. Hecht, MD, for the Society of Atherosclerosis Imaging\*

The use of electron beam tomography (EBT) for the detection and quantitation of coronary atherosclerotic plaque burden has become increasingly disseminated and has been accompanied by a corresponding increase in the scientific literature validating its utility.<sup>1</sup> However, there has not been a consensus document providing guidelines for its application. The newly formed Society of Atherosclerosis Imaging, with representation from the imaging and epidemiologic communities, has undertaken to provide such guidelines. Operating under the following charter: "To promote and coordinate an integrated approach to atherosclerosis detection and prevention emphasizing noninvasive imaging and risk factor modification," the Society of Atherosclerosis Imaging has developed recommendations that reflect current usage supported by emerging data. At the same time, considerable leeway is afforded for physician use according to individual practice patterns. Pending publication of peer reviewed data supporting other imaging modalities, these guidelines are currently applicable only to EBT.

The American College of Cardiology/American Heart Association classifications I, II, and III are used to summarize indications.

**Class I:** Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.

1. Initial diagnostic test in ambulatory adults  $\leq 65$  years of age with atypical chest symptoms, in the absence of established cardiovascular disease.<sup>2-7</sup>
2. Supplementary diagnostic test in adults  $\leq 65$  years

of age with indeterminate stress test results, in the absence of established cardiovascular disease.<sup>8-11</sup>

3. Emergency room evaluation of men  $\leq 50$  and women  $\leq 60$  years of age with chest pain and normal or nondiagnostic electrocardiograms, in the absence of established cardiovascular disease.<sup>12-14</sup>

**Class II:** Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/or efficacy of a procedure.

**IIa:** Weight of evidence/opinion is in favor of usefulness/efficacy.

1. Men 45 to 65 years of age, women 55 to 75 years of age in the absence of established cardiovascular disease; subtract 10 years if any of the following risk factors are present (thus deemed "Intermediate Risk")<sup>15-19</sup>: family history of premature coronary artery disease (first-degree male relative  $< 55$  years of age and female relative  $< 65$  years of age); hypertension; smoking (current or within last year); elevated low-density lipoprotein or reduced high-density lipoprotein based on current National Cholesterol Education Program guidelines.<sup>20</sup>
2. Diabetic men 35 to 65 years of age and women 35 to 75 years of age without known cardiovascular disease.<sup>21-23</sup>
3. Assist physicians in decision-making regarding initiation or change of drug therapy for cholesterol abnormalities in patients without established cardiovascular disease.

**IIb:** Usefulness/efficacy is less well established by evidence/opinion.

1. Monitoring progression and effects of treatment after interval of  $\geq 1$  years.<sup>24-26</sup>
2. Evaluating the etiology of heart failure.<sup>27,28</sup>
3. Following patients after cardiac transplantation.<sup>29</sup>

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\*See Appendix for the Board of Directors of the Society of Atherosclerosis Imaging.

**Class III:** Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful.

1. Pregnancy.
2. Prior coronary artery bypass surgery or coronary artery stent placement.
3. Established coronary artery disease without plan for follow up study to track progression/treatment.

## APPENDIX

**Society of Atherosclerosis Imaging:** President: Harvey S. Hecht, MD; Secretary/Treasurer: George P. Rodgers, MD; Director of Medical Affairs: John A. Rumberger, MD, PhD; Board of Directors: Stephan Achenbach, MD, Arthur A. Agatston, MD, Daniel S. Berman, MD, B. Greg Brown, MD, PhD, Matthew J. Budoff, MD, Tracy Q. Callister, MD, William P. Castelli, MD, James Ehrlich, MD, Alan D. Guerci, MD, Warren R. Janowitz, MD, David King, Lewis H. Kuller, MD, DrPH, Daniel J. Rader, MD, Paolo Raggi, MD, William C. Roberts, MD, Patrick F. Sheedy II, MD, and Alan G. Wasserman, MD.

1. Rumberger JA, Brundage BH, Rader DJ, Kondos G. Electron beam computed tomographic coronary calcium scanning: a review and guidelines for use in asymptomatic persons. *Mayo Clin Proc* 1999;74:243–252.
2. Budoff MJ, Georgiou D, Brody A, Agatston AS, Kennedy JM, Wolfkiel C, Stanford W, Shields P, Lewis RJ, Janowitz WR, Rich S, Brundage BH. Ultrafast computed tomography as a diagnostic modality in the detection of coronary artery disease—a multicenter study. *Circulation* 1996;93:898–904.
3. Kennedy J, Shavelle R, Wang S, Budoff M, Detrano RC. Coronary calcium and standard risk factors in symptomatic patients referred for coronary angiography. *Am Heart J* 1998;135:696–702.
4. Detrano R, Tzung H, Wang S, Puentes G, Fallavollita J, Shields P, Stanford W, Wolfkiel C, Georgiou D, Budoff M, Reed J. Prognostic value of coronary calcification and angiographic stenoses in patients undergoing coronary angiography. *J Am Coll Cardiol* 1996;27:285–290.
5. Rumberger JA, Sheedy PF II, Breen JR, Schwartz RS. Coronary calcium as determined by electron beam computed tomography, and coronary disease on arteriogram: effect of patient's sex on diagnosis. *Circulation* 1995;91:1363–1367.
6. Kaufmann RB, Sheedy PF, Maher JE, Bielak LF, Breen JF, Schwartz RS, Peyser PA. Quantity of coronary artery calcium detected by electron beam computed tomography in asymptomatic subjects and angiographically studied patients. *Mayo Clin Proc* 1995;70:223–232.
7. Guerci AD, Spadaro LA, Goodman KJ, Lledo-Perez A, Newstein D, Lerner G, Arad Y. Comparison of electron beam computed tomography scanning and conventional risk factor assessment for the prediction of angiographic coronary artery disease. *J Am Coll Cardiol* 1998;32:673–679.
8. Schmermund A, Bailey KR, Rumberger JA, Reed JE, Sheedy PF II, Schwartz RS. An algorithm for noninvasive identification of angiographic three-vessel and/or left main coronary artery disease in symptomatic patients on the basis of cardiac risk and electron-beam computed tomographic calcium scores. *J Am Coll Cardiol* 1999;33:444–452.
9. Hattori Y, Imazu M, Yamabe T, Yamakido M, Nakanishi T, Ito K. Comparative study of dobutamine stress electron-beam computed tomography and exercise thallium scintigraphy in the diagnosis of patients with suspected coronary artery disease. *Jpn Circ J* 1998;62:83–90.
10. Schmermund A, Denktas AE, Rumberger JA, Christian TF, Sheedy PF II, Bailey KR, Schwartz RS. Independent and incremental value of coronary artery calcium for predicting the extent of angiographic coronary artery disease: comparison with cardiac risk factors and radionuclide perfusion imaging. *J Am Coll Cardiol* 1999;34:777–786.

11. Rumberger JA, Behrenbeck T, Breen JF, Sheedy PF II. Coronary calcification by electron beam computed tomography and obstructive coronary artery disease: a model for costs and effectiveness of diagnosis as compared with conventional cardiac testing methods. *J Am Coll Cardiol* 1999;33:453–462.
12. Laudon DA, Vukov LF, Breen JF, Rumberger JA, Wollan PC, Sheedy PF II. Use of electron-beam computed tomography in the evaluation of chest pain patients in the emergency department. *Ann Emerg Med* 1999;33:15–21.
13. McLaughlin VV, Balogh T, Rich S. Utility of electron beam computed tomography to stratify patients presenting to the emergency room with chest pain. *Am J Cardiol* 1999;84:327–328.
14. Budoff MJ, Kaufer ES, Han J, Mao S, Brundage BH. Prognostic value of coronary calcification in a chest pain population (abstr). *J Am Coll Cardiol* 2000;35:462A.
15. Arad Y, Sparado LA, Goodman K, Lledo-Perez A, Sherman S, Lerner G, Guerci AD. Predictive value of electron beam computed tomography of the coronary arteries. *Circulation* 1996;93:1951–1953.
16. Detrano RC, Wong ND, Shavelle R, Tang W, Doherty TM, Ginzton LE, Budoff MJ, Narahara KA. Coronary calcium does not accurately predict near-term future cardiac events in high-risk adults. *Circulation* 1999;99:2633–2638.
17. Guerci AD, Spadaro LA, Popma JJ, Goodman KJ, Brundage BH, Budoff M, Lerner G, Vizza RF. Relation of coronary calcium score by electron beam computed tomography to arteriographic findings in asymptomatic and symptomatic adults. *Am J Cardiol* 1997;79:128–133.
18. Wong ND, Detrano RC, Diamond G, Rezayat C, Mahmoudi R, Chong EC, Tang W, Puentes G, Kang X, Abrahamson D. Does coronary artery screening by electron beam computed tomography motivate potentially beneficial lifestyle behaviors? *Am J Cardiol* 1996;78:1220–1223.
19. Rumberger JA, Sheedy PF II, Breen JF, Schwartz RS. Coronary calcium, as determined by electron beam computed tomography, and coronary disease on arteriogram. Effect of patient's sex on diagnosis. *Circulation* 1995;91:1363–1367.
20. Summary of the second report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II). *JAMA* 1993;269:3015–3023.
21. Rewers M, Ehrlich J, Jensen L, Seigel R, Barriga K, Garg S, Janowitz W, Eckel R. High prevalence of asymptomatic coronary atherosclerosis detected by electron beam computed tomography in young adults with IDDM (abstr). *Diabetes* 1998;47:A12.
22. American Diabetes Association. Management of dyslipidemia in adults with diabetes. American Diabetes Association: Clinical Practice Recommendations 1999. *Diabetes Care* 1999;22:556–559.
23. Peters SR, Khaleeli E, Ko JY, Budoff MJ. The use of electron beam computed tomography to predict clinical significance of coronary calcification in diabetics (abstr). *J Am Coll Cardiol* 1999;33:415A.
24. Callister T, Raggi P, Coil B, Lippolis NJ, Russo DJ. Effect of HMG-CoA reductase inhibitors on coronary artery disease as assessed by electron-beam computed tomography. *N Engl J Med* 1998;339:1972–1978.
25. Maher JE, Bielak LF, Raz JA, Sheedy PF, Schwartz RS, Peyser PA. Progression of coronary artery calcification: a pilot study. *Mayo Clin Proc* 1999;74:347–355.
26. Budoff MJ, Lane KL, Bakhsheshi H, Mao SS, Grassman BO, Friedman BC, Brundage BH. Rates of progression of coronary calcification by electron beam computed tomography. *Am J Cardiol* 2000;86:8–11.
27. Budoff MJ, Shavelle DM, Lamont DH, Kim T, Akinwale P, Kennedy JM, Brundage BH. Usefulness of electron beam computed tomography scanning for distinguishing ischemic from non-ischemic cardiomyopathy. *J Am Coll Cardiol* 1998;32:1173–1178.
28. Le T, Ko JY, Kim HT, Akinwale P, Budoff MJ. Comparison of echocardiography and electron beam tomography in differentiating the etiology of heart failure. *Clin Cardiol* 2000; in press.
29. Ludman PF, Lazem F, Barbir M, Yacoub M. Incidence and clinical relevance of coronary calcification detected by electron beam computed tomography in heart transplant recipients. *Eur Heart J* 1999;20:303–308.