Universiteit
Leiden
The Netherlands

Multimodality imaging in chronic coronary artery disease

Henneman, M.M.

Citation
Henneman, M. M. (2008, December 18). *Multimodality imaging in chronic coronary artery disease*. Retrieved from https://hdl.handle.net/1887/13367

Version:	Corrected Publisher's Version
License:	Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden
Downloaded from:	https://hdl.handle.net/1887/13367

Note: To cite this publication please use the final published version (if applicable).

General introduction and outline of the thesis

080237 Henneman boek.indb 9 03-11-2008 10:56:26

General introduction

Coronary artery disease (CAD) is one of the leading causes of morbidity and mortality in the Western world today with still increasing prevalence. For men and women with a first clinical presentation of stable angina pectoris, the 2 year incidence rate of non-fatal myocardial infarction and death due to CAD were 14.3 and 5.5% in men and 6.2 and 3.8% in women.[1 2] More recent data from clinical trials involving the anti-anginal therapy and/or revascularization estimate the annual mortality to range from 0.9 to 1.4% per year[3-7], with an annual incidence of non-fatal myocardial infarction between 0.5 and 2.6%.[4 6] The diagnosis and assessment of CAD involve clinical assessment, blood tests and specific (non-) invasive tests to confirm the diagnosis of ischemia in patients with suspected chronic CAD. In addition, information is needed with regard to prognosis and the efficacy of treatment in these patients. Non-invasive cardiac imaging plays an important role in the diagnosis and management of patients with suspected or known chronic CAD. To this end, both functional and anatomical imaging modalities are currently available.

Detection of CAD

Functional non-invasive imaging focuses on the detection of significant flow-limiting stenoses. Modalities that are traditionally used for this purpose are single photon emission computed tomography (SPECT)[8], positron emission tomography (PET)[9], (contrast) stress echocardiography[10 11] and cardiac magnetic resonance imaging (CMR)[12]. With these techniques the haemodynamic consequences of coronary artery stenoses can be assessed by detecting the presence of perfusion abnormalities or left ventricular (LV) systolic dysfunction. More recently, attention has been directed towards early detection of CAD, since knowledge of pre-clinical CAD may be of great value for patient management and may considerably improve outcome. Therefore, extensive research is currently performed in the field of non-invasive anatomical imaging, for instance of evaluation of coronary calcium burden or non-invasive coronary angiography with multi-slice computed tomography (MSCT) and CMR. In particular, MSCT may be an attractive modality as it allows assessment of the presence of significant stenosis as well as the presence of atherosclerosis with high accuracy. Moreover, to some extent information on plaque composition can be obtained, including the detection of non-calcified plaque. This may be an important advantage over other atherosclerosis imaging techniques such as coronary calcium scoring.

The high negative predictive value is considered to be the major strength of MSCT coronary angiography and it has been shown that a normal MSCT virtually excludes CAD. However, it is feared that improper use of the technique may result in the observation of atherosclerosis in many patients rather than effective rule out. As a consequence, subsequent referral for additional diagnostic tests may only increase resulting in a considerable burden on healthcare economics. It is therefore important to identify which patient populations may benefit the most from this novel technique.

Heart failure

Chronic CAD can eventually lead to heart failure. Chronic systolic heart failure is a complex of symptoms arising when delivery of oxygen to the metabolizing tissues is impaired due to defective function of the heart as a pump. European data show that, in individuals aged 55, almost 1 in 3 will develop heart failure during their remaining lifespan.[13] Pharmacological therapy is the cornerstone in the management of heart failure. The introduction of ACE inhibitors[14-16], spironolactone[17] and beta blocking agents[18] has contributed to an improvement in survival, morbidity and symptoms. However, despite optimal medical therapy and recent advances in heart failure treatment, the 5 year mortality still exceeds 50%.

Cardiac resynchronization therapy (CRT) has shown to be beneficial in patients with end-stage heart failure. Not only improvement in New York Heart Association functional class, quality of life and exercise capacity has been observed after implantation of a CRT device, but also a reduction in hospitalization for heart failure and an increase in survival have been demonstrated. However, despite strict criteria for patient selection for CRT, still up to 30% of the patients does not benefit from CRT implantation.[19] Extensive research has been executed to identify new parameters to predict which patients will respond to CRT and which patients will not. An important criterion is the presence of LV dyssynchrony. Several studies show that patients with LV dyssynchrony as assessed with echocardiographic techniques, are more likely to respond to CRT.[20 21] Also the presence of viable myocardium and the absence of scar tissue play an important role in the response to CRT.[22 23] The application of phase analysis to gated perfusion SPECT can potentially provide all this information (LV dyssynchrony, viability and scar tissue) from one data set.

Objective and outline of the thesis

The objective of this thesis is to evaluate the role of MSCT in the non-invasive evaluation of patients with suspected or known CAD and to assess the value of nuclear imaging in patients with heart failure and in specific, in the patient selection for CRT. In **Part I** of this thesis the additional value of MSCT is described in terms of assessment of global and regional LV function and the assessment of perfusion defects. Moreover, the prevalence of a "normal" MSCT scan is investigated as well as the role of MSCT imaging in patients presenting with suspected acute coronary syndrome. In **Chapter 1**, an overview is provided of the currently used imaging modalities to detect CAD. **Chapter 2** focuses on the assessment of global and regional LV function and volumes with MSCT as compared with 2D echocardiography and gated SPECT. In **Chapter 3**, LV functional assessment is compared between 2D echocardiography and 64-slice MSCT. Comprehensive cardiac assessment of both LV function and perfusion in addition to coronary angiography in patients with prior myocardial infarction is performed in **Chapter 4**. In **Chapter 5** attention is directed to the detection of healed myocardial infarction with MSCT. In **Chapter 6**, MSCT coronary angiography is used in the evaluation of patients presenting with suspected acute coronary syndrome and the atherosclerotic burden and plaque

morphology are related to the presence of coronary calcium. Finally, in **Chapter 7**, the prevalence of a "normal" MSCT study in patients with suspected CAD is described and observations are linked to clinical presentation and the pretest likelihood of CAD.

Part II focuses on the role of nuclear imaging in patients with heart failure.

In **Chapter 8**, the potential role of nuclear imaging in the selection of heart failure patients for CRT is discussed. The degree of LV dyssynchrony as evaluated with phase analysis from gated perfusion SPECT is compared to the degree of LV dyssynchrony as assessed with tissue Doppler imaging in patients with severe heart failure in **Chapter 9**. Finally, in **Chapter 10**, the degree of LV dyssynchrony as assessed with phase analysis is shown to allow prediction of response to CRT.

References

1. Murabito JM, Evans JC, Larson MG, Levy D. Prognosis after the onset of coronary heart disease. An investigation of differences in outcome between the sexes according to initial coronary disease presentation. *Circulation* 1993;88:2548-55.
2. Kannel WB, Feinleib M. Natural history of angina pectoris in the Framingham study. Prognosis and survival. *Am J Cardiol* 1972;29:154-63.
3. Henderson RA, Pocock SJ, Clayton TC, *et al*. 7 year outcome in the RITA-2 trial: coronary angioplasty versus medical therapy. *J Am Coll Cardiol* 2003;42:1161-70.
4. Pepine CJ, Handberg EM, Cooper-DeHoff RM, *et al*. A calcium antagonist vs. a non-calcium antagonist hypertension treatment strategy for patients with coronary artery disease. The International Verapamil-Trandolapril Study (INVEST): a randomized controlled trial. *JAMA* 2003;290:2805-16.
5. Rehnqvist N, Hjemdahl P, Billing E, *et al*. Effects of metoprolol vs. verapamil in patients with stable angina pectoris. The Angina Prognosis Study in Stockholm (APSIS). *Eur Heart J* 1996;17:76-81.
6. Dargie HJ, Ford I, Fox KM. Total Ischaemic Burden European Trial (TIBET). Effects of ischaemia and treatment with atenolol, nifedipine SR and their combination on outcome in patients with chronic stable angina. The TIBET Study Group. *Eur Heart J* 1996;17:104-12.
7. Juul-Moller S, Edvardsson N, Jahnmatz B. Double-blind trial of aspirin in primary prevention of myocardial infarction in patients with stable chronic angina pectoris. The Swedish Angina Pectoris Aspirin Trial (SAPAT) Group. *Lancet* 1992;340:1421-5.
8. Underwood SR, Anagnostopoulos C, Cerqueira M, *et al*. Myocardial perfusion scintigraphy: the evidence. *Eur J Nucl Med Mol Imaging* 2004;31:261-91.
9. Klocke FJ, Baird MG, Lorell BH, *et al*. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging--executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). *Circulation* 2003;108:1404-18.
10. Bax JJ, van der Wall EE, de Roos A, Poldermans D. Clinical nuclear cardiology. State of the art and future directions. Philadelphia: Mosby, 2005.
11. Moir S, Haluska BA, Jenkins C, *et al*. Incremental benefit of myocardial contrast to combined dipyridamole-exercise stress echocardiography for the assessment of coronary artery disease. *Circulation* 2004;110:1108-13.
12. Paetsch I, Jahnke C, Wahl A, *et al*. Comparison of dobutamine stress magnetic resonance, adenosine stress magnetic resonance, and adenosine stress magnetic resonance perfusion. *Circulation* 2004;110:835-42.
13. Bleumink GS, Knetsch AM, Sturkenboom MCJM, *et al*. Quantifying the heart failure epidemic: prevalence, incidence rate, lifetime risk and prognosis of heart failure. *Eur Heart J* 2004;25:1614-9.
14. The SAVE investigators. Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after myocardial infarction. *N Engl J Med* 1992;327:669-77.
15. The SOLVD investigators. Effect of enalapril on survival in patients with reduced left ventricular ejection fractions and congestive heart failure. *N Engl J Med* 1991;325:293-302.
16. The CONSENSUS trial study group. Effects of enalapril on mortality in severe congestive heart failure. *N Engl J Med* 1987;316:1429-35.
17. Pitt B, Zannad F, Remme WJ, *et al*. The effect of spironolactone on morbidity and mortality in patients with severe heart failure. *N Engl J Med* 1999;341:709-17.
18. Packer M, Coats AJ, Fowler MB, *et al*. Effect of carvedilol on survival in severe chronic heart failure. *N Engl J Med* 2001;344:1651-8.
19. Bristow MR, Saxon LA, Boehmer J, *et al*. Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50.
20. Bax JJ, Bleeker GB, Marwick TH, *et al*. Left ventricular dyssynchrony predicts response and prognosis after cardiac resynchronization therapy. *J Am Coll Cardiol* 2004;44:1834-40.
21. Suffoletto MS, Dohi K, Cannesson M, *et al*. Novel speckle-tracking radial strain from routine black-and-white echocardiographic images to quantify dyssynchrony and predict response to cardiac resynchronization therapy. *Circulation* 2006;113:960-8.
22. Bleeker GB, Kaandorp TA, Lamb HJ, *et al*. Effect of posterolateral scar tissue on clinical and echocardiographic improvement after cardiac resynchronization therapy. *Circulation* 2006;113:969-76.
23. Ypenburg C, Schalij MJ, Bleeker GB, *et al*. Impact of viability and scar tissue on response to cardiac resynchronization therapy in ischaemic heart failure patients. *Eur Heart J* 2007;28:33-41.

080237 Henneman boek.indb 14 03-11-2008 10:56:26