Computed Tomography for Suspected Coronary Artery Disease

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Summary and conclusions

Computed tomography coronary angiography (CTCA) is a rapid and noninvasive radiographic imaging method to identify stenoses in the coronary arteries. It is used to investigate suspected coronary artery disease. This technology has advanced rapidly in recent years, enabling improved imaging of vessels while reducing radiation. CTCA is being promoted as a potential triage method[1] to determine which patients can avoid further investigation via invasive coronary angiography (ICA). This report assesses the diagnostic test accuracy of CTCA in patients with intermediate probability of nonacute (stable) coronary artery disease. (Facts 1, Facts 2)

[1] *Triage is a process for classifying and prioritising patients. In this context, patients with positive findings from CTCA are investigated further using other modalities.*

SBU's appraisal of the evidence

- For individuals with intermediate probability of stable coronary artery disease, CTCA is a sensitive method, i.e. it misses few clinically significant stenoses. However, it is less specific, i.e. occasionally it indicates a constriction when there is no clinically significant stenosis. In the studies of individuals with intermediate probability of coronary artery disease, sensitivity is 94 to 100 percent, and specificity is 63 to 94 percent.

- Optimising the diagnostic test accuracy of the method and reducing the radiation dose would require investing in modern equipment and staff training.

- For the patient group as a whole, it is estimated that a strategy starting with CTCA would currently lead to a higher radiation dose than using ICA alone, assuming that the prevalence of clinically significant stenoses is 55 percent. The lower the prevalence of clinically significant stenoses, the lower the total radiation dose at the group level with the CTCA strategy. The reason is that fewer patients would require further examination after CTCA.

- New computed tomography equipment delivers a lower effective radiation dose compared to ICA. Currently, a CTCA examination with state-of-the-art equipment delivers an effective radiation dose similar in magnitude to the natural background radiation per year.

- In Sweden, a CTCA examination costs approximately half as much as an ICA examination. The total cost of the CTCA strategy depends on the number of patients that must be examined with both CTCA and ICA. Assuming a 55 percent prevalence of clinically significant stenoses, the CTCA strategy is estimated to be somewhat more expensive than using ICA alone. The lower the probability of clinically significant stenoses, the lower the total cost of the CTCA strategy.

- Controlled trials are needed to assess CTCA as a prognostic and treatment management tool for coronary artery disease.

Technology and target group

Cardiovascular diseases are the most common causes of death in Western nations. These diseases result from layers of atherosclerotic plaque on vessel walls. The plaque can lead to stenoses in the coronary vessels, which can impair the normal blood supply to the heart muscle and cause angina. Plaque can break away and cause myocardial infarction.

The approach towards investigating stable coronary artery disease depends on the patient's symptoms, the probability that coronary artery disease is responsible for the symptoms, and an assessment of the patient's risk for developing severe coronary artery disease, e.g. myocar-

Facts 1 Probability of coronary artery disease.

The prevalence of angina in the population is approximately 5 to 20 percent, depending on the definition. Angina usually results from stenoses in the coronary arteries, constricting the supply of oxygen to the cardiac muscle during exertion. The probability of coronary artery disease is rated as low, intermediate, or high. In this context, intermediate means neither high nor low, but a range between 10 to 85 percent probability. In determining the probability of coronary artery disease, consideration is given to several factors, e.g. age, gender, symptomatology, medical history, clinical examination, ECG, and laboratory tests. Exercise tests are usually used as part of the basic examination. Men and women aged above 60 years with typical symptoms of stable angina have a high probability of coronary artery disease. Individuals without symptoms have a low probability of coronary artery disease, regardless of gender and age. Patients with intermediate probability include, e.g. women below 60 years of age with typical symptoms of coronary artery disease, or patients of both genders above 50 years of age with difficult-to-assess symptoms.

dial infarction, or risk of death. Depending on the results of the basic examination (including exercise testing) some patients will be referred for further investigation.

Anatomic radiography involving ICA is the current reference standard method for identifying clinically significant stenoses. The method's diagnostic test accuracy is good. Furthermore, it can be used concurrently in the treatment of stenoses. Hence, ICA is the primary choice in individuals having a high probability of coronary artery disease, a risk of severe heart disease, or who have symptoms that do not respond adequately to medical treatment. The method exposes patients to radiation and some risk for other complications.

Preferably, noninvasive methods (usually myocardial scintigraphy or stress echocardiography) should be used to examine patients with intermediate probability of coronary artery disease, according to current guidelines from the Swedish National Board of Health and Welfare [1]. The choice of diagnostic method is determined primarily by the local resources, e.g. availability of equipment and skills at the clinical facility in question.

Facts 2 CTCA for suspected coronary artery disease.

Clinically significant stenoses in the coronary arteries in patients whose symptoms persist despite medication, or in patients with signs of severe oxygen deficiency in the heart, motivate percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG). Hence, positive findings from CTCA lead to further investigation, often involving ICA. High prevalence of clinically significant stenoses requires more patients to be followed-up with ICA and treated accordingly. Low prevalence leads to few positive findings from CTCA, and few patients need to be examined with both methods.

Computed tomography coronary angiography (CTCA) is a relatively new noninvasive imaging method that is fast and painless. The technology has advanced rapidly in recent years, which has enhanced the capacity to image coronary vessels while using lower radiation doses. However, the method places high demands on equipment and trained staff.

CTCA could be used as a triage method to rule out clinically significant stenoses and to identify patients who do not require further investigation. Signs of clinically significant stenosis, as detected by CTCA, lead to further investigation with ICA. Due to the risk of cancer, clinicians try to avoid using two diagnostic methods that expose the patient to radiation. Hence, it is important to select the appropriate group of patients for CTCA. Patients with a high probability of coronary artery disease are inappropriate candidates for CTCA since many must undergo further investigation. Likewise, patients with a low probability are inappropriate due to radiation, cost, and risks for unexpected secondary findings. Only those patients found to have intermediate probability (as described in Facts 1) are candidates for CTCA investigation.

Primary questions

- What is the diagnostic test accuracy of computed tomography coronary angiography (CTCA) in determining coronary artery stenosis compared to the reference standard, i.e. invasive coronary angiography (ICA), in investigating patients with intermediate probability of stable coronary artery disease?
- What complications and side effects can accompany the examination?
- What does the examination cost? Is it cost-effective?

Patient benefit

❑ Overall, the method is found to have good diagnostic capability to rule out clinically significant stenoses in patients with intermediate probability of stable coronary artery disease (Evidence grade 1)*. Positive findings, however, justify further investigation with ICA or other noninvasive methods.

The included studies and meta-analysis report consistently high sensitivity with CTCA; between 94 and 100 percent compared to ICA. Variation in sensitivity between the studies is low. The negative predictive value (NPV) ranges between 90 and 100 percent. Specificity is lower, between 63 and 94 percent, with substantially greater variation between the studies. Positive predictive value (PPV) ranges between 58 and 97 percent.

❑ More recent CT devices, with the potential for prospective examinations, expose patients to a lower effective radiation dose compared to the average dose from corresponding ICA examinations. Assuming a 55 percent prevalence of clinically significant stenoses, it is estimated that just over 60 percent of the patients with positive CTCA findings must also be examined using ICA. Hence, the group as a whole receives a higher total radiation dose.

The radiation dose can be expected to be lower when examinations involve modern equipment and specially trained staff. Assessing patient groups that have a lower prevalence of clinically significant stenoses will require fewer dual examinations, thereby lowering the radiation dose.

Economic aspects

❑ The scientific evidence is insufficient* to draw any firm conclusions on the cost-effectiveness of the method.

❑ In Sweden, a CTCA examination costs approximately half as much as an ICA examination. Assuming 55 percent prevalence of clinically significant stenosis, the CTCA strategy yields a somewhat higher total cost than direct ICA examination. If prevalence falls below 40 percent, the CTCA strategy is economically advantageous.

* Criteria for evidence grading SBU's conclusions

Evidence grade 1 – Strong scientific evidence. The conclusion is corroborated by at least two independent studies with high quality, or a good systematic overview.

Evidence grade 2 – Moderately strong scientific evidence. The conclusion is corroborated by one study with high quality, and at least two studies with medium quality.

Evidence grade 3 – Limited scientific evidence. The conclusion is corroborated by at least two studies with medium quality.

Insufficient scientific evidence – No conclusions can be drawn when there are not any studies that meet the criteria for quality.

Contradictory scientific evidence – No conclusions can be drawn when there are studies with the same quality whose findings contradict each other.

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SBU evaluates healthcare technology

The Swedish Council on Health Technology Assessment (SBU) is a national governmental agency that assesses healthcare technologies. SBU analyses the benefits, risks, and costs of different methods and compares the scientific facts to prevailing practices in Sweden. SBU's goal is to provide stronger evidence for everyone engaged in shaping the delivery of health services.

The SBU Alert reports are produced in collaboration with experts from the respective subject areas, the National Board of Health and Welfare, the Medical Products Agency, the Swedish Association of Local Authorities and Regions, and a special advisory panel (the Alert Advisory Board).

This assessment was published in 2011. Findings based on strong scientific evidence usually continue to apply well into the future. However, findings based on insufficient, limited, or contradictory evidence might have already been replaced by more recent findings.

The complete report is available in Swedish.

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