

### **Coronary Artery Calcium Scans Detect Early CAD**

Nurses play a critical role in educating patients about therapeutic lifestyle changes and primary prevention strategies to modify cardiovascular risk factors. The ideal time for disease prevention is during the initial stages of plaque development before symptoms appear. Coronary atherosclerosis is a slow progressive disease that oftentimes goes unrecognized until a person develops symptoms. By the time symptoms start to occur the coronary artery disease is usually in a relatively advanced stage requiring either percutaneous or surgical revascularization. The opportunity for aggressive risk factor modification to prevent cardiovascular disease is missed. What is needed is a way to identify asymptomatic people who are at high risk for cardiovascular events early in their disease process. Traditional cardiovascular risk factors are well established (elevated lipid levels, hypertension, smoking, obesity, lack of exercise, diabetes, family history heart disease) and helpful to predict future cardiovascular disease. Many people however suffer cardiovascular events in the absence of these established coronary artery disease risk factors (Raggi, 2003). Approximately 50% of acute myocardial infarctions occur in people without any prior history of coronary artery disease. So how can we as nurses help identify these high-risk patients and prevent the progression of cardiovascular disease?

This article will review the role of calcium in the development of coronary artery disease and discuss the non-invasive test that identifies calcium deposits in the artery walls during the early stages of coronary atherosclerosis.

#### **The role of calcium in coronary atherosclerosis**

It is important to understand the impact of the calcification process in the development of coronary artery disease. During the early stages of coronary artery atherosclerosis calcium starts to accumulate within the plaque. As the atherosclerotic process progresses the amount of calcification increases. During the advanced stages of atherosclerosis a large amount of coronary artery calcification may be present.

Calcification is not a degenerative disease; it is not a part of the “normal” aging process.

Atherosclerosis is the only disease process known to cause calcium to deposit in coronary artery walls.

Calcium is not found in normal coronary arteries. This is an important point to discuss with your patients since many people believe that typically as we age are arteries “harden” or become calcified.

### **Myocardial Infarction**

Myocardial infarctions usually occur in patients who have a mild or moderate coronary artery stenosis that undergoes plaque rupture, which then triggers an acute thrombotic event. These mild to moderate coronary lesions may not cause symptoms prior to the myocardial infarction and/or may not cause enough ischemia to be picked up during a routine stress test. This is why it is critical to identify patients early in their disease process. Traditional non-invasive tests used to evaluate coronary artery disease (exercise stress test, nuclear scan, and stress echocardiography) only detect coronary lesions that are severe enough to limit blood flow and cause myocardial ischemia. People with very mild coronary artery disease or early atherosclerosis will have a false negative test result. Coronary calcium screening is able to identify non-obstructive mild coronary artery lesions before symptoms develop. Most nurses are familiar with the routine stress tests used to screen symptomatic patients for coronary artery disease. Nurses need to familiarize themselves with the calcium scan test that is gaining widespread use throughout the United States as an early screening tool for coronary artery disease in asymptomatic patients. If your patient is scheduled for a coronary artery calcium scan you will need to be able to explain how the test is performed and the purpose of the scan.

### **Coronary Artery Calcium Scan**

The calcium screening heart scan is a non-invasive test that detects calcium deposits in the coronary artery walls. The test is performed with an electron beam cat scanner (EBCT) that permits very rapid scanning. No medication, contrast, intravenous access or exercise is required to perform the

scan. The images are triggered with the assistance of ECG monitoring during diastole and a several second breath hold to eliminate motion artifact. The actual scan only takes about thirty seconds and computer software then quantifies the calcium area and density. EBCT can detect coronary artery disease in all stages of its development. Patients must be willing to pay for the test; it is presently not reimbursed by most insurance plans. The average cost for the scan is about two to four hundred dollars. As more data becomes available on the benefits and accuracy of the scans this reimbursement issue may change.

The EBCT detects the presence, location and extent of calcium deposits in the coronary system. The calcium-scoring scan is not able to neither identify the exact location of a significant coronary artery lesion, determine the precise percent stenosis, nor identify non-calcified soft plaques. One definite advantage of the EBCT is the lack of false positive test results, calcium deposits are only found in the presence of plaque (Lawler, 2005). So if your patient has a positive test they have some degree of coronary artery disease. The quantity of coronary artery calcium predicts the total atherosclerotic plaque mass and the likelihood of developing future cardiovascular events. Separate calcium scores may be obtained for the left main artery, left anterior descending artery, left circumflex, and right coronary artery but the total calcium score is most important. The EBCT can detect minute calcium deposits, which is what is usually present during the early stages of coronary artery disease. It is important that your patient understands that the presence of any coronary calcification signifies some degree of coronary artery disease. The amount of calcium determines the degree of risk; people with low total calcium scores are at a lower cardiovascular risk than high scores.

A meta-analysis reported an overall predictive accuracy of approximately 70% for EBCT to diagnose obstructive coronary artery disease. Interscan reliability of calcium scores has been

questioned and has been reported to vary more with lower calcium scores (Wilson, 2003). One study reported a calcium score variability of 28% in women and 43% in men when repeat scans were performed on the same individual (Yoon, 2002). This really needs to be evaluated further and may be dependent on the facility, equipment or physician interpreting the results.

### **Coronary Calcium Scores**

Your patient will receive a total calcium score after the test is completed. The physician will discuss the significance of the test results with the patient. Calcium scores range from zero (no plaque) to several thousand (extensive plaque), the score is a unit less measurement calculated for the entire coronary system. A calcium score of zero indicates the absence of any calcium and an extremely low likelihood of obstructive coronary artery disease. This places your patient in a low risk category. A calcium score greater than 400 signifies extensive calcification and a high likelihood of significant coronary artery disease (Klodas, 1999)(Lau, 2005). The higher the total score the greater the overall plaque burden. Your patient needs to understand that a high coronary calcium score does indicate the presence of coronary atherosclerosis but does not always correlate with a significant obstructive lesion. As the coronary atherosclerotic and calcification process progresses the artery may start to expand outward and preserve some of the lumen, this is referred to as positive remodeling.

If your patient has a high calcium score (>400) they should undergo further evaluation for myocardial ischemia with an exercise stress test or nuclear stress test. Asymptomatic people with high calcium scores are very likely to have an abnormal nuclear stress test indicative of silent ischemia. In one study 46% of patients with coronary artery calcium scores greater than 400 had an abnormal nuclear scan while 0% of patients with coronary artery calcium scores less than 10 had an abnormal nuclear scan (He, 2000). If your patient is asymptomatic but has an intermediate calcium score (10 to 400) they should undergo a thorough risk assessment and individualized risk factor modification. The calcium

score should be used to guide therapy decisions.

### **Indications for coronary calcium scoring scan**

Some patients may ask you if they should have a calcium scan. The coronary calcium scan (EBCT) is most useful in asymptomatic patients with intermediate risk, to help determine the need for aggressive risk factor management. (See calcium scan indications/contraindications chart) In the Rotterdam Coronary Calcification Study 29% of men and 15% of women over 55 years old with no known heart disease or cardiac risk factors were found to have extensive coronary calcification (Oei, 2004). The increased risk in these patients would probably have been overlooked and the opportunity for primary prevention strategies missed. A study performed on 400 asymptomatic people with cardiac risk factors found that 78% of the people who had calcium present on EBCT had a normal nuclear stress test and would have been incorrectly told they did not have coronary artery disease (He, 2000). Studies have found that the more cardiovascular risk factors a person has the higher the prevalence of calcium (Wong, 1994)(Hoff, 2001)(Oei, 2004). However, in patients with numerous cardiac risk factors and a high likelihood of coronary artery disease coronary calcium scoring will be of little additional benefit in predicting atherosclerosis. These patients should automatically be receiving aggressive primary prevention strategies. Patients who are experiencing symptoms suggestive of coronary disease (chest pain, shortness of breath) are not good candidates for this scan and should probably have a stress test performed. Patients with an intermediate cardiovascular risk profile are the ones who will gain valuable information regarding atherosclerotic burden and need for aggressive risk factor modification.

Women have been reported to have less coronary artery calcification than men. The mean prevalence of calcification in women occurs about one decade later than in men, coinciding with the incidence of cardiovascular events in women (Janowitz, 1993)(Redberg, 2002). The prevalence of

calcium in adults 30 to 39 years of age is 21% for men and 11% for women, while in adults 40 to 49 years of age the prevalence is 44% in men and 23% in women (O'Malley, 1999). A calcium score of 175 may be average for a 65-year-old male but grossly abnormal for a 55-year-old female. Calcium deposits have also been found to increase with age irrespective of gender (Wong, 1994)(Hoff, 2001) (Schurgin, 2001). You need to ensure that your patient understands that a person's age, gender and ethnicity need to be considered when evaluating the calcium score results.

<u>Average Coronary Calcium Scores</u>	<u>Men</u>	<u>Women</u>	(Mitchell, 2001)
< 40 years old	0	0	
45 to 49 years old	0	0	
50 to 54 years old	5	0	
55 to 59 years old	36	0	
60 to 64 years old	95	0	
65 to 69 years old	201	8	
70 to 74 years old	302	28	
> 74 years old	521	149	

There is conflicting data regarding coronary artery calcium prevalence in African Americans. African Americans may be less likely than Caucasians to have high coronary artery calcium scores even though their cardiovascular event rate is higher (Lee, 2003). A recent study evaluating asymptomatic adults with known cardiovascular risk factors reported a lower prevalence of coronary calcification and less calcium progression over seven year follow-up in African Americans and Hispanics compared to Caucasians (Kawakubo, 2005). The Dallas Heart Study reported a similar prevalence of coronary artery calcification among middle-aged African American and Caucasian men and women (Jain, 2004).

**Coronary Calcification: Implications on Cardiovascular Outcomes**

After the patient receives their calcium score they need to understand the impact the test results may have on their overall cardiovascular health. Coronary calcium has been reported to be an independent predictor of stable angina, myocardial infarction, cardiovascular death, and need for coronary revascularization (Arad, 2002)(Arad, 2005)(Alexopoulos, 2003)(Redberg, 2002) (Schmerund, 2001). The recently published four-year follow-up from the St. Francis Heart Study reported a higher incidence of adverse cardiovascular events in asymptomatic 50 to 70 year old Caucasians with baseline coronary calcium scores great than 100 (Arad, 2005). There is a direct relationship between increasing calcium scores and the occurrence of adverse events (Anand, 2003) (Greenland, 2004). The patient's total calcium score should guide your nursing interventions.

Asymptomatic people with very high calcium scores ( $\geq 1,000$ ) have been found to have an approximately 25% risk per year of developing a myocardial infarction or cardiovascular death (Anand, 2003)(Raggi, 2003). These are very high-risk patients who need very aggressive risk factor modification and should be referred for further cardiovascular testing. Patient education and nursing interventions should center on the patients risk factors and calcium score. Patients who are at low risk with low calcium scores (0 to 10) should receive education about healthy lifestyles, weight loss, blood pressure management, smoking cessation and cholesterol management with a goal low-density lipoprotein (LDL) level of less than 130. Patients who are at moderate risk (calcium scores between 11 and 100) need more aggressive management with a goal LDL level of less than 100 and possibly the addition of aspirin and medications to manage cholesterol levels if needed. Patients with calcium scores above 400 are in a very high-risk category and require aggressive risk factor modification and should probably undergo a stress test. Patients with very high scores, above 1000, should be referred for a stress test or cardiac catheterization. It is important for your patient to understand the impact of

cardiovascular risk factors combined with the calcium score on their overall cardiovascular health.

### **Implications for Women**

The overall prevalence of arterial calcium in women is about half that of men until age sixty (O'Rourke, 2000)(Budoff, 2002)(Raggi, 2004). EBCT scans may however prove to be more beneficial for screening women than men. Many times women present with atypical symptoms and are more likely to have false positive exercise stress tests and/or nuclear scans. Calcium scoring scans have been reported to have a higher predictive value for significant coronary artery disease in women than in men (Budoff, 2002).

Women with normal lipid levels are more likely to experience angina/myocardial infarction than men. A study of asymptomatic women who underwent lipid testing and EBCT found that 46.5% of the women with abnormal coronary calcium scans would have been incorrectly labeled low risk based on their lipid profile (Hecht, 2001). The standard lipid profile does not always adequately reflect a woman's cardiovascular risk and other tests need to be developed to correctly identify cardiac risk in women.

Diabetes mellitus and not exercising regularly has been associated with increased coronary artery calcium scores in Caucasian women but not African American women (Khurana, 2003). Another study in asymptomatic women found that the following risk factors smoking, elevated total cholesterol levels, and hypertension were all associated with higher Coronary Artery Calcium Scores (Mielke, 2001). Women with these risk factors should be targeted for primary prevention. This is an area that needs to be evaluated further but suggests that coronary artery calcium scores may prove to be very beneficial in assessing cardiovascular risk profiles in women.

### **Potential Drawbacks of Calcium Scans**

Non-calcified, soft plaques will not be detected by EBCT. This may falsely reassure some

people who are at high risk. You need to make sure your younger patients know that they may develop a significant stenosis in the absence of calcification. Heavy smokers who are young may not have calcium deposits present but are still at high cardiovascular risk and prone to coronary spasm and thrombus formation (Raggi, 2003). It is critical that these patients understand that the lack of calcium does not rule out the possible presence of soft plaque. The impact of smoking on the coronary arteries and the importance of smoking cessation should be stressed. There has been some research to suggest that patients with unstable angina are prone to have fewer calcified plaques than patients with stable angina (Becker, 2003). There is not enough data to support using the coronary calcium scans in symptomatic patients or patients already known to be at high risk.

#### **Monitoring disease progression with coronary calcium scans**

Calcium scans have been used to evaluate and estimate the yearly progression of atherosclerotic disease. Several studies have reported an annual progression rate of 22 to 52% per year (Budoff, 2001)(Anand, 2003). People with a higher yearly increase in calcium volume have been found to be more likely to have a myocardial infarction (Wilson, 2003). Asymptomatic diabetic patients with suboptimal glucose control and people with hypertension have been reported to be more likely to develop calcium progression (Yoon, 2002)(Snell, 2003). These patients should be targeted for cardiovascular prevention strategies.

Angiographic studies have shown that coronary artery disease progression can be slowed or even regression obtained with appropriate lipid management. Studies using EBCT scans have also demonstrated a slower progression and minor decrease in total coronary artery calcium scores with optimal statin therapy in both diabetics and non-diabetics (Raggi, 2003)(Anand, 2003)(Achenbach, 2002)(Budoff, 2005). There are several large ongoing studies that are evaluating the effectiveness of EBCT in monitoring disease progression and regression. Calcium scanning may become a useful tool

in the future to evaluate the effectiveness of treatment methods.

### **Conclusions**

Calcium deposits start to develop during the early stages of atherosclerosis; if we are able to identify the early presence of calcium we are able to identify preclinical coronary artery disease during the asymptomatic stage. This can allow for the implementation of early aggressive risk factor reduction and possibly prevent plaque progression. If plaque can be identified during the preliminary stages of development risk factor modification may be more advantageous. Nurses need to be knowledgeable about the calcification process of coronary artery disease and the implications of the calcium score on cardiovascular health in order to provide the appropriate patient education and support. Nurses play an integral role in educating people about cardiovascular disease and cardiovascular risk factors. Patients need to understand that the presence of any arterial calcium is indicative of coronary artery disease. A recent study demonstrated that patients with high coronary artery calcium scores were more motivated to adhere to lifestyle changes and be compliant with medication protocols (Kalia, 2004). The calcium scan may help persuade patients to take their risk factors more seriously. By comprehending the process of atherosclerosis and calcification nurses can more thoroughly explain the benefits and importance of preventing or halting disease progression with aggressive risk factor management.

In order to improve patient outcomes nurses need to familiarize themselves with this test and develop an understanding of its prognostic benefits and drawbacks.

### **Indications for Coronary Artery Calcium Scans:**

1. Family history heart disease (especially premature heart disease)
2. History of smoking
3. Hypertension

4. Obesity
5. Elevated lipid levels
6. Diabetes
7. Men over 40 years old or postmenopausal women
8. Young people with atypical symptoms

**Contraindications for Coronary Artery Calcium Scans:**

1. Known coronary artery disease
2. People over 70 years old (little clinical benefit)
3. Pregnant women
4. Arrhythmias (Chronic atrial fibrillation, resting tachycardia – heart rate greater than 90 bpm)  
will compromise image quality

**Nursing Implications:**

Procedure Review:

- a. Non-invasive test, no contrast/IV access/exercise required
- b. Lie on cat scan table, ECG electrodes applied to chest
- c. Actual scan only takes about 30 seconds
- d. Physician will review results with patient post procedure

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