Clinical Use of CT Coronary Calcium Scoring

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Disclosures

I have no relevant relationships with commercial interests to disclose.
FRAMINGHAM RISK TOOL

Risk of “MI” or “Coronary Death” over 10 years

- **LOW RISK**
  - < 10% Risk of Events / 10 yr.
- **INTERMEDIATE RISK**
  - 10 to 20% Risk of Events / 10 yr.
- **HIGH RISK**
  - > 20% Risk of Events / 10 yr.

ACC / AHA RISK CALCULATOR

- Age
- Gender
- Race
- T Chol
- HDL
- SBP
- DBP
- Treated for HTN
- Diabetes
- Smoker

- **LOW RISK**
  - < 10% over 10 yrs.
- **INTERMEDIATE RISK**
  - 10 - 20% over 10 yrs.
- **HIGH RISK**
  - > 20% over 10 yrs.
HOW WELL DO RISK TOOLS WORK?

Who has higher cardiovascular risk based on risk factors?

Sir Winston Churchill, 91
- Overweight
- Not Fit
- Heavy Smoker

Jim Fixx, 53
- Not Overweight
- Very Fit
- Non-Smoker

LIMITATIONS OF USING RISK TOOLS TO DETERMINE TREATMENT ALGORITHMS

STUDY OF 121,000 US people with HEART ATTACKS:

- 62% of MEN and 53% of WOMEN had ONE or ZERO RISK FACTORS
- 13% of people with FATAL MI’s had NO RISK FACTORS
- More than 75% of cardiac events occurred in persons classified as LOW or INTERMEDIATE RISK.
- Most people with one or more RISK FACTORS never develop disease

POSSIBLE NEW PARADIGM?

- Risk Factors
- Susceptible Individual
- Clinical Disease

Glagov's coronary remodeling hypothesis

progression
compensatory expansion maintains constant lumen
expansion overcome: lumen narrows

normal vessel → minimal CAD → moderate CAD → severe CAD

Coronary Calcium begins to deposit early on in stable plaques.

CORONARY ARTERY CALCIFICATION: “CAC”

- “CAC” is Pathognomonic for Coronary Artery Disease
- Ca++ - PO4 Hydroxy - appetite binds with Cholesterol in Plaques
- Circulating proteins normally associated with Bone Remodeling also regulate Coronary Calcium deposition.
CT CALCIUM SCORING

- Patient lays on gantry
- Electrodes applied
- Scout Film to set imaging planes for the Heart
- Prospective Gating or “Step and Shoot” method to obtain 3 mm slices.
- NOT SPIRAL CT
- Minimum Radiation dosimetry.

Calcium Defined as any pixel with a CT value of 130 Hounsfield Units or Above Within a Coronary Artery Distribution
“Agatson Score” Method

\[
\text{Score} = \text{MCTN} \times \text{area} \ (\text{mm}^2) \\
\text{Maximal computer tomographic number} \\
1 \ 130-199 \text{ HU} \ \\
2 \ 200-299 \text{ HU} \ \\
3 \ 300-399 \text{ HU} \ \\
4 \ > 400 \text{ HU} \\
\]

EBT score example: 
Lesion with density of 313 HU (MCTN: 3) 
Area size: 8 mm 
EBT score: 3 \times 8 = 24

“Histopathologic Correlative Study” to compare total histologic plaque volume to the volume of Calcified Plaque. 

About 20% of all plaque is Calcified. 80% is Non-Calcified
Prevalence of ANY Coronary Artery Calcium detected by EBCT Correlated by Age (Decades) Asymptomatic Men and Women


PROGNOSTIC STUDY

- 632 Asymptomatic Patients
- Prospective Study
- Followed over 32 months
- Annualized Event Rates correlated to categories of CT Calcium Score

Raggi, Callister, et al: Circulation 2000; 101; 850-855
ST FRANCIS HEART STUDY

• Prospective Study of 5585 Asymptomatic people.

• CAC Score changed Risk Class of 67% of patients in Framingham Intermediate (10 – 20%) Risk Group.

• In Framingham High Risk Group, 45% were reclassified to lower risk by CAC Score

• In Framingham Low Risk Group 29% had CAC score > 100.

FAMILY HISTORY OF PREMATURE CAD EVENTS

• Family History of CAD is NOT included in the FRAMINGHAM Risk Tool
• Most (70%) of patients sustaining First MI by age 45 yrs fall into the “Low Risk” Framingham Group

Akosah K. J. Am Coll Cardiol. 2003; 41: 1475-1479

• 95% of First, Unheralded MI’s in young patients (<45 yrs) were correctly predicted (Retrospectively) by EBCT Coronary Calcium Score

Pohle K. Heart. 2003; 89: 625-628

Standard Risk Assessment Tools do not account well for FAMILY HISTORY as an independent risk of coronary events.

CT Calcium Scoring is a stronger predictor of risk in patients with Family History of Premature Coronary Events.

CAC SCORE > 75% for Age & Sex Matched Population

• Highest Quartile versus Lowest Quartile of CAC Score
  – Odds Ratio 22 to 1

• Highest Quartile ALL NCEP Risk Factors versus Lowest Quartile
  – Odds Ratio 7 to 1

Raggi, et al; Circulation 2000; 101; 850-855
ALL CAUSE MORTALITY IN 25,253 PATIENTS RELATED TO CAC SCORES

Cumulative Survival by Coronary Calcium Score

Budoff, et al. JACC 2007; 49: 1860 - 70

CAC SCORE and ALL CAUSE MORTALITY

EFFECT OF ZERO CALCIUM SCORE ON MORTALITY IN ALL AGE GROUPS
Results of a 15 Year Prospective Study

Valenti, V. A 15 year warranty period for asymptomatic individuals without coronary artery calcium: a prospective follow up of 9715 individuals. JACC Cardiovasc Imaging. 2015 August; 8(8): 900 - 909

CARDIOVASCULAR MORTALITY IN DIABETICS RELATED TO CAC SCORE

Subhashish, A. Coronary Calcium Score Predicts Cardiovascular Mortality in Diabetes. (Diabetes Heart Study) Diabetes Care. 2013 Apr; 36(4): 972-977
**EFFECT OF STATIN TREATMENT ON CT CALCIUM SCORE PROGRESSION**

- 149 Asymptomatic Patients followed for 15 months
  - 105 got STATINS; 44 did not
- Repeat CT Calcium Score at 12 to 15 months
- All Untreated Patients had Progression of CT Calcium Score

**NUMBER NEEDED TO TREAT WITH ASA TO SHOW BENEFIT AS A FUNCTION OF CAC SCORE**

The 1st SHAPE Guidelines

Conceptual Flow Chart

Step 1
Test for Presence of the Disease

Atherosclerosis Test

Step 2
Based on the Severity of the Disease and Presence of Risk Factors

Calcium Score | Plaque Burden | Event Rate | Recommendations for Management
---|---|---|---
0 | No Evidence of CAD | 0.11% | Promote Healthy Lifestyle Repeat CT Calcium Scan in 5 to 10 yrs.
0 – 10 | Minimal to Zero CAD Evidence of Early Stages | 0.11% | Lifestyle Modifications Repeat CT Calcium Scan in 5 yrs.
11 – 100 | Mild to Moderate CAD | 2.1% | Risk Factor Modifications ASA, Statins Repeat CT Calcium Scan in 5 yrs.
101 – 400 | Moderate CAD Possibly Obstructive | 4.1% | Risk Factor Modifications ASA, Statins Repeat CT Calcium Scan in 5 yrs.
101 – 400 (> 75th %) | Moderate CAD. Possibly Obstructive. Increased risk for patients in > 75th percentile for Age and Sex. | > 4.1% | Risk Factor Modifications ASA, Statins. Consider B-Blocker. Stress Testing Recommended
> 400 | Extensive CAD with High Likelihood of Obstructive disease in at least one major vessel. | 4.8% | Risk Factor Modifications. Stress Testing Recommended.
Value of CT Calcium Score in Asymptomatic Patients

- Early Detection
- Risk Stratification
- Therapeutic Intervention
- ? Follow up of Treatment
Thank You