



April 2011

# Newsletter

Arbeitsgruppe Cardio-CT der Deutschen Gesellschaft für Kardiologie – Herz- und Kreislaufforschung

Herzlich Willkommen zum fünften Newsletter der Arbeitsgemeinschaft 24 „Cardio-CT“ der Deutschen Gesellschaft für Kardiologie- Herz- und Kreislaufforschung. Wir hoffen, dass die enthaltenen Informationen wieder Ihr Interesse finden.

Über Rückmeldungen zum Newsletter oder zu Angelegenheiten der Arbeitsgruppe freuen wir uns:

Stephan Achenbach (stephan.achenbach@innere.med.uni-giessen.de)

Stefan Möhlenkamp (stefan.moehlenkamp@uk-essen.de)

## 1. Empfehlungen zur Senkung der Strahlendosis beim Koronarkalknachweis mittels CT

Die Society of Atherosclerosis Imaging and Prevention (SAIP) hat gemeinsam mit der Society of Cardiovascular CT Empfehlungen herausgegeben zu den Protokollen, die bei der CT-Koronarangiographie verwendet werden sollten, um die Strahlenexposition zu senken. Es wird empfohlen:

- Die Dosis unter 3.0 mSv zu halten und eine mittlere Dosis von 1.0-1.5 mSv anzustreben (DLP 200 mGy·cm)
- Die Dosis bei jedem Patienten aufzuzeichnen und die durchschnittliche Dosis pro Quartal zu evaluieren
- Beta Blocker zu erwägen, wenn die Frequenz > 75/min beträgt
- Spiralakquisition mit retrospektivem Gating zu vermeiden und prospektiv getriggerte axiale Aufnahmen („Step-and-shoot“) oder high-pitch Spiral CT Protokolle („Flash“) zu verwenden
- 120 kV Röhrenspannung zu verwenden
- Den Röhrenstrom an die Physiognomie des Patienten anzupassen
- Die Scanlänge zu minimieren
- 3.0 mm Schichtdicke zu rekonstruieren und die größte Kollimation zu verwenden, die 3.0 mm Schichtdicke zulässt.

Die Empfehlungen sind erhältlich unter:

Voros S, et al. *Guideline for minimizing radiation exposure during acquisition of coronary artery calcium scans with the use of multidetector computed tomography A report by the Society for Atherosclerosis Imaging and Prevention Tomographic Imaging and Prevention Councils in collaboration with the Society of Cardiovascular Computed Tomography. J Cardiovasc Comput Tomogr. 2011;5(2):75-83*

## 2. Europäisches Kardio CT Register

In der Pilotphase des Europäischen Kardio CT Register wurden bisher mehr als 4000 Patienten eingeschlossen und auf der Jahrestagung der Deutschen Gesellschaft für Kardiologie- Herz- und Kreislaufforschung in Mannheim werden mehrer Abstracts aus diesem Register als Vortrag oder Poster vorgestellt.

Das Register wird am Institut für Herzinfarktforschung in Ludwigshafen geführt. Nachdem in der Pilotphase noch einige Parameter abschließend angepasst wurden, wird es jetzt für alle Zentren geöffnet, die Daten zu diesem wichtigen Projekt beitragen möchten. Im Gegenzug erhalten alle Zentren, die am Register teilnehmen, regelmäßige Auswertungen ihrer Untersuchungsparameter und Strahlendosen im



**European Cardiac  
CT Registry**

Vergleich zu den anderen Zentren. Wir möchten die Teilnahme an diesem Register sehr ermutigen. Bitte kontaktieren Sie bei Interesse: Dr. Stephanie Aker, Institut für Herzinfarktforschung, Bremser Straße 79, 67063 Ludwigshafen, Tel. 0621/503-2818, Email [aker@herzinfarktforschung.de](mailto:aker@herzinfarktforschung.de).

#### **4. Annual Scientific Meeting der Society of Cardiovascular CT, Denver, 14.-17.7.2011**

Im Hyatt Regency Hotel Denver findet vom 14.-17. Juli 2011 das 6th Annual Scientific Meeting der Society of Cardiovascular CT (SCCT) statt. Diese Konferenz deckt alle Aspekte der kardialen und vaskulären Computertomographie ab, bietet Informationen für Anfänger wie für sehr fortgeschrittene Anwender und wird jedes Jahr von etwa 800 bis 1000 Teilnehmern besucht. Weitere Informationen finden sich unter <http://www.scct.org/annualmeeting/2011/>.

#### **5. Aus der wissenschaftlichen Literatur**

Die folgende Liste enthält wieder einige ausgewählte Publikationen der letzten Monate aus dem Gebiet der kardialen Computertomographie als Anregung und ohne Anspruch auf Vollständigkeit.

*Möhlenkamp et al., Quantification of Coronary Atherosclerosis and Inflammation to Predict Coronary Events and All-Cause Mortality. J Am Coll Cardiol 2011;57:1455-64*

Bei 3966 Personen ohne bekannte KHK oder akute Inflammation aus der Heinz Nixdorf Recall Studie wurden die Framingham-Risiko-Score (FRS)-Variablen, das hsCRP und der Kalkscore (CAC) gemessen. Die Myokardinfarkte, plötzlichen Herztode und die Gesamtmortalität wurden nach 5 Jahren erhoben. Der Kalkscore und das hsCRP waren unabhängige Prädiktoren für Koronareignisse und für die Gesamtmortalität. Das NRI (net reclassification improvement) betrug 23.8% für den Kalkscore und 10.5% für das hsCRP. Die Hinzunahme des CAC-Scores zum FRS und dem hsCRP verbesserte die prädiktive Trennschärfe für Koronareignisse, nicht aber die zusätzliche Verwendung des hsCRP zusätzlich zum FRS und CAC-Score. Bei Personen mit einem CAC=0 war ein  $hsCRP \geq 3$  mit einem deutlich erhöhten koronaren Risiko verbunden. Für die Vorhersage der Gesamtmortalität zeigten CAC bzw. hsCRP einen ausgewogeneren und sich ergänzenden Beitrag. Ein Risikoindex aus CAC und hsCRP identifizierte Personen mit besonders hohem bzw. niedrigem Risiko. Fazit: Das Risiko für koronare Ereignisse und die Gesamtmortalität das durch die subklinischen Koronarsklerose und die Inflammation vermittelt wird, kann durch Quantifizierung von CAC und hsCRP gemessen werden. Insbesondere der CAC-Score verbesserte die koronare Risikoprädiktion und prädiktive Trennschärfe, während das hsCRP besonders bei Personen mit sehr niedrigem CAC-Score eine prädiktive Bedeutung zu haben scheint.

*Alan Rozanski et al., Impact of Coronary Artery Calcium Scanning on Coronary Risk Factors and Downstream Testing - The EISNER (Early Identification of Subclinical Atherosclerosis by Noninvasive Imaging Research) Prospective Randomized Trial. J Am Coll Cardiol 2011;57:1622-32*

2,137 Probanden wurden vor Beratung zu Lebensstil-/Risikofaktoren einem Diagnose-Arm mit oder ohne CAC-Score-Quantifizierung randomisiert zugewiesen. Endpunkt waren die Änderung der CVD-Risikofaktoren und im Framingham-Risiko-Score (FRS). Es wurde auch die nachfolgende medikamentöse Therapie und der Einsatz weiterführender Diagnostik bewertet. Am Kalkscore-Arm zeigten sich günstigere Änderungen des Blutdrucks, des LDL-Cholesterins, des Taillenumfang bei Personen mit erhöhtem Bauchumfang, und ein Trend zur Gewichtsreduktion bei übergewichtigen Personen. Während der FRS im Arm ohne Koronarkalkmessung anstieg, blieb der FRS im Arm mit CAC-Score-Messung unverändert. Die Diagnose- und Therapiekosten waren in beiden Armen vergleichbar, stiegen im CAC-Arm aber mit steigendem CAC-Score. Fazit: Die Randomisierung in den Kalkscore-Arm führte zu einer Verbesserung der KHK-Risikofaktoren, ohne nachfolgende Kosten zu erhöhen.

*Khera A. Less is more - Texas atherosclerosis imaging bill. Quiet origins, broad implications. Arch Int Med 2011;171(4):281-283*

Ein sehr kritischer Beitrag zu einem neuen Gesetz in Texas, das die Krankenversicherer verpflichtet, die Kosten für bildgebende Verfahren zum Nachweis kardiovaskulärer Erkrankungen (insbesondere CAC- und IMT-Messung) alle 5 Jahre bei Personen zwischen 45-75 Jahren zu übernehmen. Es werden Hintergründe zum Gesetzgebungsverfahren und die Implikationen für das Gesundheitssystem diskutiert.

*Allam AH, et al. Atherosclerosis in ancient egyptian mummies: the Horus study JACC Cardiovasc Imaging. 2011 Apr;4(4):315-27.*

Die Autoren untersuchten 52 ägyptische Mumien mittels Computertomographie, konnten bei 44 Mumien kardiovaskuläre Strukturen identifizieren und fanden bei 12 dieser 44 Mumien Verkalkungen, die sich eindeutig Gefäßen zuordnen ließen sowie bei weiteren 8 Mumien Verkalkungen, die sich vermutlich kardiovaskulären Strukturen zuordnen ließen. Das Alter beim Versterben lag bei den Mumien mit sicheren oder wahrscheinlichen Gefäßverkalkungen mit 45 Jahren signifikant höher als bei Mumien ohne Verkalkungen (35 Jahre). Die Autoren fanden bei 2 Mumien Koronarverkalkungen, darunter bei einer Prinzessin, die zwischen 1580 und 1550 v. Chr. lebte und postulieren dies als den ältesten Nachweis koronarer Arteriosklerose bei einem Menschen.

*Catalan P, et al: Ruling out coronary artery disease with noninvasive coronary multidetector CT angiography before noncoronary cardiovascular surgery. Radiology 2011; 258:426-434*

133 Patienten vor nicht-koronarer Herzchirurgie wurden mittels CT zum Ausschluß von Koronararterienstenosen untersucht. Vorhofflimmern lag bei 45 dieser Patienten vor. Die koronare CT Angiographie war bei 108 der 133 Patienten diagnostisch und bei 93 ließen sich signifikante Koronarstenosen ausschließen. Diese Patienten durchliefen den chirurgischen Eingriff ohne Komplikationen, ohne eine vorherige invasive Koronarangiographie.

*Halpern EJ, Halpern DJ. Diagnosis of coronary stenosis with CT angiography: Comparison of automated computer diagnosis with expert readings. Acad Radiol (in press)*

207 CT-Koronarangiographien wurden einer automatischen Analyse mittels eines Softwareprogramms „Cor Analyzer“ unterzogen. Übereinstimmung mit der Befundung durch einen erfahrenen Untersucher lag bei 75% der Fälle vor. Die Sensitivität betrug 92% (44 von 48 Patienten mit Stenosen erkannt), die Spezifität bei 70%, der negativ prädiktive Wert bei 97% und der positiv prädiktive Wert bei 48%. Falsch-positive Befunde ereigneten sich insbesondere bei Verkalkungen, Bewegungsartefakten und Muskelbrücken.

*Hamdan A ,et al, A prospective study for comparison of MR and CT imaging for detection of coronary artery stenosis. JACC Cardiovascular Imaging 2011;4(1):50-61*

120 Patienten wurden vor einer invasiven Koronarangiographie mittels 64 Zeilen CT und 32-Kanal 3.0T MRT zur Darstellung der Koronararterien untersucht. Patienten-basiert betrug die „diagnostic accuracy“ von MRT 83% und CT 87%, dies sei nicht signifikant unterschiedlich gewesen. Die Sensitivität betrug 87% (MRT) versus 90% (CT), die Spezifität 77% vs. 83%. Die mittlere Herzfrequenz betrug 63 Schläge/min.

*Marwan M, et al: Coronary vessel and luminal area measurement using dual-source computed tomography in comparison with intravascular ultrasound: effect of window settings on measurement accuracy. J Comput Assist Tomogr 2011;35(1):113-118.*

Anhand der Datensätze von 35 Patienten, die mit CT und IVUS untersucht wurden, zeigte sich in einer systematischen Analyse verschiedener Fensterwerte, dass zur Vermessung von Gefäß- und Plaquedimensionen in der koronaren CT Angiographie die Einstellung der Bilddarstellung mit den Parametern „Fensterbreite 700 HU/ Level 200 U“ die geringste Abweichung zwischen CT und IVUS gestattete.

Ho JS, et al. Effect of increasing body mass index on image quality and positive predictive value of 100-kV coronary computed tomographic angiography. *Am J Cardiol* 2010;106:1182-1186.

Die Autoren berichten, dass ein BMI von 35 kg/m<sup>2</sup> der optimale Schwellenwert ist, unterhalb dessen eine Röhrenspannung von 100 kV zur CT Koronarangiographie eingesetzt werden kann.

## 6. Highlights vom Annual Scientific Meeting des American College of Cardiology, New Orleans, 2.-5.4.2011

Es wurden zahlreiche Abstracts aus dem **CONFIRM Registry** vorgestellt:

### **JACC 2011;57(14):E779**

*Chow BJW, Achenbach S, Al-Mallah M, Berman D, Budoff M, Cademartiri F, Callister T, Chang H-J, Delago A, Dunning A, Hadamitzky M, Hausleiter J, Kaufmann P, Raff G, Shaw L, Villines T, Min J.*

*Prognostic value of cardiac CT: The incremental value of left ventricular ejection fraction over CAD severity: Results from the multinational CONFIRM registry (Coronary CTA evaluation for clinical outcomes: an international multicenter registry)*

**Background:** Left ventricular ejection fraction (LVEF) may be evaluated in retrospectively gated coronary computed tomographic angiography (CCTA) however large multicenter studies validating the prognostic value of CCTA and LVEF are lacking. We sought to confirm the incremental prognostic value of LVEF measured using 64-slice CCTA over coronary artery disease (CAD) severity and clinical variables.

**Methods:** A large international multicenter registry (CONFIRM Registry) was screened for LVEF assessment. Patients with a history of myocardial infarction, coronary revascularization or cardiac transplantation were excluded. The pretest probability for CAD and NCEP/ATP III risk were calculated for each patient and CCTA was evaluated for CAD severity (non-obstructive CAD, high risk CAD and non-high risk CAD) and LVEF < 50%. Patients were followed for all-cause mortality.

**Results:** 27,125 patients underwent CCTA at 12 participating centres with a total of 7,165 patients meeting the analysis criteria. Follow-up was available for 7,071 (98.7%) patients (mean follow-up of 19.3±9.1 months). All-cause mortality (120 deaths) was 0.44% of patients without coronary atherosclerosis, 1.94% of patients with non-obstructive CAD, 3.15% of patients with non-high risk CAD, and 5.83% for patients with high risk CAD. Multivariable analysis confirmed that CAD severity (Hazard Ratio (HR): 1.77;CI:1.44-2.17) and LVEF <50% (HR:4.43;CI:3.05-6.44) were both independent predictors of all-cause mortality and LVEF had incremental value over CAD severity and clinical variables.

**Conclusion:** In a large, multicenter cohort, CCTA measures of CAD severity and LVEF have independent prognostic value and LVEF had incremental value over routine clinical predictors and CAD severity in patients with suspected obstructive CAD.

### **JACC 2011;57(14):E2035**

*Villines TC, Hulten E, Dunning A, Shaw LJ, Achenbach S, Al-Mallah M, Berman DS, Budoff MJ, Cademartiri F, Callister T, Chang H-J, Chow BJW, Delago A, Hadamitzky M, Hausleiter J, Kaufmann P, Lin FY, Raff GL, Goyal M, Min JK.*

*Absence of coronary artery calcium does not fully exclude obstructive CAD and future adverse events among patients referred for CTA: Results from 17,528 patients in the CONFIRM registry (Coronary CTA evaluation for clinical outcomes: an international multicenter registry)*

**Background:** Coronary artery calcium (CAC) scoring is primarily utilized as a screening test in selected asymptomatic patients. As a measure of coronary artery disease (CAD) burden, CAC scoring in symptomatic patients has been recommended in a recent American College of Cardiology Expert Statement, but concerns exist about the true prevalence of CAD among symptomatic patients with a CAC score of zero.

**Methods:** From 24,775 adults without known coronary artery disease undergoing clinically-referred coronary computed tomographic angiography (CCTA) at 12 centers in 6 countries, we identified patients who underwent simultaneous CAC (Agatston) scoring. CAD severity was assessed as <50%, ≥50% and ≥70% lumen stenosis on CCTA. Major adverse events (all death, myocardial infarction and coronary revascularization) were assessed by Kaplan Meier and Cox proportional hazards. Events occurring <90 days after the index test were censored.

**Results:** The study population consisted of 17,528 patients (50% women) of mean age 57 years, with most (89%) presenting with non-typical anginal symptoms. CAC was present in 56% (9,782) of patients (mean CAC score of 195 ± 542) and the overall prevalence of any stenosis ≥50% was on CCTA was 19%. CAC scoring had an overall sensitivity of 87%, specificity of 54%, negative predictive value of 95% and positive predictive value of 31% for the detection of any stenosis ≥50%. Among patients with CAC= 0, 79% had no CAD, 15.5% purely non-obstructive disease and 5.5% had ≥1 vessel with ≥50% stenosis (3% had ≥70% stenosis), as defined on CCTA. Among 6,596 patients with CAC=0 and complete follow-up data, during a median 2.1 (interquartile range 1.5-3.1) years, 4.8% (13/270) of patients with CAC=0 and ≥50% stenosis experienced a late adverse event, HR 5.4 (CI 2.9-10.1; p<0.001) adjusted for baseline Framingham risk score, compared to those with no CAD and no obstructive CAD, driven primarily by late coronary revascularizations (10/13).

**Conclusions:** Absence of CAC does not fully exclude the presence of obstructive CAD in patients clinically referred for CCTA. Among symptomatic patients with CAC=0, contrast coronary CT angiography provides incremental diagnostic and prognostic information.

**JACC 2011;57(14):E2035**

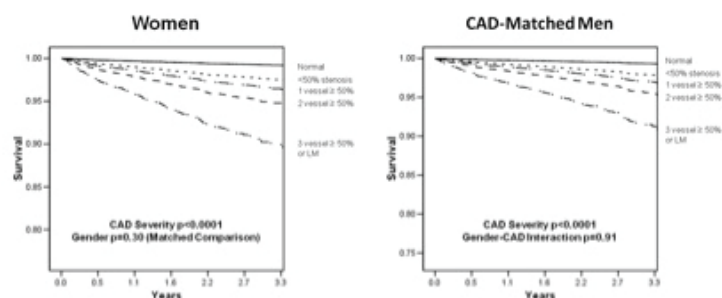
*Lin F, Chinnaiyan K, Dunning AM, Shaw LJ, Achenbach S, Al-Mallah M, Berman DS, Budoff MJ, Cademartiri F, Callister TQ, Chang H-J, Chow BJW, Delago AJ, Hausleiter J, Hadamitzky M, Kaufmann P, Raff GL, Villines T, Min JK.*

*Gender differences in all-cause death by extent and severity of CAD by CCTA: A matched analysis of the CONFIRM registry (Coronary CTA evaluation for clinical outcomes: an international multicenter registry)*

**Background:** Although women are generally considered lower risk than men for development of coronary artery disease (CAD), they experience worse prognosis after myocardial infarction and/or coronary revascularization. Whether gender differences in prognosis exist with comparable CAD extent and severity prior to development of clinical CAD events is unknown.

**Methods:** We studied 24,775 patients without prior known CAD undergoing clinically-indicated CCTA at 12 centers in 6 countries, matching men and women 1:1 by CAD extent and severity. Incident mortality in matched gender groups was examined.

**Results:** 9783 women and 9783 CAD-matched men comprised the study population, of which 1.5% died over 2.4 ± 1.1 years. Despite similar extent and severity of CAD, women were older (59.4 ± 12.4 vs 54.5 ± 12.7 years); with greater CAD risk factors; had higher rates of typical angina (17.9% vs 11.7%); and lower Framingham risk scores (9.7±6.3 vs 14.3±11.5) compared to men (p≤ 0.05 for all). When matched by CAD extent and severity, no gender differences in all-cause mortality were observed (mortality difference of matched pairs -0.2 (-0.5, 0.2)%, p=0.30, Figure).



**Conclusions:** When matched by anatomic CAD extent and severity, no gender differences in mortality are observed. Methods to improve gender-specific risk assessment require development.

**JACC 2011;57(14):E641**

Cheng V, Berman DS, Dunning AL, Achenbach S, Al-Mallah M, Budoff MJ, Cademartiri F, Callister TQ, Chang H-J, Chinnaiyan KM, Chow BJW, Delago AJ, Hadamitzky M, Hausleiter J, Kaufmann P, Lin FY, Nasir K, Raff G, Shaw LJ, Villines TC, Min JK

*Cigarette smoking, proximal coronary artery plaque composition, and risk of myocardial infarction and death: a study of non-diabetic men and women in the multi-national CONFIRM registry (Coronary CTA evaluation for clinical outcomes: an international multicenter registry)*

**Background:** Acute coronary syndromes occur more frequently in smokers and in patients who exhibit coronary atherosclerotic plaques low in calcium content (often termed “mixed” plaque [MP] and “noncalcified” plaque [NCP]) on coronary CT angiography. How cigarette smoking relates to MP and NCP and the impact of this relationship on adverse outcomes have not been established.

**Methods:** Out of 8292 patients without prior coronary artery disease who provided complete symptom, risk factor, smoking status, and statin use data, we evaluated 3434 consecutive 40-69 year-old nondiabetic patients (1838 men, 362 active smokers; 1596 women, 209 active smokers) not on statin therapy at the time of coronary CT angiography. Experienced readers examined CT images for the presence of calcified plaque (CP, contains only calcium), MP (contains calcified and noncalcified components), and NCP (contains no visible calcium) in the proximal coronary artery (ProxCA) segments. Patients were followed after CT for myocardial infarction and all-cause death.

**Results:** Active smokers were more likely to have ProxCA MP than non-smokers (men, 23% vs. 15%,  $p<0.001$ ; women, 11% vs. 7%,  $p=0.02$ ). Female active smokers were also more likely to have ProxCA NCP (9% vs. 5%,  $p=0.027$ ). MP made up a greater percentage of total number of detectable plaques in actively smoking men (42% vs. 34% in non-smokers,  $p<0.001$ ), with a similar trend in women (34% vs. 26%,  $p=0.15$ ). After adjusting for age, hypertension, dyslipidemia, and family coronary disease history, active smoking was associated with ProxCA MP (OR 1.78, 95%CI 1.32-2.41) in men and ProxCA MP (OR 1.76, 95%CI 1.08-2.88) and NCP (OR 1.74, 95%CI 1.02-2.99) in women. At a median follow-up of 2.6 years, active smokers with ProxCA MP experienced more than 4-fold higher annualized rates of myocardial infarction or death when compared to active smokers without ProxCA MP, non-smokers with ProxCA MP, and non-smokers without ProxCA MP (3.2%, 0.3%, 0.8%, 0.4%,  $p<0.001$  for men; 4.2%, 0.7%, 0.5%, 0.4%,  $p=0.007$  for women).

**Conclusion:** Active cigarette smoking is robustly associated with an increase in ProxCA MP, which in turn predicts an elevated rate of subsequent myocardial infarction and death.

**JACC 2011;57(14):E643**

Min JK, Dunning AM, Lin FY, Achenbach S, Al-Mallah M, Berman DS, Budoff MJ, Cademartiri F, Callister TQ, Chang HJ, Cheng V, Chow BJW, Delago A, Hadamitzky M, Hausleiter J, Kaufman P, Nasir K, Pencina M, Shaw LJ.

*Relationship of non-obstructive CAD to mortality: results from 18,037 patients with <50% stenosis in the CONFIRM registry (Coronary CTA evaluation for clinical outcomes: an international multicenter registry)*

**Background:** We examined mortality risk in relation to presence and extent of non-obstructive CAD, as defined by a <50% luminal diameter stenosis and identified by 64-detector row CCTA.

**Methods:** We prospectively evaluated 18,037 consecutive adults from 12 centers in 6 countries undergoing clinically-indicated 64-detector row CCTA without obstructive CAD ( $\geq 50\%$ ) by CCTA. Coronary artery segments were graded as having CAD (1-49% luminal diameter stenosis) versus not having CAD (0% luminal diameter stenosis). Events occurring <90 days after the index test were censored.

**Results:** During a median 2.1(IQR 1.5-3.1) year follow-up period, 178 deaths occurred (0.99%). Adjusted for typicality of angina and Framingham risk score (FRS), individuals with non-obstructive CAD experienced a more than 2-fold higher mortality as compared to individuals without CAD (HR 2.14, 95% CI 1.46-3.14,  $p<0.0001$ ). Increased risk of mortality was observed for individuals with 2-vessel (HR 3.09, 95% CI 1.94-4.93,  $p<0.0001$ ) and 3-vessel non-obstructive CAD (HR 3.02, 95% CI 1.73-5.27,  $p<0.0001$ ), with an independent linear increase in mortality for every additional coronary segment with CAD (HR 1.17, 95% CI 1.10-1.25,

p<0.001). Higher mortality for any non-obstructive CAD was observed even amongst patients judged low risk by FRS (HR 4.40 (95% CI 2.68-7.22), p<0.0001); as well as amongst those with no traditional medically-treatable CAD risk factors [i.e., diabetes, hypertension, and dyslipidemia] (HR 3.20, 95% CI 1.57-6.50, p=0.001). Importantly, patients without any CAD experienced a very low rate of death over the entire follow-up period (annualized 0.27% mortality).

**Conclusions:** Presence and extent of non-obstructive CAD augments prediction of individuals at risk of death.

#### **JACC 2011;57(14):E642**

*Chang H-J, Cho I, Dunning A, Delago A, Chow BJW, Berman D, Cademartiri F, Raff G, Hausleiter J, Shaw LJ, Hadamitzky M, Budoff M, Al-Mallah M, Kaufmann P, Achenbach S, Villines T, Callister T, Min JK. for the CONFIRM investigators*

*Prognostic value of CCTA in an asymptomatic population: comparisons with conventional risk stratification algorithm and calcium scoring.*

**Background:** The prognostic value of coronary computed tomographic angiography (cCTA) in asymptomatic patients has not been systematically explored. We investigated the prognostic values of cCTA in asymptomatic population, and compare them with conventional risk stratification algorithm and coronary artery calcium scoring (CACS).

**Methods:** International multicenter cCTA registry (CONFIRM Registry) was queried and asymptomatic subjects without previous coronary artery disease (CAD) were analyzed. Follow-up composite outcome (all-cause mortality and non-fatal MI) was procured. Multivariable Cox proportional hazards models were developed to predict composite outcome. Receiver-operator characteristic curves (ROC) were generated to compare differential predictive values of risk stratification algorithms based on traditional risk factors (RFs), CACS and cCTA with respect to composite outcomes.

**Results:** In all, 27,125 subjects underwent cCTA at 12 centers and 7,741 subjects met the inclusion criteria. During a mean follow-up of 26±11 months, composite outcome rated 2.2% (149 deaths and 27 non-fatal MIs). In Cox regression, compared with those with no CAD, patients with <50% coronary stenosis (HR 1.67, 95% CI 1.00-2.77, p=0.048), 1VD (HR1.89, 95% CI 1.07-3.33, p=0.029), 2VD (HR 3.06, 95% CI 1.67-5.61, p<0.0001), and 3VD or left main disease (HR 4.10, 95% CI 2.19-6.68, p<0.0001) experienced significantly increased risk of composite outcome after adjusting RFs. In ROC analysis, all of combined model of cCTA-based risk stratification algorithms (number of ≥50% stenosis vessels, Duke CAD prognostic index, segment stenosis score, segment involvement score) with traditional RFs had incremental predictive values over the traditional RFs alone (all p<0.05), but none of them had incremental predictive values over the algorithm of combining traditional RFs and CACS (all p>0.05) with respect to composite outcomes.

**Conclusions:** In asymptomatic population, presence of CAD evidenced by cCTA has a prognostic value for composite outcome, but none of current cCTA-based risk stratification algorithm showed added benefit compared with algorithm from traditional RFs and CACS.

#### Weitere Auswahl an Beiträgen

#### **JACC 2011;57(14):E832**

*Pillutla P, Li D, Ahmadi N, Budoff MJ*

*Coronary artery calcium and cardiac CT in Los Angeles county firefighters with abnormal stress tests*

**Objective:** Our objective was to determine whether Los Angeles county firefighters have higher coronary artery calcium (CAC) scores and increased atherosclerosis as determined by 64-slice cardiac multi-detector computed tomography.

**Background:** Firefighters are known to have an elevated rate of sudden cardiac death compared with the general population. It is unclear whether this finding is related to underlying cardiovascular risk factors or if firefighting inherently carries additional risk.

**Methods:** 647 asymptomatic firefighters evaluated as part of a wellness protocol were referred for cardiac multi-detector computed tomography to evaluate an abnormal exercise treadmill test. They were matched by age and cardiovascular risk factors with 2533 asymptomatic individuals undergoing cardiac computed tomography for an abnormal electrocardiogram or exercise treadmill test. CAC and prevalence of obstructive coronary artery disease by vessel were derived.

**Results:** 49 percent of firefighters had detectable CAC compared with 43% of controls ( $p=0.015$ ). Although lesions were most prevalent in the left anterior descending artery (LAD) in both groups, more firefighters had any LAD stenosis when compared with controls (42 percent among firefighters compared with 28 percent in controls,  $p<0.0001$ ). Firefighters were more likely to have left main coronary artery lesions as well (7 percent compared with 3.7 percent,  $p<0.0001$ ). Firefighters also had significantly higher total CAC scores when compared with controls (66 +/- 8 in firefighters compared with 33 +/- 4,  $p<0.001$ ). Multivariate logistic regression showed that, even after adjustment for conventional coronary artery disease risk factors, firefighting status was positively associated with the presence of LAD lesions (OR 1.2, 95% CI 1.12-1.29,  $p<0.0001$ ).

**Conclusions:** Our data suggest that asymptomatic firefighters have more atherosclerosis and CAC than matched controls. Given the high prevalence of sudden cardiac death among firefighters, these findings may have important implications for more aggressive firefighter screening and treatment for asymptomatic coronary artery disease.

#### **JACC 2011;57(14):E887**

*Becker A, von Ziegler F, Tittus J, Greif M, Nikolaou K, Becker C.*

*Ruling out of significant CHD by exclusion of coronary calcifications with cardiac multidetector row CT.*

**Background:** Multidetector Row Computed Tomography (MDCT) is an established diagnostic modality for reliable non invasive detection of coronary calcifications as a marker of coronary atherosclerosis. Calcium Scoring (CS) has shown to be a reliable tool for risk stratification of asymptomatic patients. But it still remains unclear whether CS is a useful parameter for ruling out of significant coronary heart disease (CHD) in symptomatic patients where CHD is suspected. The purpose of this study was to prove diagnostic accuracy for ruling out CHD by exclusion of coronary calcium deposits.

**Methods:** An overall of 4096 symptomatic patients (2685 men, age of  $58.2 \pm 15$  years) with suspected CHD and an indication for invasive coronary angiography (ICA) were included. All patients underwent ICA and quantitative coronary analysis (QCA) for stenosis graduation was performed. As significant CHD a luminal obstruction of  $\geq 50\%$  in at least one coronary vessel was defined. Within 3 days MDCT (Siemens Sensation 4, Siemens Volume Zoom 16, Siemens Medical Solutions, Siemens, Forcheim, Germany) coronary calcium screening was performed and calcium Volume Score (VS) was calculated. Evaluation was blinded to the results of ICA.

**Results:** A significant CHD was found in 1576 men and 607 women showing a mean VS of  $634 \pm 499$  which was significantly higher than mean VS of  $187 \pm 101$  in 1109 men and 804 women without significant CHD  $p < 0,001$ . An overall of 578 patients had no evidence of coronary calcium. Within this group of patients a significant CHD was detected in 7 men and 5 women all being younger than 60 years. Using a VS threshold of 1 a negative predictive value (NPV) of 98% with a sensitivity of 99% could be calculated. Specificity was 30% and positive predictive value was found to be 62%. Increasing the VS threshold to 100 led to an increase of specificity (47%) and PPV (66%), but simultaneously decreased sensitivity (82%) and NPV (71%).

**Conclusion:** Ruling out of significant CHD in patients older than 60 years is possible by the exclusion of coronary calcifications with a high negative predictive value. In younger patients or with the use of higher score thresholds the use of CS for this purpose is not reliable and additional diagnostic modalities such as MDCT angiography are recommended.



**JACC 2011;57(14):E885**

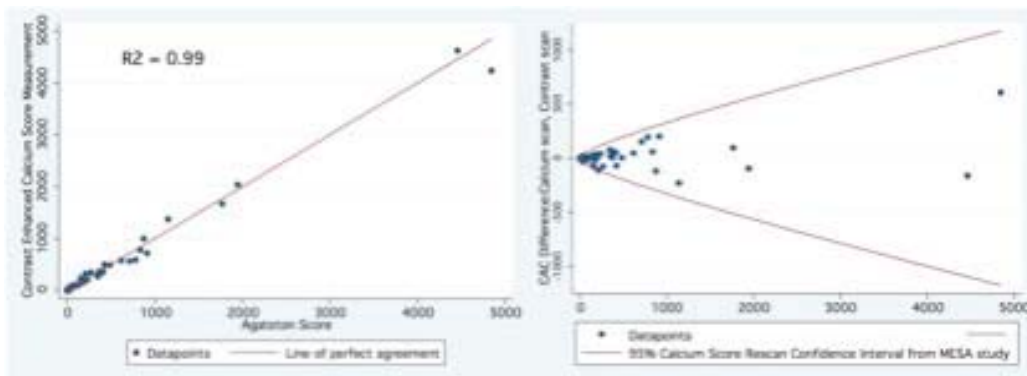
Otton J, Lønborg JT, Boshell D, Feneley M, Sammel N, Sesel K, Bester L, Wainwright C, McCrohon J.

*A novel method of coronary calcium quantification allows the evaluation of both calcium score and coronary anatomy from a single contrast enhanced CT scan*

**Background:** Coronary artery calcium (CAC) measurement currently requires a second non-contrast scan in addition to contrast enhanced CT coronary angiography, increasing the total radiation dose. We sought to derive and validate a method of measuring coronary calcium from standard contrast enhanced CTs.

**Methods:** All calcium scores and contrast scans were performed using a wide volume 320 detector-row scanner according to standard clinical protocols. We used a developed algorithm to quantify extra-luminal coronary calcium in the major epicardial vessels using a semi-automated technique. One hundred contrast and corresponding Agatston calcium score measurements were used for initial parameter estimation. The technique was then prospectively validated in a further 100 patients according to pre-specified inclusion criteria (ACTRN 12610000354088).

**Results:** Calcium scores ranged from 0 to 4842. Correlation of the contrast scan derived calcium score with the measured CAC was extremely high ( $r^2=0.99$ ). Using standard CAC bands (0-10,11-100,101-400,>400), agreement of the virtual calcium score with the measured was near perfect ( $\kappa = 0.88$ ). Inter-rater



reliability was excellent (Intra-class correlation =0.99).

**Conclusion:** Calcium scores can be accurately measured from standard contrast enhanced cardiac CT scans, removing the need for a second non-contrast calcium score scan. Radiation dose reductions of between 10% and 50% across standard protocols can be expected with this technique.

**JACC 2011;57(14):E827**

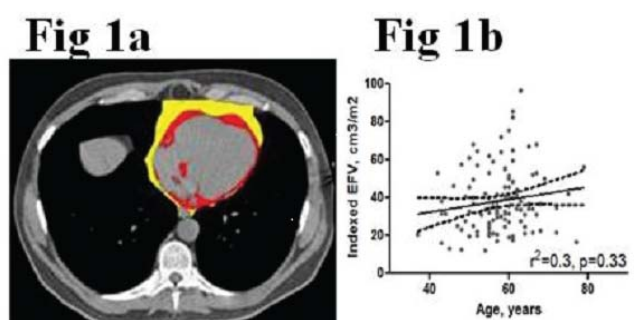
Shmilovich H, Dey D, Cheng VY, Nakazato R, Otaki Y, Nakanishi R, Rajani R, Slomka PJ, Thomson LEJ, Hayes SW, Friedman JD, Wong ND, Shaw LJ, Budoff M, Rozanski A, Berman DS.

*Epicardial fat volume normal limits using non-contrast enhanced cardiac CT in a healthy population*

**Background:** Epicardial fat volume (EFV) quantified on non contrast cardiac computed tomography is associated with risk of cardiovascular events, although normal limits have not been defined.

**Methods:** We retrospectively analyzed 120 asymptomatic, non diabetic patients (32 men, mean age  $57.6 \pm 7.2$  years) without cardiac disease with coronary calcium score of 0. Patients had low density lipoprotein < 160 mg/dL, triglycerides < 500 mg/dL, and a 10 yr CV event risk of  $\leq 6\%$  by Framingham risk score (FRS). EFV was quantified by a blind reader using validated software (Fig 1a) and indexed to body surface area (BSA). EFV distribution was found to be non-Gaussian, and the nonparametric Wilcoxon rank sum and Kruskal-Wallis tests were used to compare EFV between groups.

**Results:** Mean BSA was  $1.9 \pm 0.2$  m<sup>2</sup>. EFV was correlated to BSA ( $r=0.36$ ,  $p<0.0001$ ). Median indexed EFV was  $34.3$  cm<sup>3</sup>/m<sup>2</sup> (95% CI  $31.8$ - $38.3$  cm<sup>3</sup>/m<sup>2</sup>). Minimum, 25th and 75th percentiles, and maximum



values were 12.3, 25.6, 47.6 and 96.6 cm<sup>3</sup>/m<sup>2</sup>, respectively. The 95th percentile was 68.3 cm<sup>3</sup>/m<sup>2</sup>. No statistically significant differences in EFV were found between genders and quartiles of age and FRS ( $p=0.37$ , 0.11 and 0.44, respectively, Fig 1b).

**Conclusions:** In a low risk population without coronary calcification, indexed EFV ranged from 12.3 to 96.6 cm<sup>3</sup>/m<sup>2</sup> with a median value of 34.3 cm<sup>3</sup>/m<sup>2</sup>. EFV was not related to gender, age and standard CV risk factors but was related to BSA. We suggest considering 68.3 cm<sup>3</sup>/m<sup>2</sup> as the upper normal limit for EFV.

#### **JACC 2011;57(14):E819**

*Ahmadi A, Chandy M, Grunau G, Faraji R, Rezazadeh S, Heilbron B, Ramanathan K, Taylor CM, Leipsic J.*

*The predictive value of traditional risk factors in the assessment of CAD burden in south Asians vs non-south Asians: a coronary CTA study*

**Background:** Compared to age-matched Americans from the United States, South Asians (SA) have three to four times the rate of coronary artery disease (CAD) morbidity and mortality. We sought to evaluate the association between cardiac risk factors and CAD burden on coronary CT angiography (CCTA) in SA and Non South Asians (NSA).

**Methods:** Consecutive CCTAs performed at a quaternary center in Vancouver, Canada between January 2008 and Sep 2010 were reviewed. Patients' demographics and self reported cardiac risk factors were obtained. CCTAs were interpreted using an 18-segment model. Each segments' degree of stenosis was quantified. Segments' scores were summed to generate a total stenosis score (TSS). Patients were divided to SA and NSA groups based on their ethnicity. Independent sample T tests and multivariate linear regression were utilized to assess the association between the individual cardiac risk factors and CAD burden in each group.

**Results:** The cohort consisted of 1042 pts with 170 (16%) SA. The mean age of SA was 54.4 y vs. 59.6y in NSA ( $P<0.003$ ). Among SA subset, hypertension, family history of premature CAD and male sex were associated with higher mean TSS (2.04 vs. 0.94, 1.66 vs. 1.14, and 1.64 vs. 0.94 respectively.  $P<0.04$ ). Multivariate analyses showed family history of premature CAD, hypertension, and age had the greatest correlation with CAD burden. Among NSA subset, male sex, dyslipidemia, diabetes, hypertension, higher body mass index were associated with higher mean TSS (2.10 vs. 0.87, 1.81 vs. 1.34, 2.56 vs. 1.40, 2.14 vs. 1.78, and 1.71 vs. 1.16 respectively.  $P<0.05$ ). In multivariate analyses, hypertension, age and male sex were most correlated with CAD burden while family history of premature CAD showed no statistically significant correlation with CAD burden.

**Conclusion:** The association between traditional risk factors and atherosclerosis on CT differs between SA and NSA. Application of risk assessment models derived and tested in predominantly NSA populations may not be appropriate in the SA population. Further studies on the association of cardiac risk factors and CAD burden by ethnicity are warranted.

#### **JACC 2011;57(14):E639**

*Groothuis J, Beek AM, Brinckman SJ, Meijerink MR, v.d. Oever ML, Hofman MM, van Kuijk C, van Rossum AC.*

*Combined non-invasive functional and anatomical diagnostic work-up in clinical practice: the magnetic resonance and computed tomography in suspected CAD (MARCC) study*

**Background:** The combined use of CTCA and myocardial perfusion imaging allows the non-invasive evaluation of coronary morphology and function. Cardiovascular MR (CMR) has several advantages: it can simultaneously assess myocardial perfusion, ventricular and valvular function, cardiomyopathy and aortic disease and does not involve any ionizing radiation. We investigated the combined use of cardiac computed tomography (CT) and CMR for the diagnostic evaluation of patients with suspected CAD in clinical practice.

**Methods:** A total of 192 patients with low or intermediate pre-test probability of CAD underwent CT (coronary calcium scoring and angiography) and CMR (assessment of ventricular function, adenosine stress myocardial perfusion and late gadolinium enhancement imaging). All patients with obstructive CAD on CTCA and/or myocardial ischemia on CMR were referred for invasive coronary angiography (ICA). Fractional flow reserve was measured in case of intermediate lesions (30-70% diameter stenosis) on ICA. Patients who did

not undergo ICA were followed-up for major adverse cardiac events. The diagnostic performance for detection of significant CAD was determined for CTCA, CMR and the combination of CTCA and CMR. Additional cardiac and extra-cardiac findings by CT and CMR were registered.

**Results:** The combination of CTCA and CMR significantly improved specificity and overall accuracy for detection of significant CAD compared to either CTCA or CMR alone: 94% and 91% versus 39% and 57%,  $p < 0.0001$  (CTCA) or 82% and 83%,  $p = 0.016$  (CMR), respectively. No events were recorded during follow-up ( $18 \pm 6$  months) in 104 patients who did not undergo ICA. Furthermore, the combined strategy provided an alternative diagnosis in 18 patients (such as myocarditis, hypertrophic cardiomyopathy and dilated cardiomyopathy).

**Conclusions:** The combined use of CT and CMR significantly improved specificity and overall diagnostic accuracy for the detection of significant CAD, and allowed the detection of alternative (extra-) cardiac disease in patients without significant CAD.

### JACC 2011;57(14):E820

Engel LC, Verdini D, Major GP, Abbara S, Hoffmann U, Kalra M, Brady J, Ghoshhajra B.

Antropomorphic measurements on CT images: a potential surrogate or replacement for BMI when selecting cardiothoracic CT dose parameters?

**Background:** Significant cardiac CTA dose reductions have been shown by adjustment of scanner tube voltage according to BMI, while maintaining diagnostic contrast-to-noise ratio (CNR). We sought to evaluate an anthropomorphic measure (chest area), as a potentially more appropriate predictor of the kV needed to scan the heart than BMI.

**Methods and Materials:** 182 consecutive patients whom underwent a cardiac CTA exam (kVp selection based on BMI) between April 2010 and September 2010 were included. Chest area was obtained by tracing an axial full-field-of-view image at the mid left atrial level. Linear regression between BMI and chest area was used to stratify patients into 4 chest area classes. Patients were also stratified by WHO BMI classes. CNR was compared between concordant and discordant chest area and BMI classes.

**Results:** 61% of patients (111/182) had concordant chest area and BMI classes. 17.6% of all patients (32/182) were potentially underdosed (chest area class > BMI class), while 21.4% (39/182) were potentially overdosed (chest area class < BMI class). CNR was significantly different ( $p = 0.028$ ), between the underdosed group (mean CNR  $10.3 \pm 2.6$ ), compared to the concordant group ( $11.2 \pm 4.1$ ) and the overdosed group ( $12.3 \pm 4.3$ ).

**Conclusion:** Chest area classes and BMI classes were often discordant, potentially leading to over- or underdosing when using BMI to select kV. Our data suggest that chest area could better inform kV, supported by significantly different CNR measurements between the groups.

		Body-Mass-Index				
		Underweight < 18.5 kg/m <sup>2</sup>	Normal range 18.5 – 24.99 kg/m <sup>2</sup>	Overweight 25 – 29.99 kg/m <sup>2</sup>	Obese ≥ 30 kg/m <sup>2</sup>	
Chest Area	Large ≥ 842.9 cm <sup>2</sup>	0	0	15	43	 <p>Group 1: underdosed patients</p> <p>Group 2: concordant doses</p> <p>Group 3: overdosed patients</p>
	Medium 712.9 – 842.6 cm <sup>2</sup>	0	16	40	7	
	Small 543.8 – 712.6 cm <sup>2</sup>	1	26	22	1	
	Very small < 543.8 cm <sup>2</sup>	2	9	0	0	

Table: Agreement of BMI and chest area using 4 different categories: BMI is classified according to the World Health Organization system of classification. Categories for chest area were formed by using the equation  $y = 26.0 \cdot \text{BMI} + 62.8$  which was derived from the linear regression analysis.