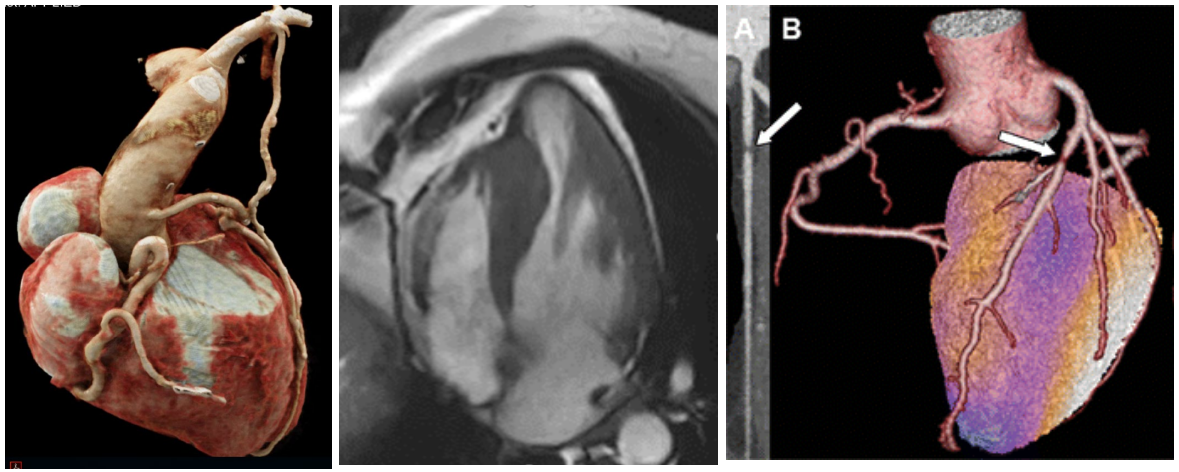
Handout: Fortbildung vom 17. Juni 2021 Privatklinik Obach

INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HOPITAL UNIVERSITAIRE DE BERNE
BERN UNIVERSITY HOSPITAL

Stellenwert des Koronar-CTs und der funktionellen Bildgebung bei der Abklärung der KHK



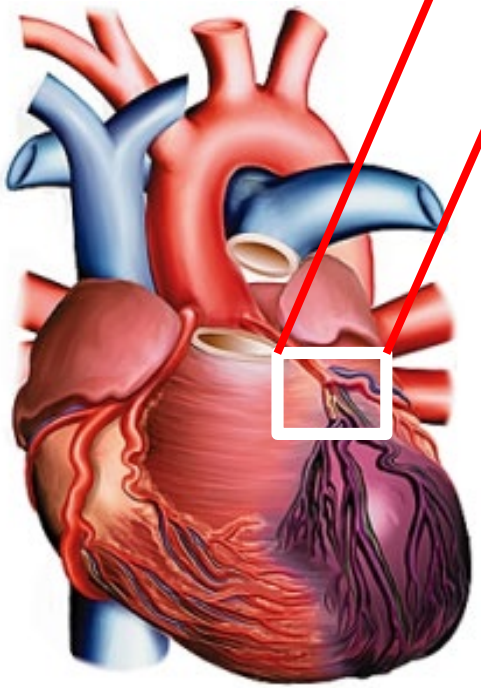
Prof. Dr. med. Christoph Gräni
Leiter Kardiovaskuläre Bildgebung
Inselspital Bern

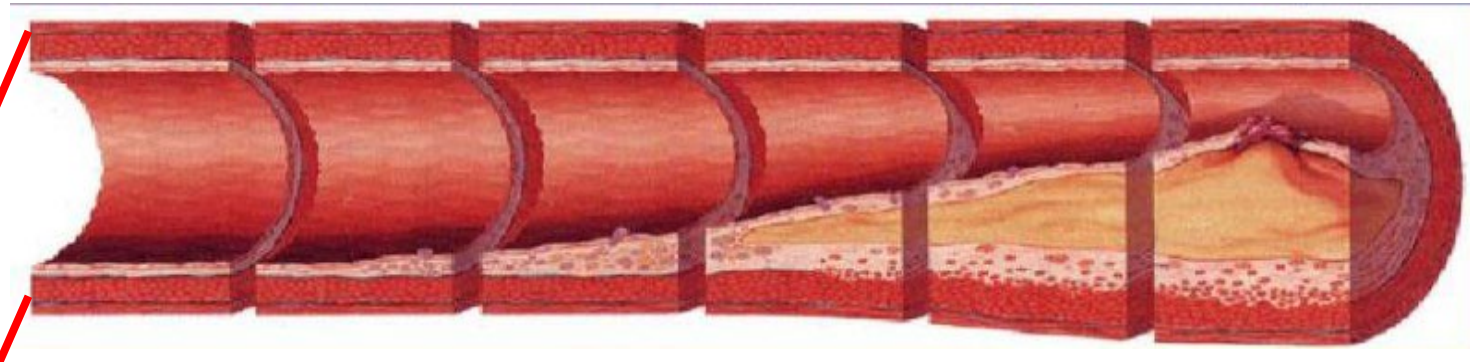
Agenda

Nicht-invasive Bildgebung bei:

- Stabilen Thoraxschmerzen

Koronare Herzkrankheit (KHK): Risikofaktoren





Risikofaktoren:

- **Alter**
- **Geschlecht**
- **Gene**

Modifizierbare Risikofaktoren

- **Rauchen**
- **Diabetes mellitus**
- **Arterielle Hypertonie**
- **Dyslipidämie**
- **Adipositas (Bewegungsmangel)**

Was gibt es für verschiedene Modalitäten zur Abklärung der KHK?

Funktion

- Stress-Echokardiographie
- Nuklear-medizinische Methoden (SPECT/PET)
- Stress-MRI

Anatomie

- Koronar-CT
- Invasive Koronarangiographie (+Therapie!)

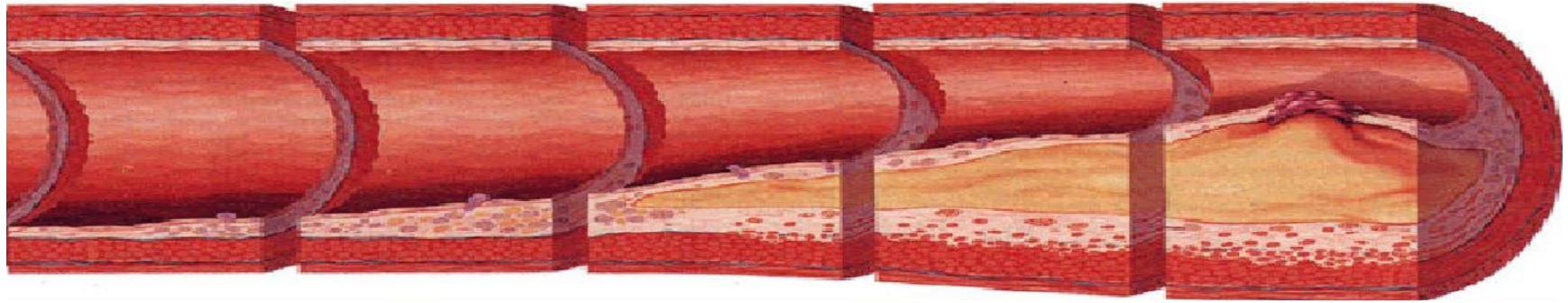
Einleitung – Nichtinvasive Abklärung der KHK

Funktion

- Ergometrie
- Stress-Echo
- SPECT
- PET
- MRI

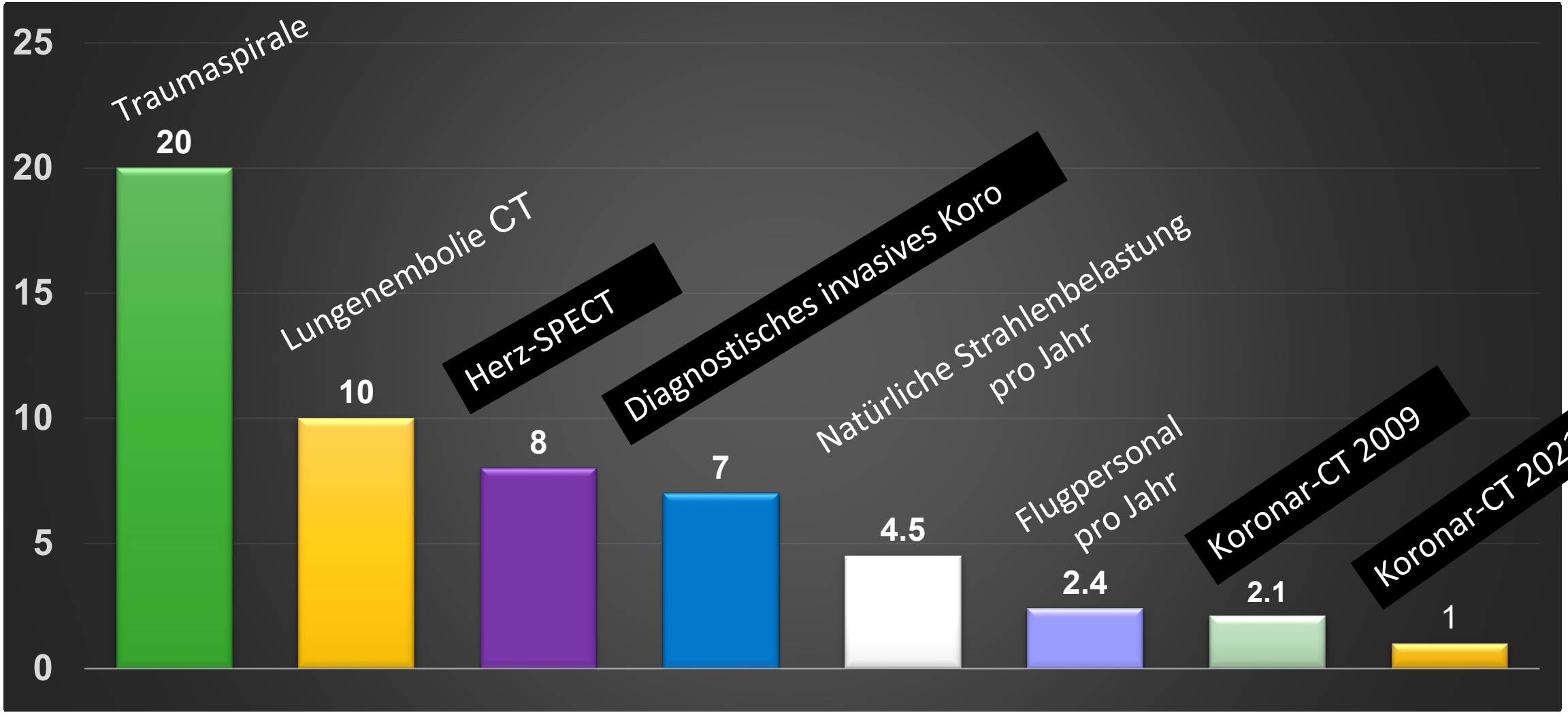
Anatomie

- Koronar-CT



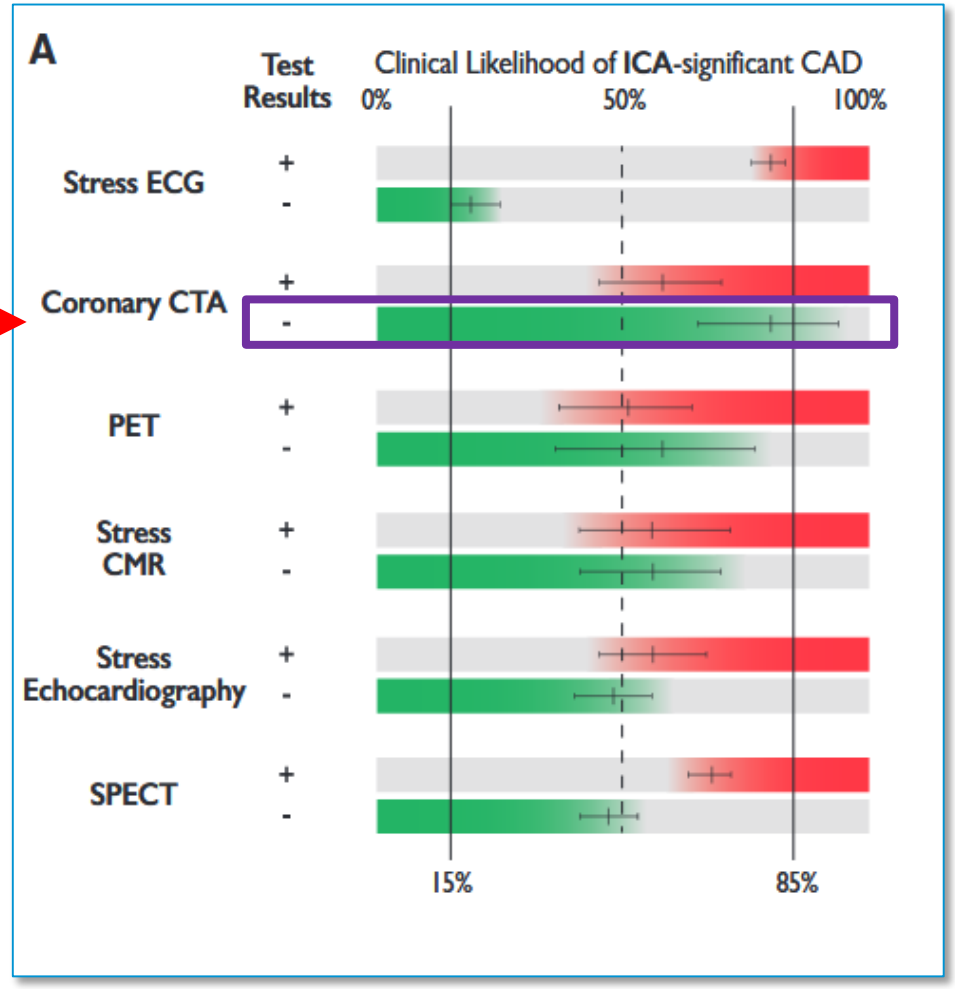
Stenosegrad 20% 40% 60% 80%

Strahlenbelastung



Vergleich der verschiedenen Modalitäten

Negativer Prädiktiv Wert 99%

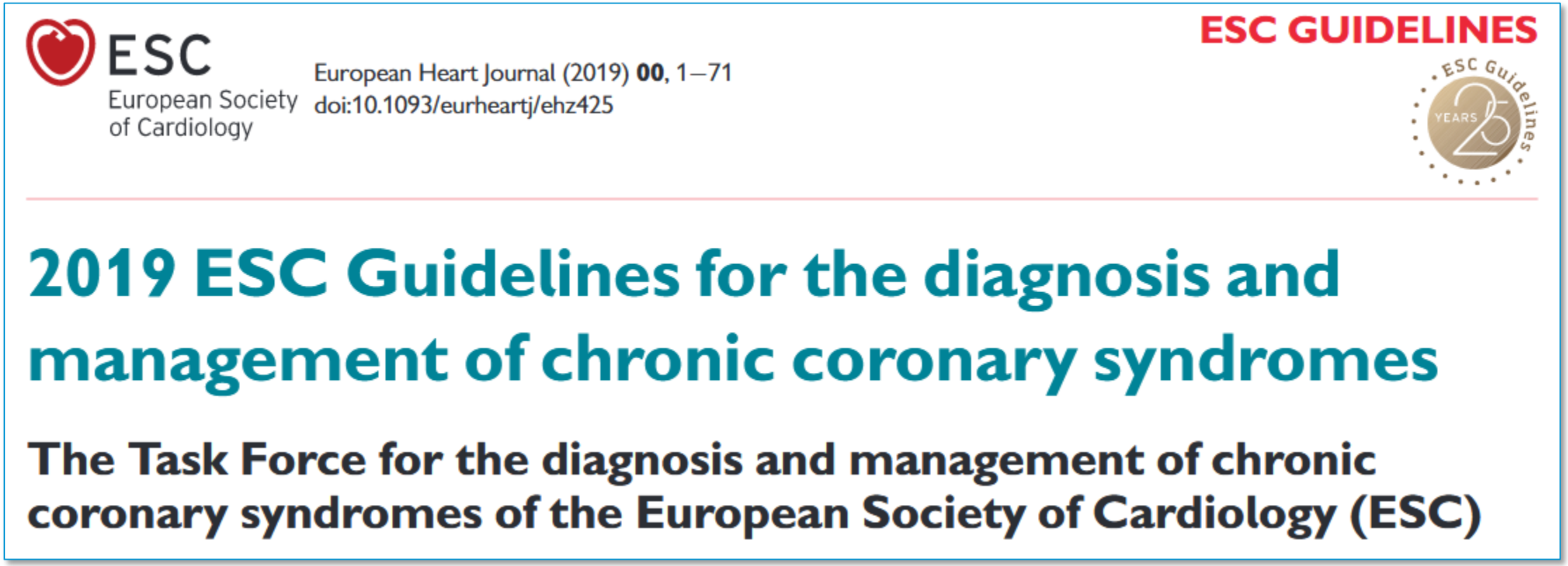


Clinical Likelihood range where test can **rule-in** CAD (Post-test probability will rise above 85%)

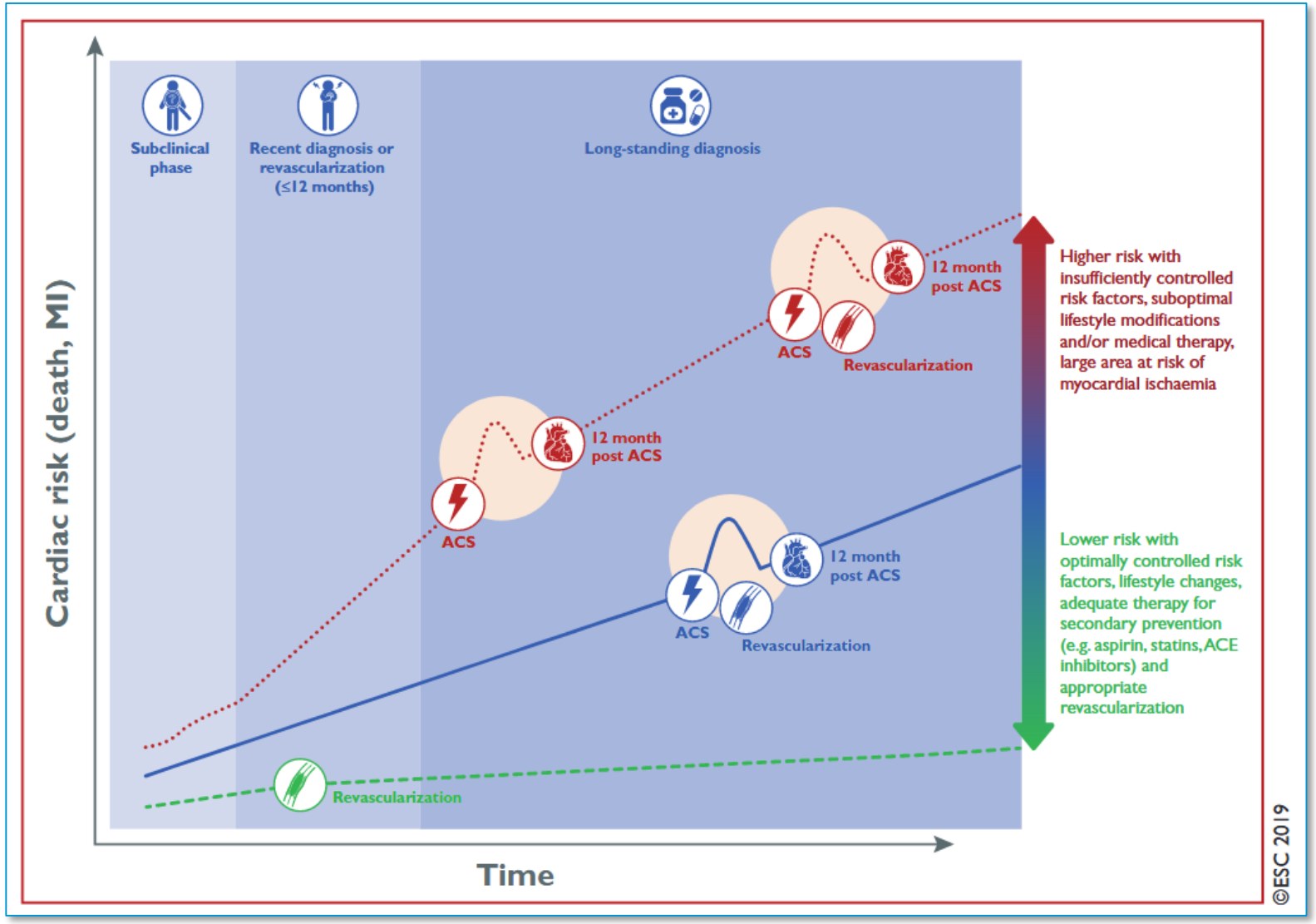
Clinical Likelihood range where test can **rule-out** CAD (Post-test probability will rise below 15%)

Knuuti J. et al. Eur Heart J. 2019 Aug 31

Was sagen die neuen Guidelines?



Chronisches Koronarsyndrom



Knuuti J. et al. Eur Heart J. 2019 Aug 31

Chronisches Koronarsyndrom

New major recommendations in 2019	
Basic testing, diagnostics, and risk assessment	
Non-invasive functional imaging for myocardial ischaemia or coronary CTA is recommended as the initial test for diagnosing CAD in symptomatic patients in whom obstructive CAD cannot be excluded by clinical assessment alone.	I
It is recommended that selection of the initial non-invasive diagnostic test be based on the clinical likelihood of CAD and other patient characteristics that influence test performance, local expertise, and the availability of tests.	I
Functional imaging for myocardial ischaemia is recommended if coronary CTA has shown CAD of uncertain functional significance or is not diagnostic.	I
Invasive angiography is recommended as an alternative test to diagnose CAD in patients with a high clinical likelihood and severe symptoms refractory to medical therapy, or typical angina at a low level of exercise and clinical evaluation that indicates high event risk. Invasive functional assessment must be available and used to evaluate stenoses before revascularization, unless very high grade (>90% diameter stenosis).	I

Knuuti J. et al. Eur Heart J. 2019 Aug 31

Klinische Vortestwahrscheinlichkeit bezüglich KHK

Typische Angina:	1. Retrosternaler Druck • Typischer Charakter • Dauer Minuten, nicht Sekunden 2. Provoziert durch Anstrengung oder psychischen Stress 3. Verschwindet in Ruhe oder nach Nitroglyzerin **Alle 3 Charakterisika sind zutreffend**
Atypische Angina	2 von 3 Charakteristika
Nicht-anginöser Thoraxschmerz	1 oder 0 dieser Charakteristika

Symptome

Alter

	Typical		Atypical		Non-anginal		Dyspnoea[a]	
Age	Men	Women	Men	Women	Men	Women	Men	Women
30–39	3%	5%	4%	3%	1%	1%	0%	3%
40–49	22%	10%	10%	6%	3%	2%	12%	3%
50–59	32%	13%	17%	6%	11%	3%	20%	9%
60–69	44%	16%	26%	11%	22%	6%	27%	14%
70+	52%	27%	34%	19%	24%	10%	32%	12%

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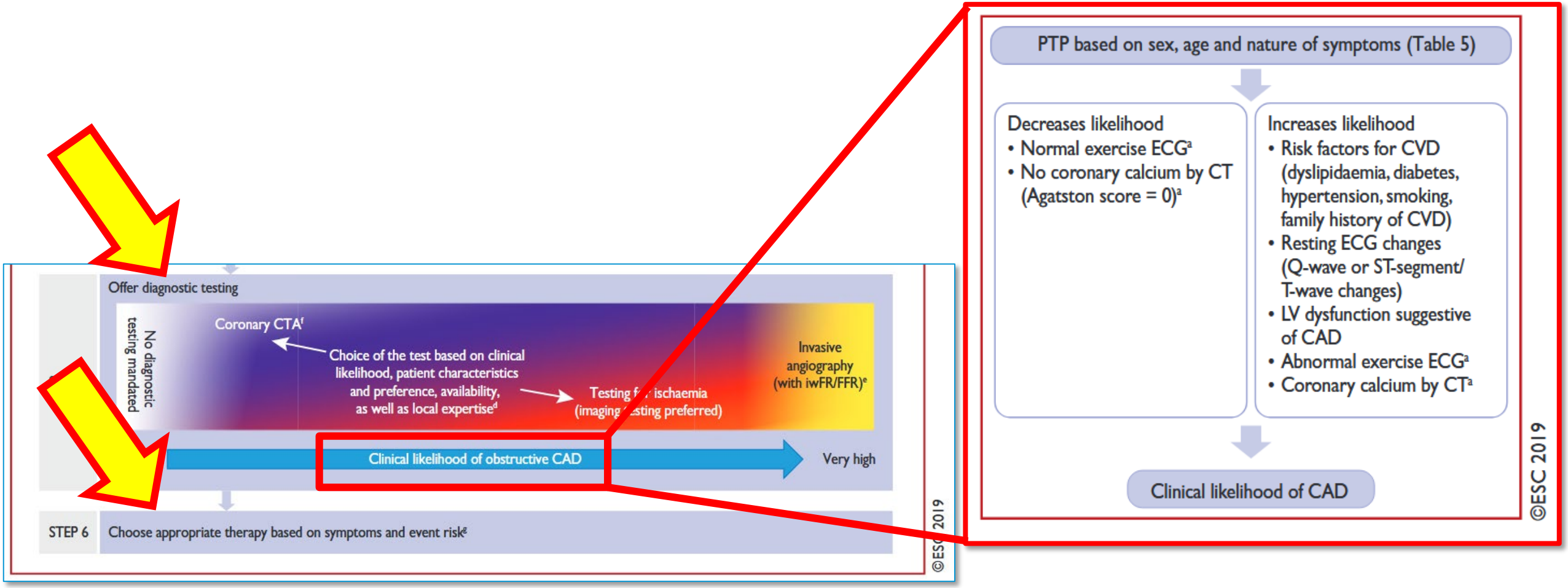
Geschlecht

Knuuti J. et al. Eur Heart J. 2019 Aug 31

Wann soll welcher Test angewendet werden?



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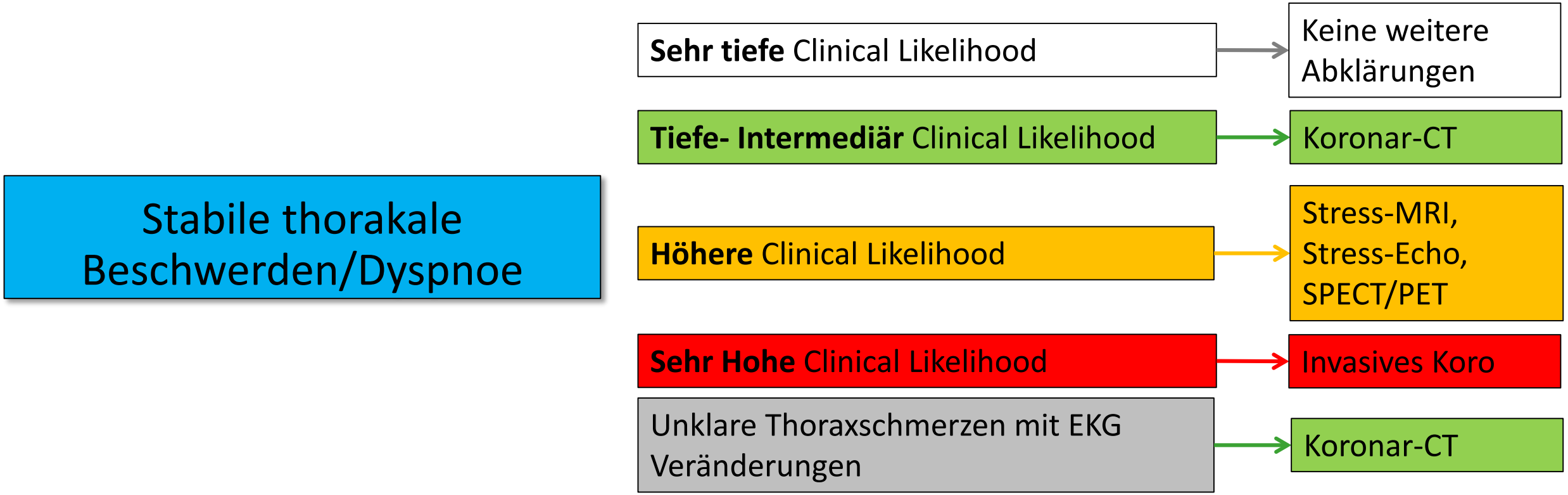
Wie soll ich Patienten mit stabilen Thoraxschmerzen abklären?

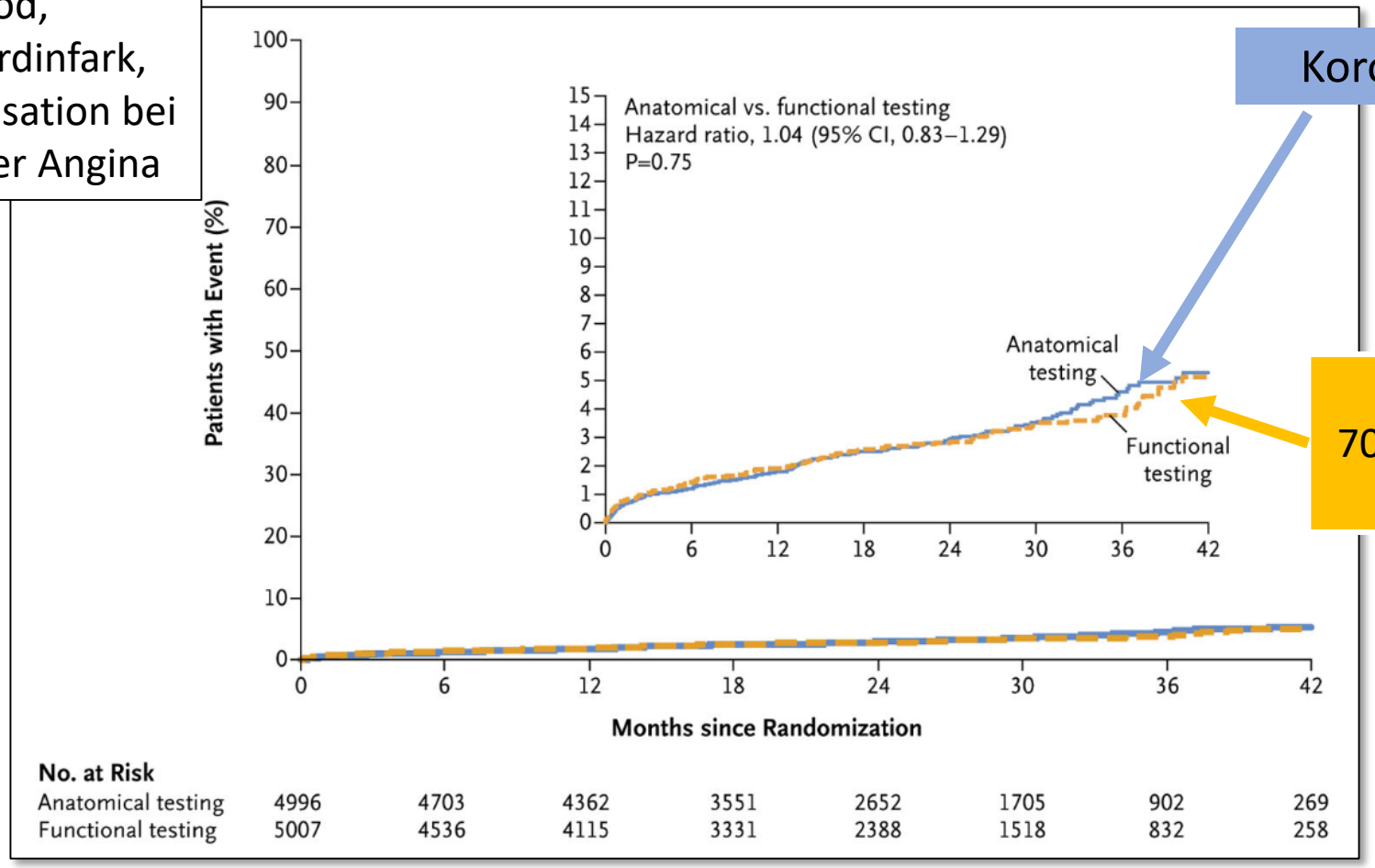


Adaptiert von Knuuti J. et al. Eur Heart J. 2019 Aug 31

PROMISE Trial

Symptomatische Patienten mit intermediärem Risiko bezüglich KHK
randomisiert Funktionell vs. Anatomisch

Tod,
Myokardinfark,
Hospitalisation bei
instabiler Angina



Koronar-CT

Funktionell:
70% Nuklear, 20% Stress-Echo,
10% Stress-EKG.

Douglas PS. Et al. N Engl J Med. 2015 Apr 2;372(14):1291-300

Scot-Heart Trial

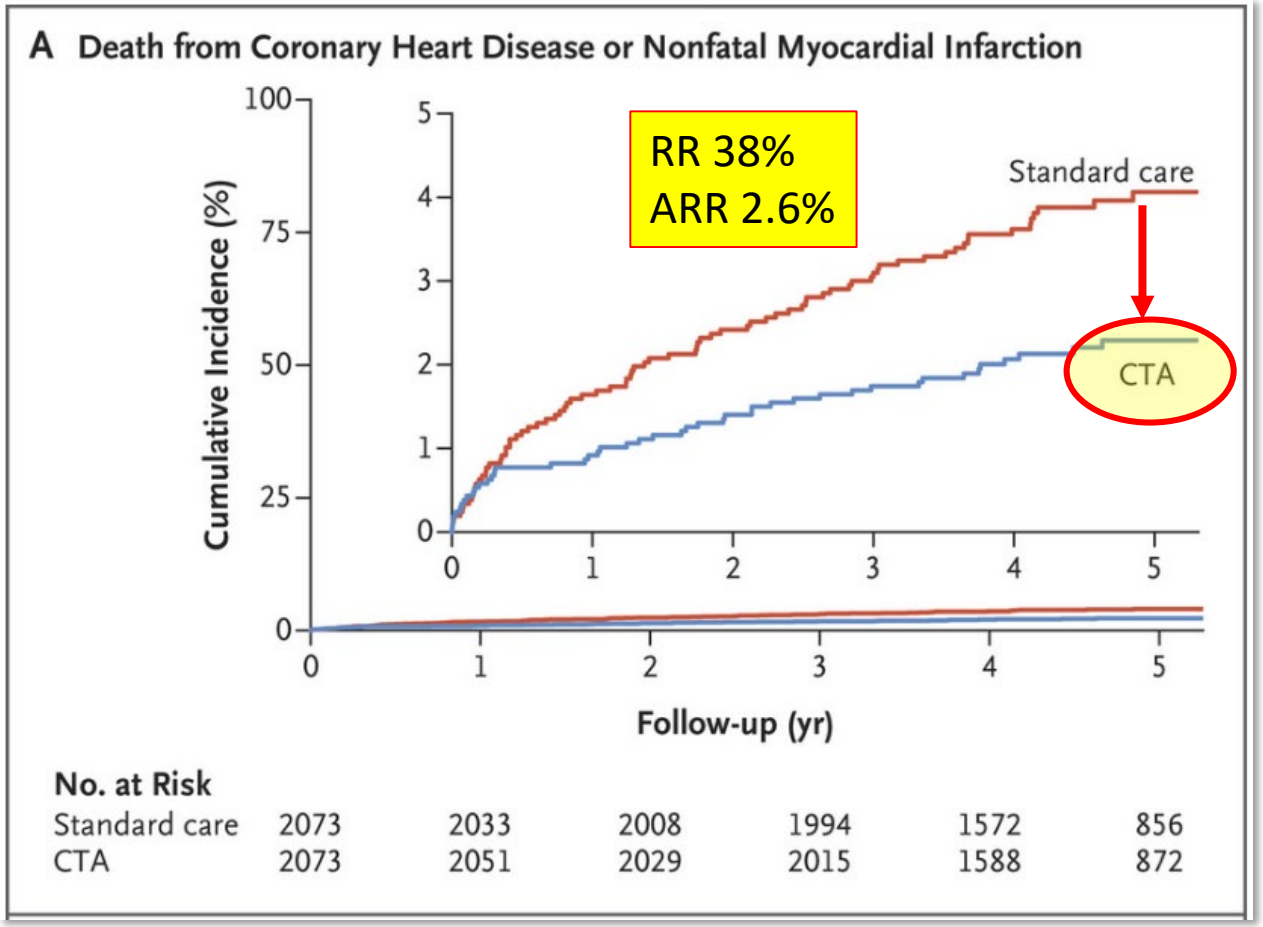
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Coronary CT Angiography and 5-Year Risk of Myocardial Infarction

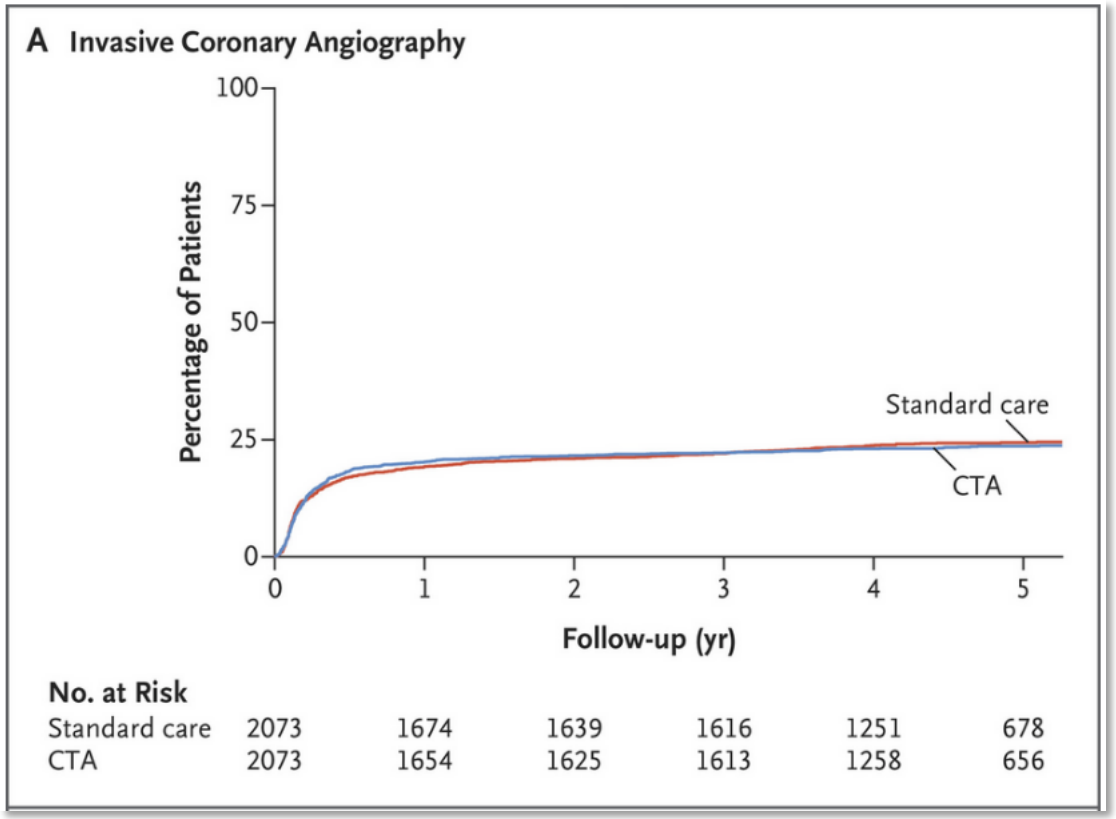
September 6, 2018
N Engl J Med 2018; 379:924-933
DOI: 10.1056/NEJMoa1805971

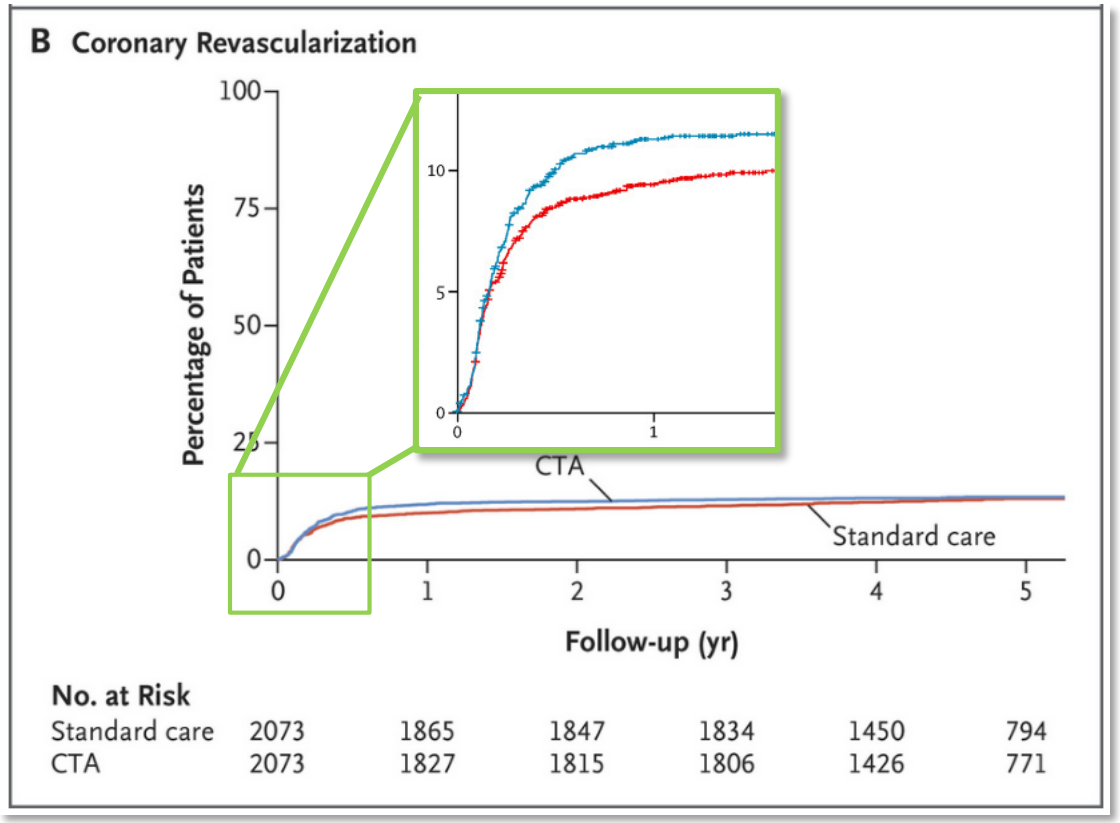
Characteristic	All Participants (N=4146)	Standard Care (N=2073)	Standard Care plus CTA (N=2073)
Stress ECG performed — no./total no. (%)	3517/4128 (85)	1764/2063 (86)	1753/2065 (85)
Normal results	2188/3283 (67)	1103/1651 (67)	1085/1632 (66)
Inconclusive results	566/3283 (17)	284/1651 (17)	282/1632 (17)
Abnormal results§	529/3283 (16)	264/1651 (16)	265/1632 (16)
Further investigations — no./total no. (%)	1315/4140 (32)	633/2069 (31)	682/2071 (33)
Stress imaging			
Radionuclide scintigraphy	389/4142 (9)	176/2070 (9)	213/2072 (10)
Other imaging	30/4142 (<1)	16/2070 (<1)	14/2072 (<1)
Invasive coronary angiography	515/4142 (12)	255/2070 (12)	260/2072 (13)



Forbes J et al. N Engl J Med. 2018 Sep 6;379(10):924-933.

Scot-Heart Trial





- *Koronar-CT:* Nicht-stenosierende Koronarsklerose wird entdeckt und in der Ergometrie verpasst
- *Koronar-CT:* Früh und korrekt invasiver Koronarangiographie zugewiesen

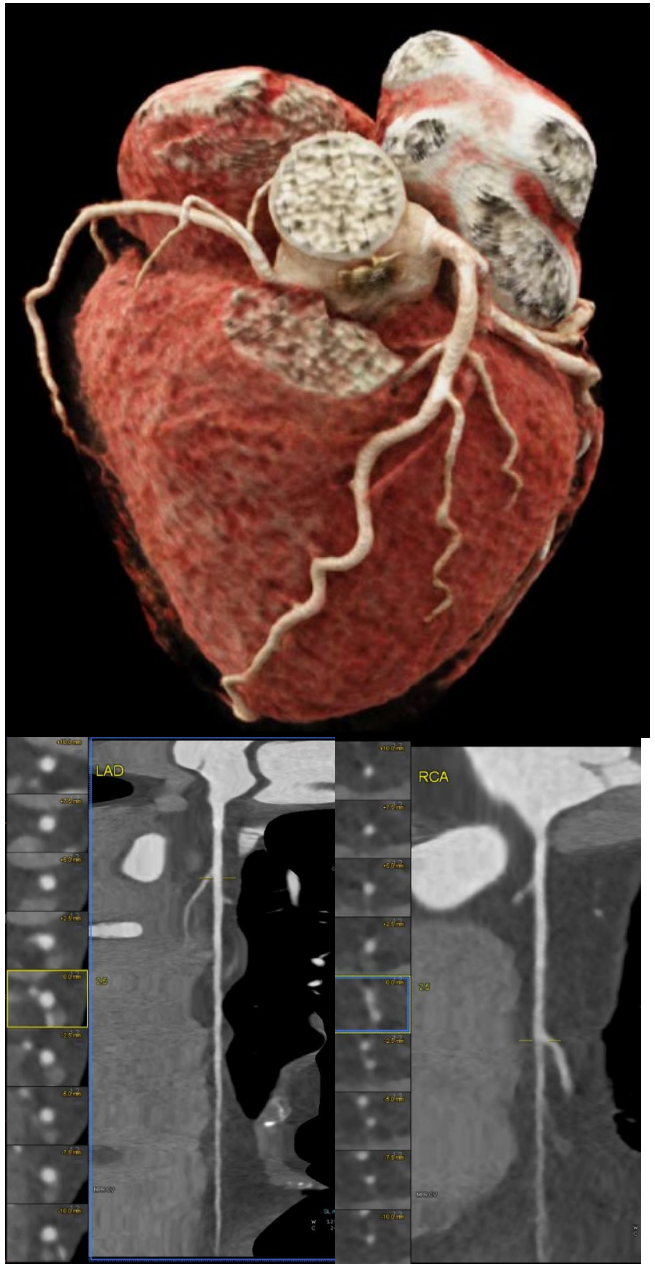
Forbes J et al. N Engl J Med. 2018 Sep 6;379(10):924-933.

Koronar-CT Patientenselektion

- Tiefe-bis mittlere Vortestwahrscheinlichkeit bezüglich KHK
- Sinusrhythmus
- Normale Nierenfunktion
- Kein Viagra/Cialis/Levitra 12-24h vor Untersuchung →Hypotonie

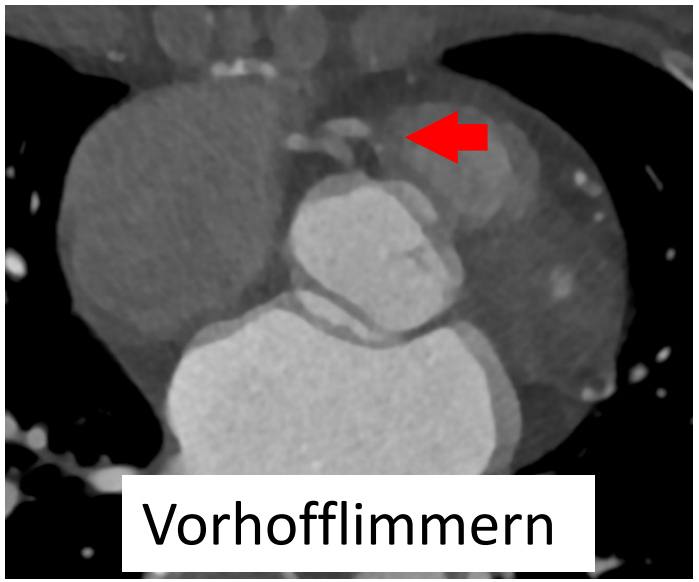
Ablauf

- i.v. Betablockergabe (z.B. Beloc Zok, max. 30mg)
- 2 Hübe Nitroglyzerin
- Kalziumscore Scan (nativ)
- Koronar-CT Angiographie mit Kontrastmittel (30-90ml, je nach BMI)

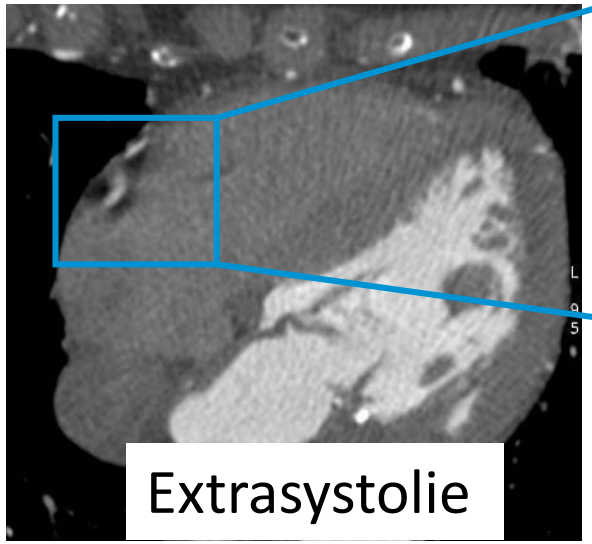


Die Koronar-CT ist nicht geeignet:

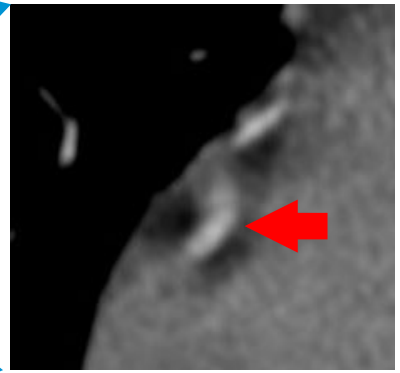
- Patienten mit hoher Vortestwahrscheinlichkeit für KHK → invasive Koro
- Bei Patienten mit Stents
- Patienten mit Vorhofflimmern oder Arrhythmien
- Patienten mit einer Kontraindikation für Nitroglyzerin (schwere Aortenstenose)



Vorhofflimmern



Extrasystolie

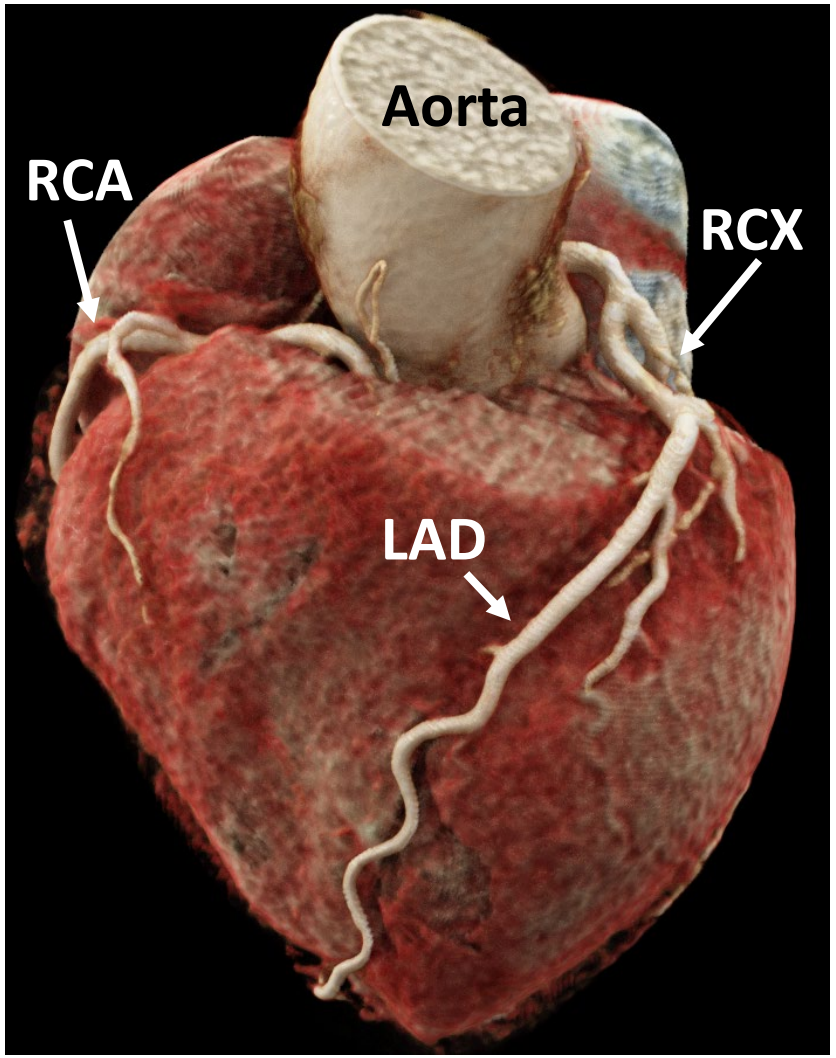


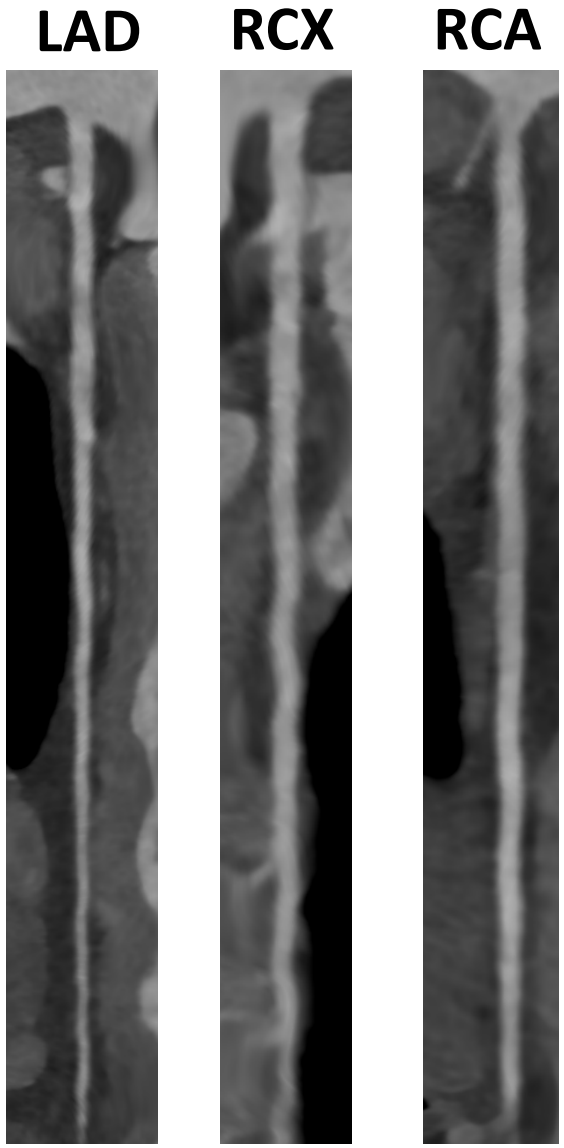
Stents

Beispiel 1

- 56 jähriger Patient stellt sich nach einer Skitour auf der Notfallstation vor wegen neu aufgetretenen Schmerzen über der Brust beim Bergaufgehen.
- EKG und Troponin: seriell unauffällig
- Vorgeschichte: Keine relevanten Vorerkrankungen.
- CVRF: pos. FA
- Status: BMI 28 kg/m2; Normoton; Normokard; klinisch unauffällig
- Medikation: Keine

Beispiel 1





Koronar-CT: Kalk- und stenosefreie Koronarien. Normale Koronaranatomie.

→ Nicht invasiv

→ Wenig Strahlendosis (1mSv)

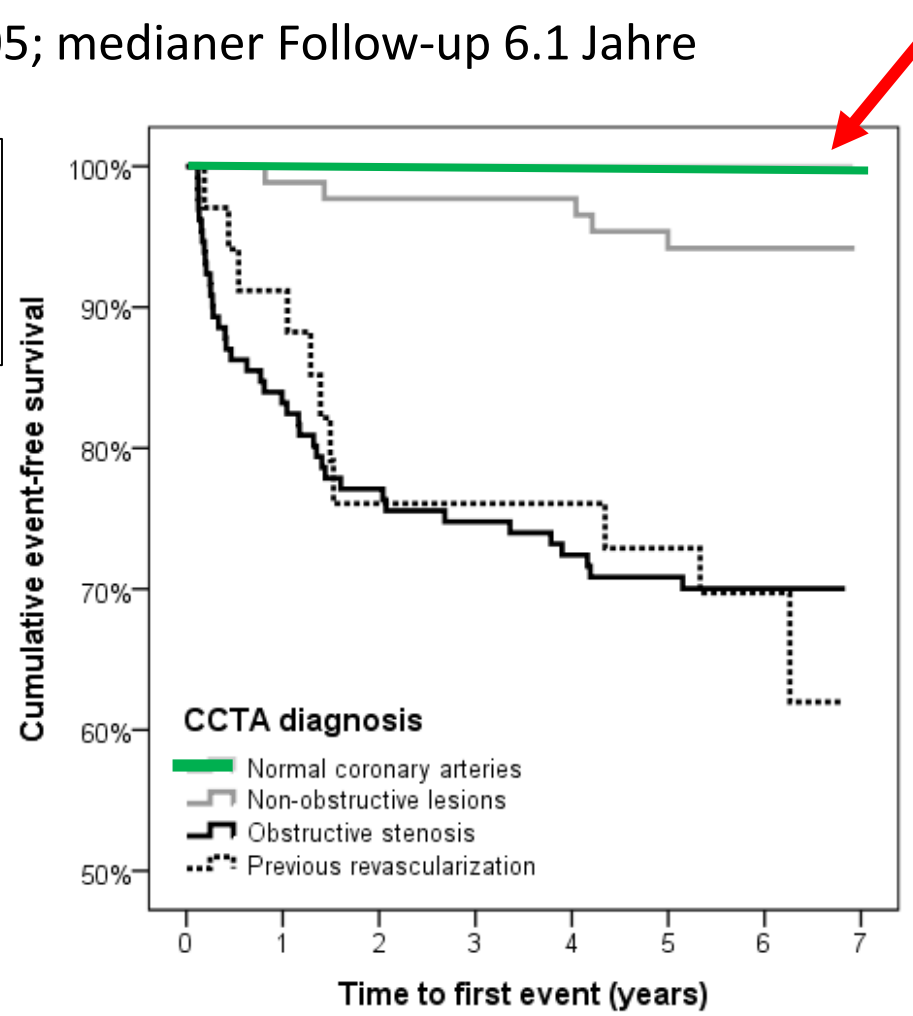
→ wenig Kontrastmittel (50mL)

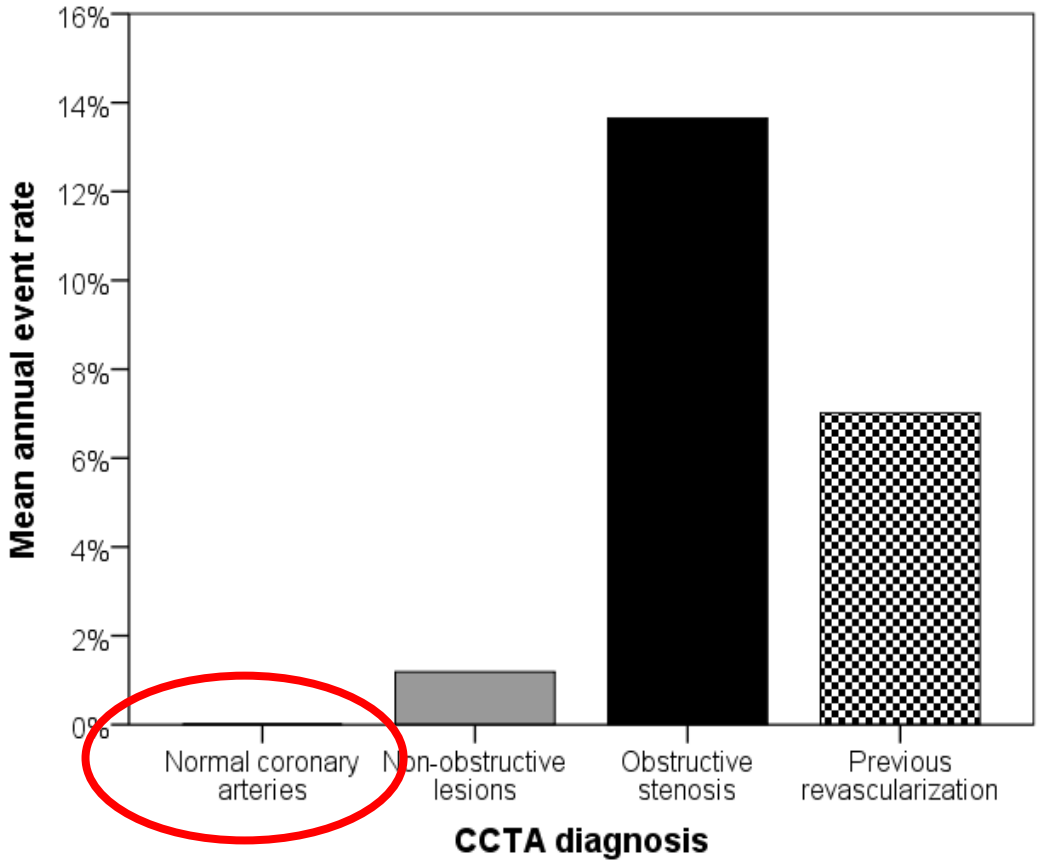
→ Rasch (<30 Minuten)

Prognostische Wertigkeit des normalen Koronar-CT

n = 405; medianer Follow-up 6.1 Jahre

Herztod, Myokardinfarkt, elektive Revaskularisation



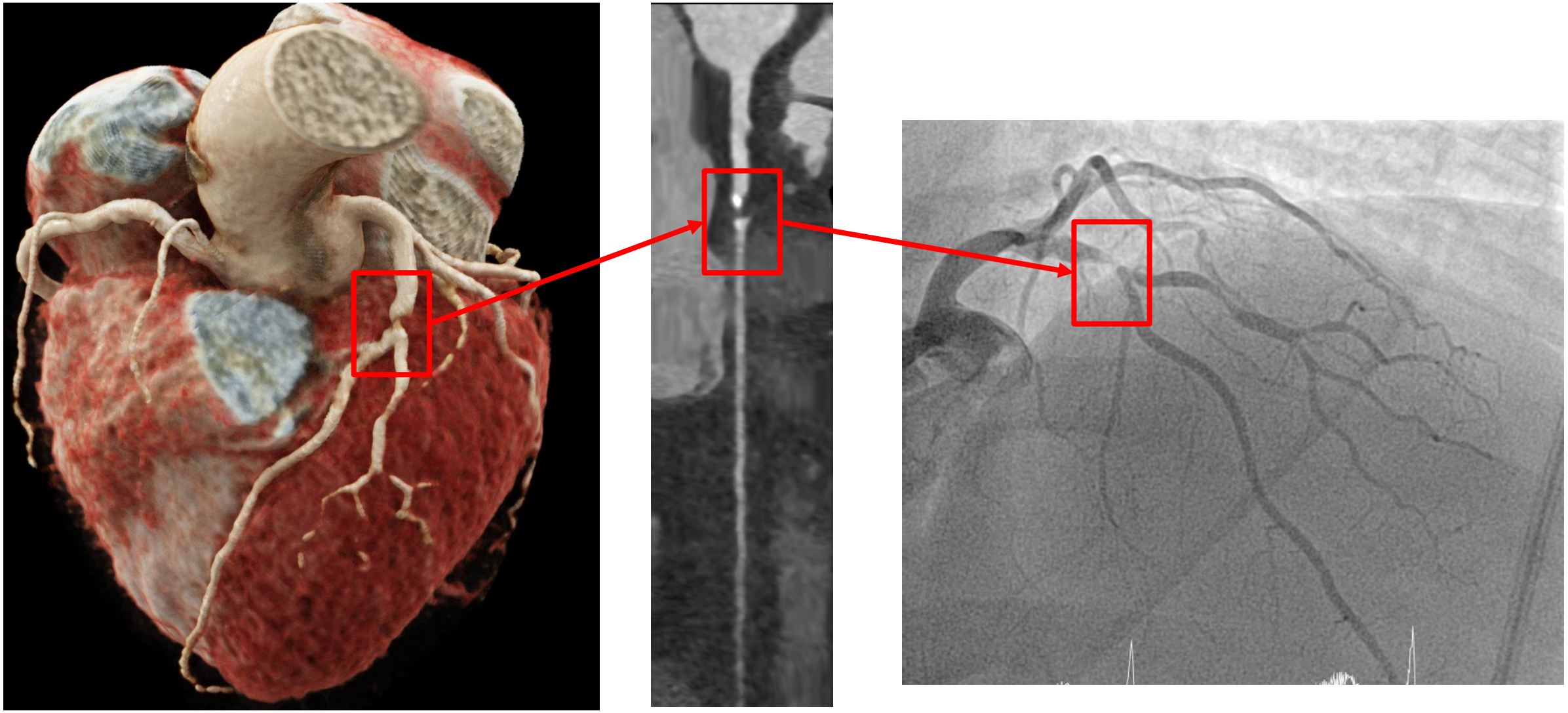


Clerc OF & Gräni C et al. Eur Radiol. doi: 10.1007/s00330-017-4849-1.

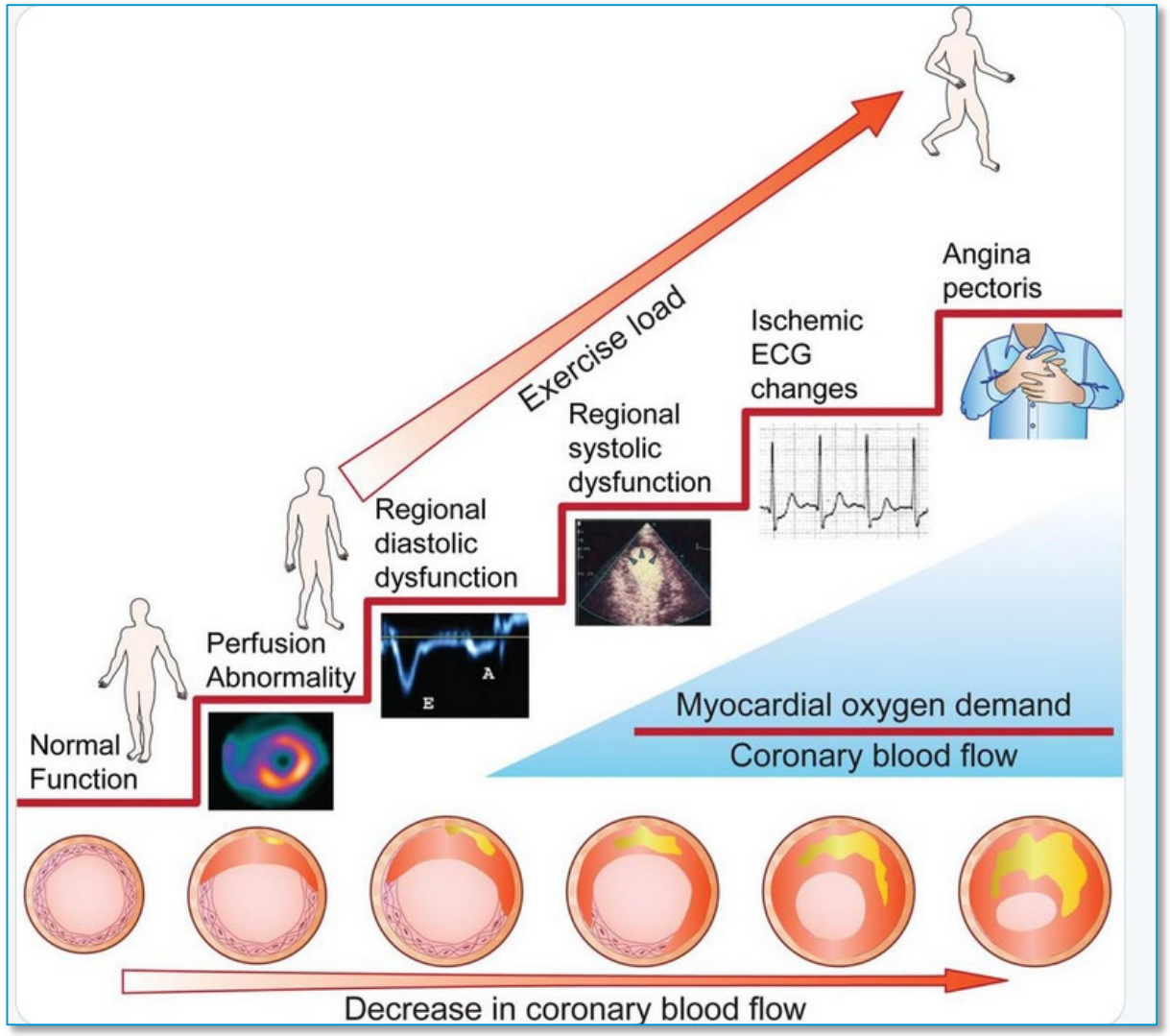
Beispiel 2

- 52 jährige Frau mit Hypertension
- Seit 3 Wochen brennenden retrosternalen Schmerzen bei Velofahren und Flachliegen. Häufiges Aufstossen.
- Vor zwei Wochen sei kardiale Abklärung. Labor und EKG sei unauffällig gewesen.
- Trotz PPI Einnahme bestehen Beschwerden

Beispiel 2

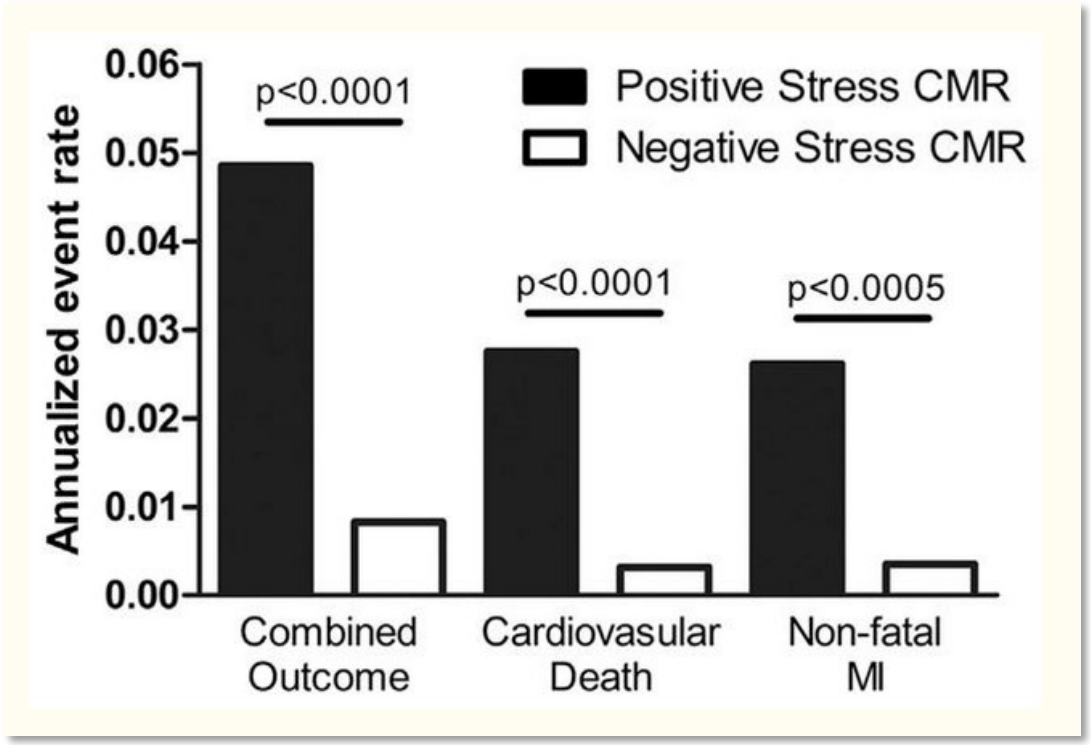


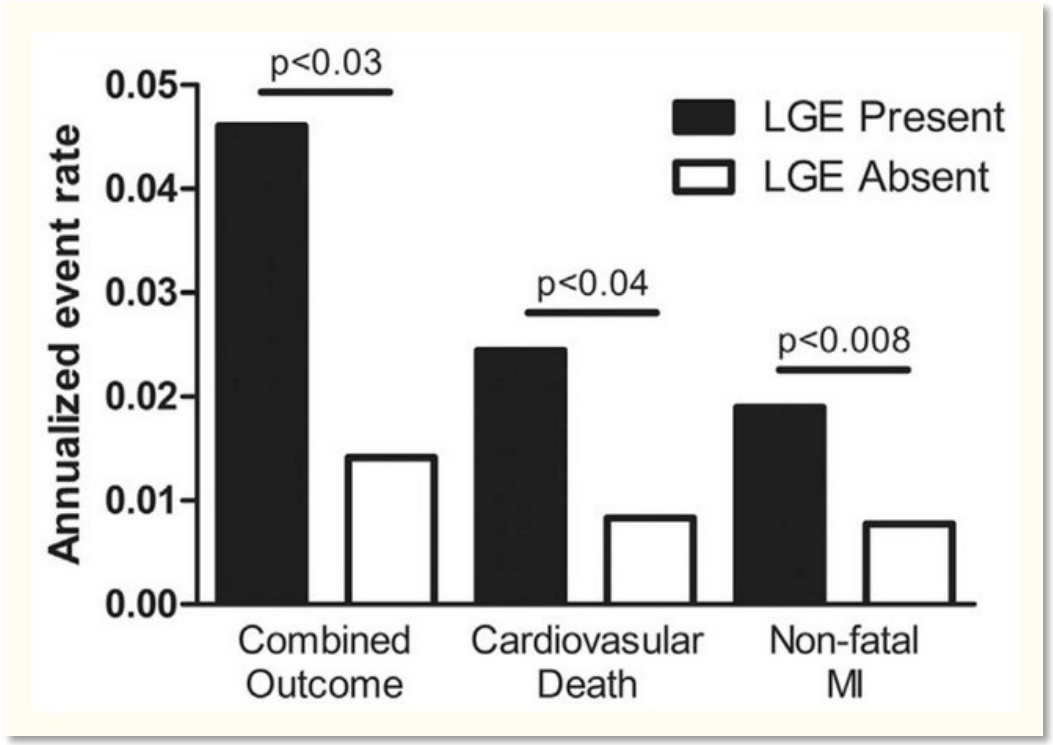
Ischämiekaskade



Stress- MRI Prognose

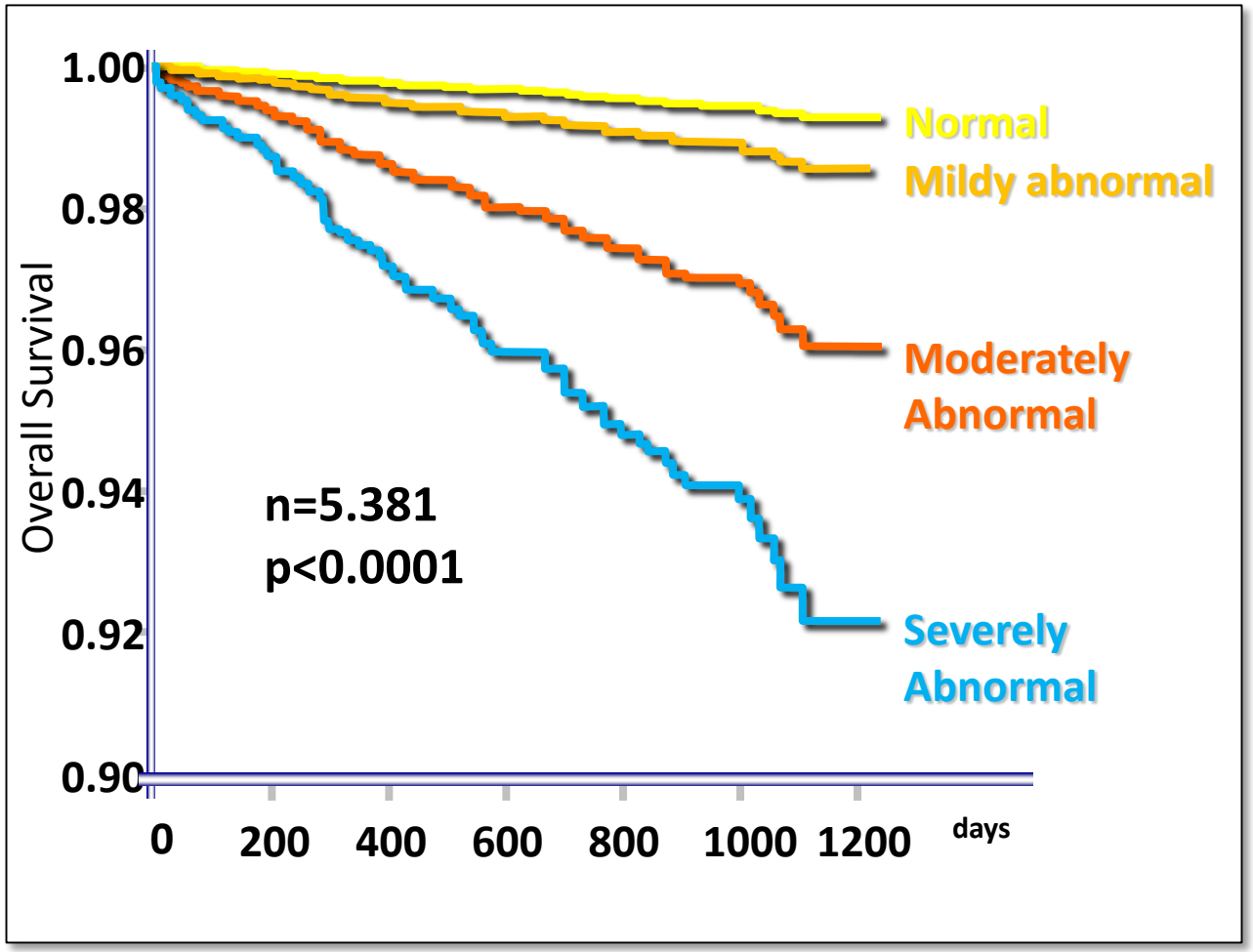
Meta-analyse: 11,636 Patienten mit bekannter oder Verdacht auf KHK



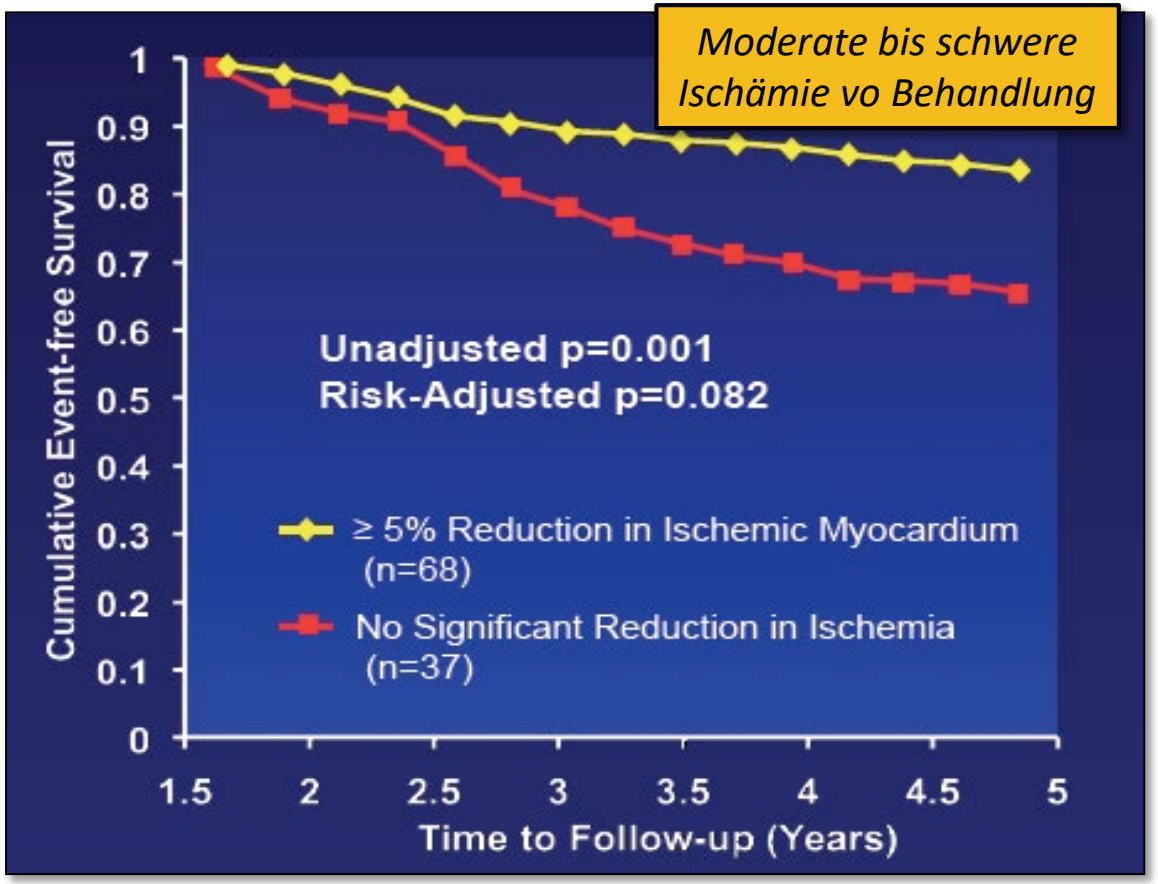


Lipinski MJ et al. J Am Coll Cardiol. 2013 Aug 27;62(9):826-38.

SPECT: Ist Ischämie prognostisch?



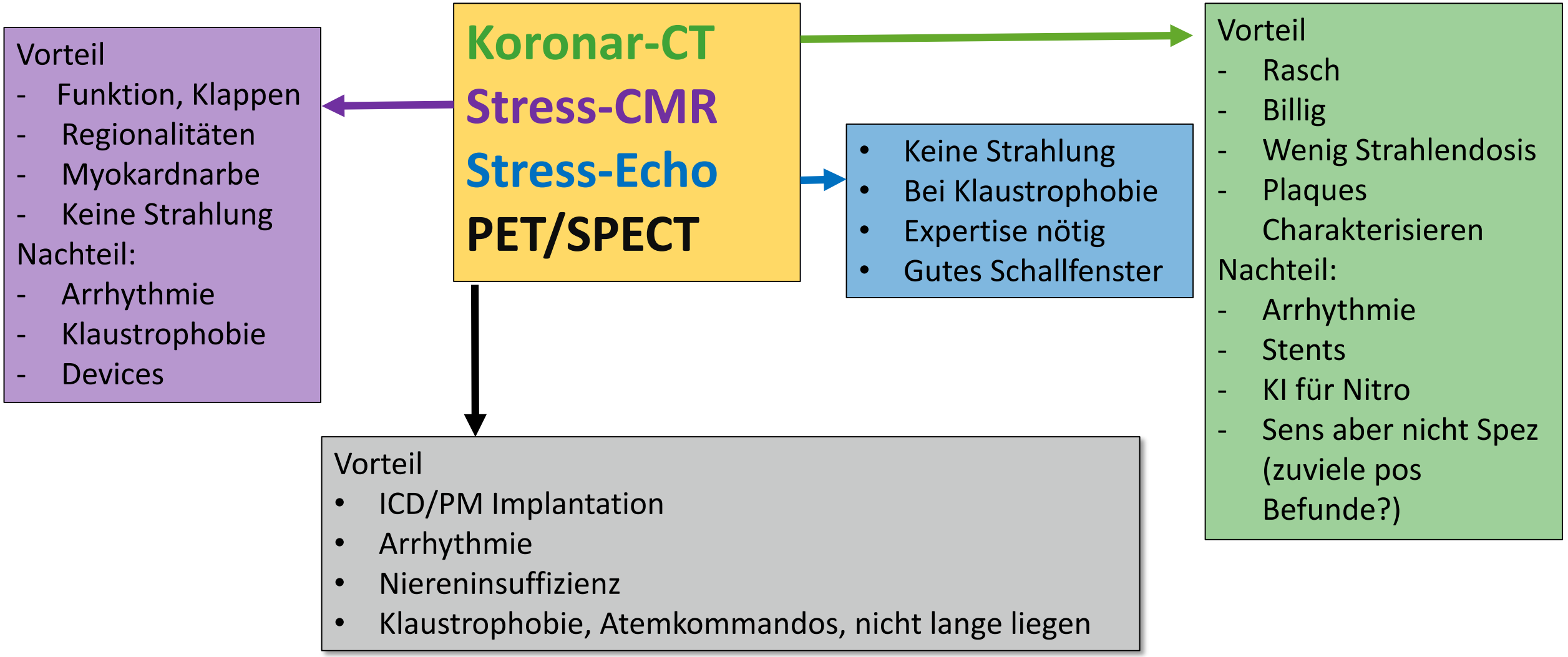
COURAGE Nuclear sub-studie



Hachamovitch R et al. Circulation. 1998 Feb 17;97(6):535-43.

Shaw LJ et al. Circulation. 2008 Mar 11;117(10):1283-91.

Welchen Test wählen bei der Abklärung der KHK?

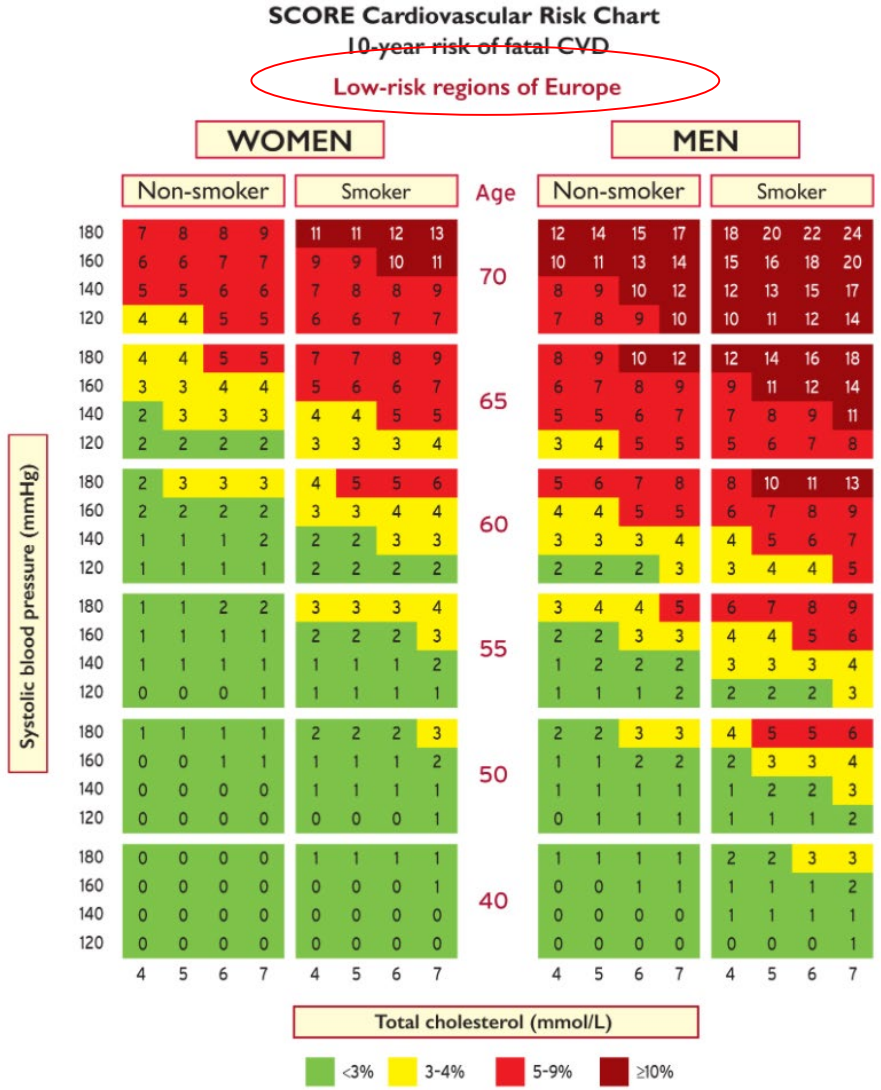


Agenda

Nicht-invasive Bildgebung bei:

- Asymptomatische Individuen

Einschätzung des kardiovaskulären Risikoprofils



Risikomodifikatoren

Social deprivation: the origin of many of the causes of CVD.
Obesity and central obesity as measured by the body mass index and waist circumference, respectively.
Physical inactivity.
Psychosocial stress including vital exhaustion.
Family history of premature CVD (men: <55 years and women: <60 years).
Chronic immune-mediated inflammatory disorder.
Major psychiatric disorders.
Treatment for human immunodeficiency virus infection.
Atrial fibrillation.
Left ventricular hypertrophy.
Chronic kidney disease.
Obstructive sleep apnoea syndrome.
Non-alcoholic fatty liver disease.

Mach F. et al. Eur Heart J. 2020 Jan 1;41(1):111-188.

Therapie bei asymptomatischen Patienten

	Total CV risk (SCORE) %	Untreated LDL-C levels					
		<1.4 mmol/L (55 mg/dL)	1.4 to <1.8 mmol/L (55 to <70 mg/dL)	1.8 to <2.6 mmol/L (70 to <100 mg/dL)	2.6 to <3.0 mmol/L (100 to <116 mg/dL)	3.0 to <4.9 mmol/L (116 to <190 mg/dL)	≥4.9 mmol/L (≥190 mg/dL)
Primary prevention	<1, low-risk	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	I/C	I/C	I/C	I/C	IIa/A	IIa/A
	≥1 to <5, or moderate risk (see *Table 4*)	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	I/C	I/C	IIa/A	IIa/A	IIa/A	IIa/A
	≥5 to <10, or high-risk (see *Table 4*)	Lifestyle advice	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/A	IIa/A	IIa/A	I/A	I/A	I/A
	≥10, or at very-high risk due to a risk condition (see *Table 4*)	Lifestyle advice	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/B	IIa/A	I/A	I/A	I/A	I/A
Secondary prevention	Very-high-risk	Lifestyle intervention, consider adding drug if uncontrolled	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention	Lifestyle intervention and concomitant drug intervention
	Class[a]/Level[b]	IIa/A	I/A	I/A	I/A	I/A	I/A

© ESC 2019

Mach F. et al. Eur Heart J. 2020 Jan 1;41(1):111-188.

Kalziumscore

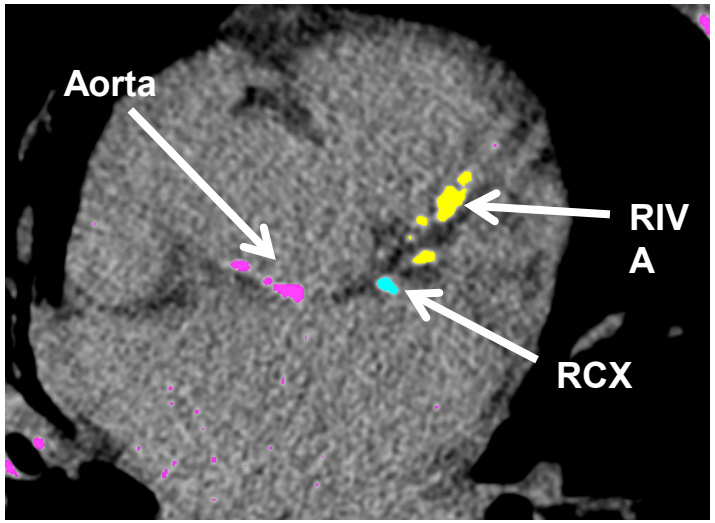
- Bei asymptomatischen Patienten mit schwierig einzuschätzendem kardiovaskulärem Risikoprofil
- Guter Prädiktor für kardiovaskuläre Events
- Nativ CT nur über Herz, keine Nadel, kein Kontrastmittel, keine Medikamente, schnell
- Tiefe Strahlendosis (0.1-0.6mSv)*

- CAVE: Koronar-CT bei hochrisiko Patienten erwägen**

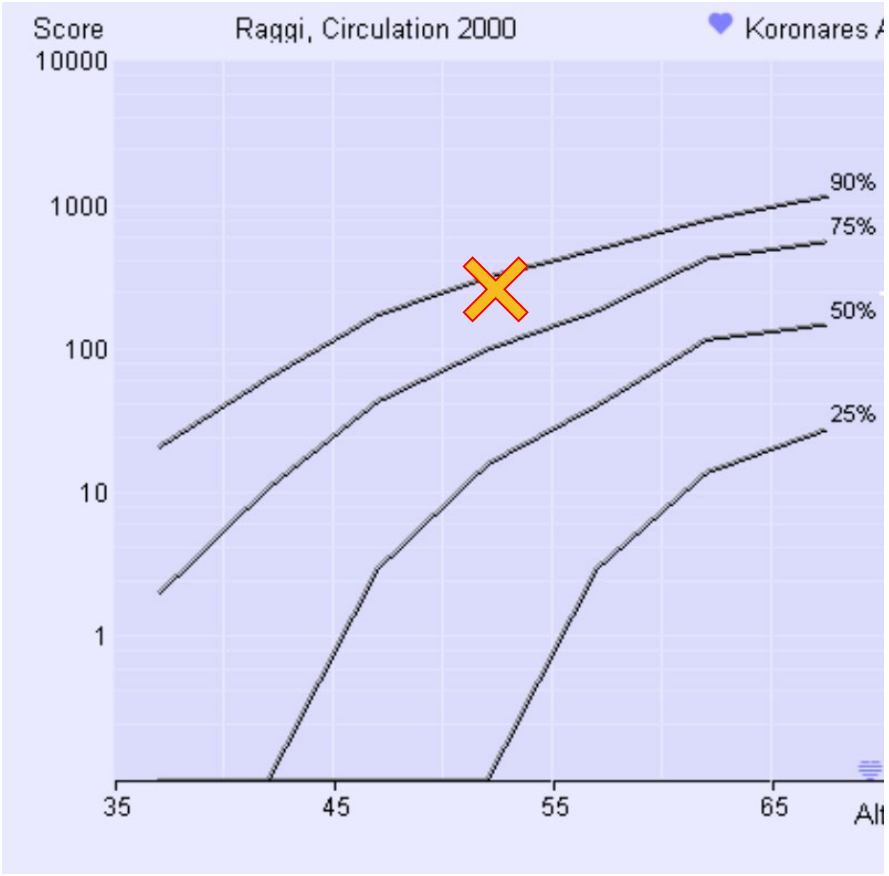
*Gräni C. et al. Eur Heart J Cardiovasc Imaging. 2018 Feb 8.

**Mach F. et al. Eur Heart J. 2020 Jan 1;41(1):111-188.

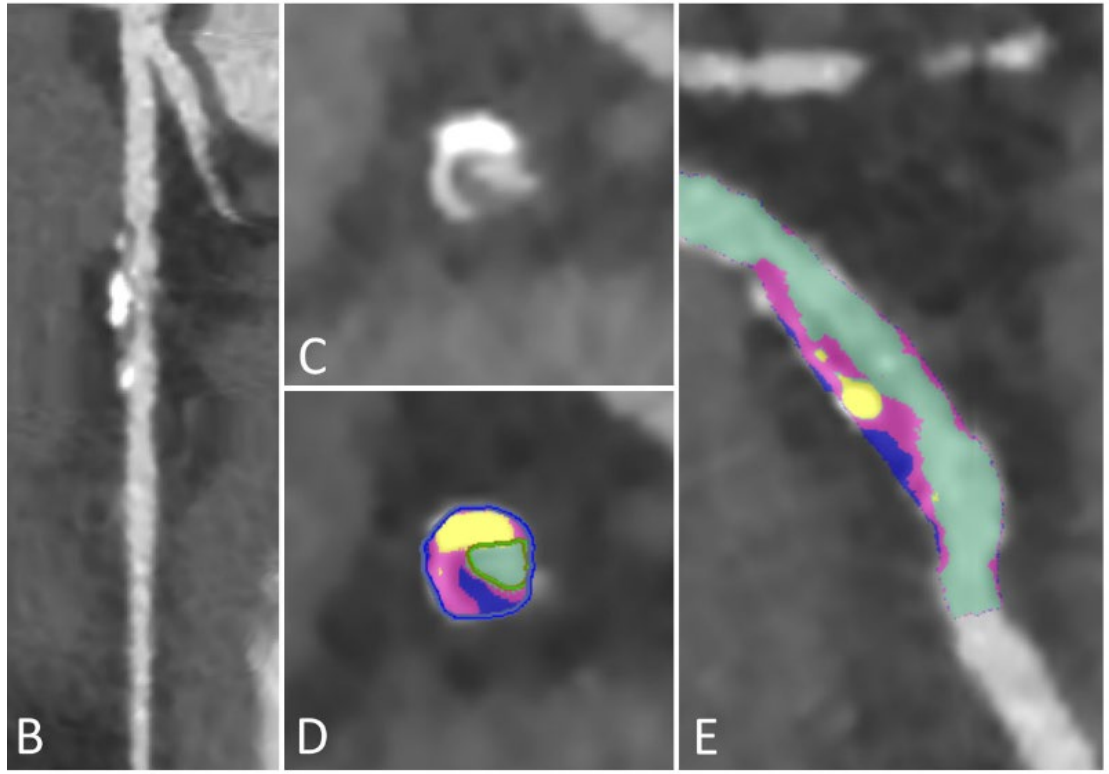
Kalziumscore:



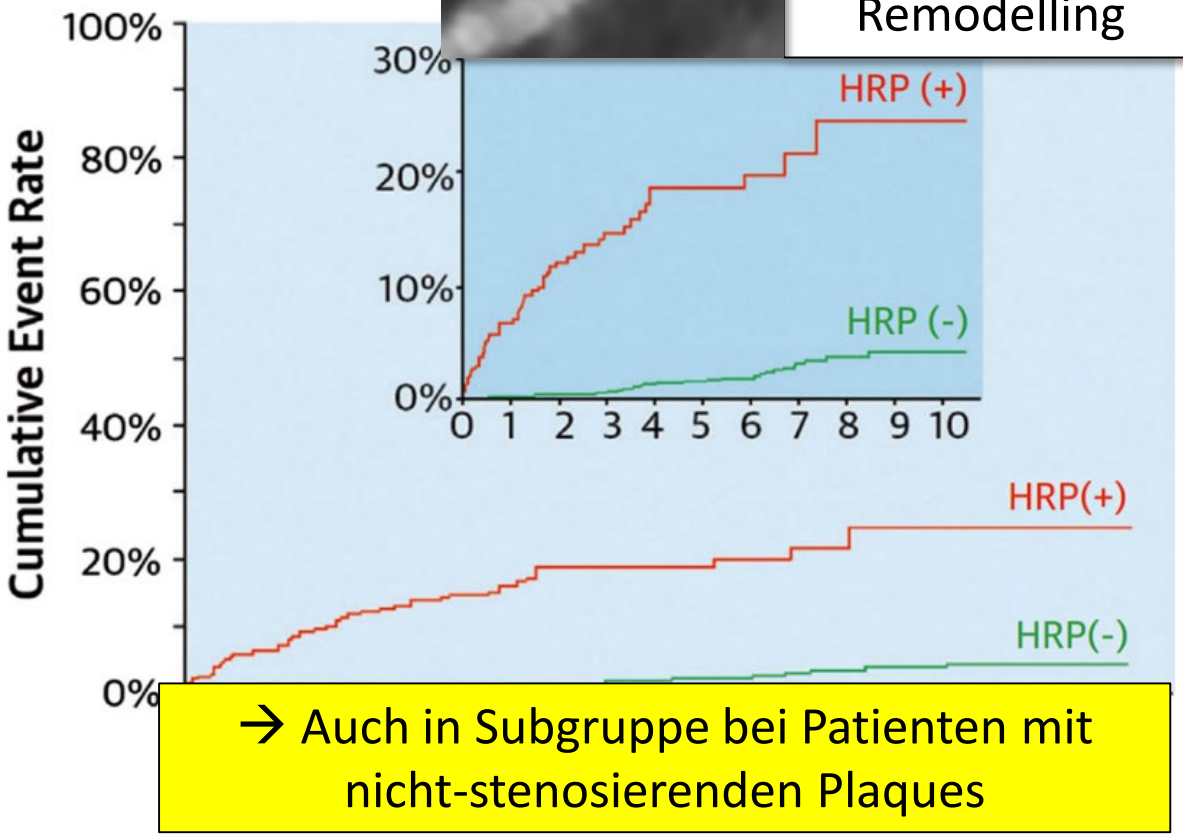
Arterie	Läsionen	Volumen/mm³	Äquiv. Masse/mg	Score
LM	0	0.0	0.00	0.0
LAD	4	180.9	37.91	221.2
CX	2	14.7	2.19	10.7
RCA	0	0.0	0.00	0.0
Total	**6**	**195.6**	**40.11**	**231.9**
U1	0	0.0	0.00	0.0
U2	0	0.0	0.00	0.0



Welche weitere Vorteile hat das Koronar-CT?



Hoch-risiko Plaques: tiefe Attenuation <30 HU, positives Remodelling

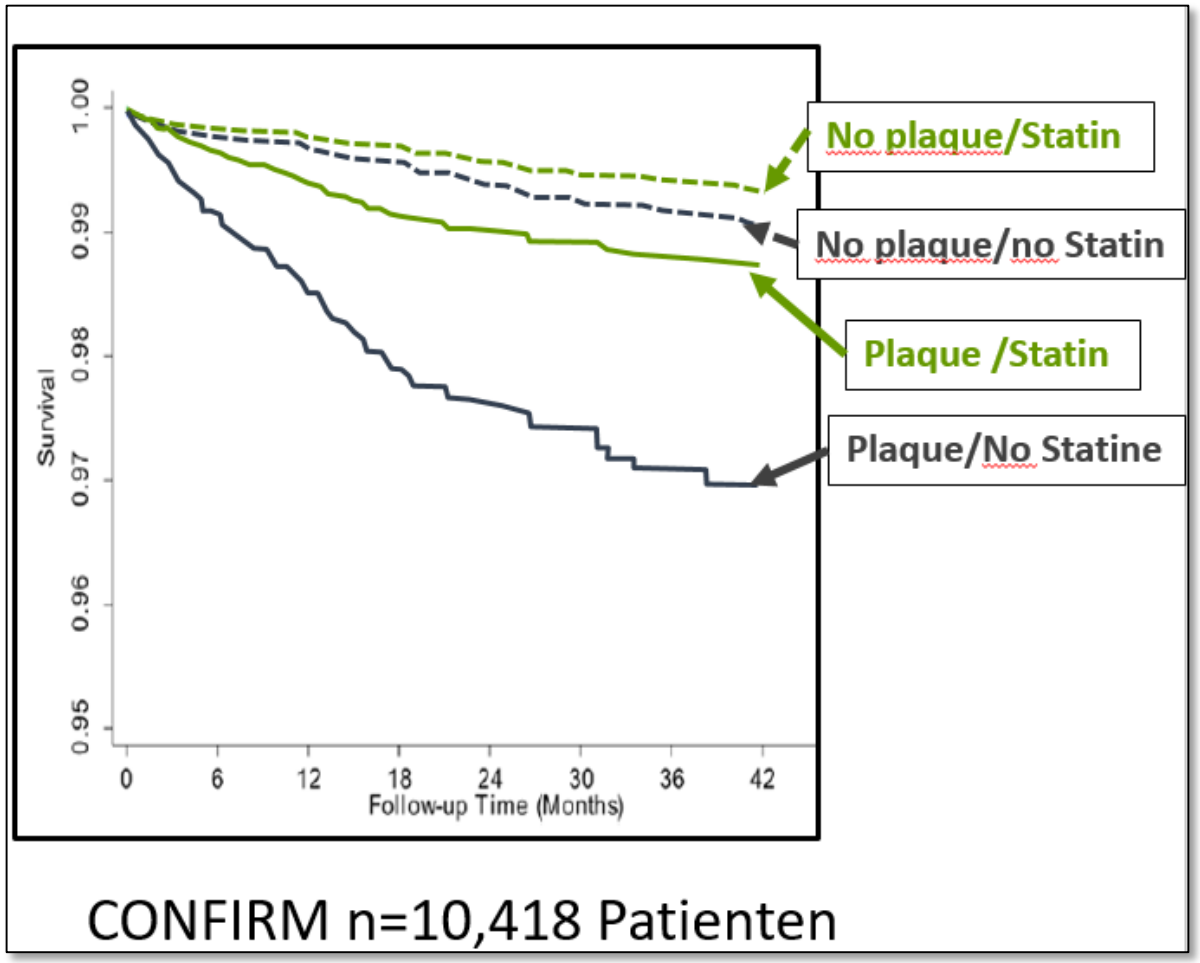


→ Auch in Subgruppe bei Patienten mit nicht-stenosierenden Plaques

Giannopoulos AA & Gräni C et al. J Nucl Cardiol. 2017 Jul.

Motoyama S et al. J Am Coll Cardiol 2015;66:337-46.

Statine Verbessern das Outcome bei Patienten mit nicht-stenosierender Koronarsklerose



Multivariable Analyse:
6% höheres Risiko für jedes zusätzliche Segment mit nicht-obstruktiver Plaque (*P*=0.021)

Chow BJ et al. Arterioscler Thromb Vasc Biol. 2015 Apr;35(4):981-9

Kalziumscore: Wann einsetzten? Und wie bestimmt der CACS die Therapie?

TABLE 2 Summary of 4 Major Guidelines and Expert Consensus Documents on Use of Coronary Artery Calcium for Risk Assessment in Asymptomatic Patients

Guideline/Statement	Summary of CT Recommendations
2013 ACC/AHA risk assessment guideline	If, after quantitative risk assessment using traditional risk factors, a risk-based treatment decision is uncertain, CAC score may be considered to inform treatment decision making. Class IIb, Level of Evidence: B (7).
2016 European guidelines on CVD prevention	CAC scoring may be considered as a risk modifier in CV risk assessment. Class IIb, Level of Evidence: B (8).
2017 expert consensus from the Society of Cardiovascular Computed Tomography	It is appropriate to perform CAC testing in the context of shared decision making for asymptomatic individuals without clinical ASCVD who are 40–75 years of age in the 5%–20% ten-year ASCVD risk group and selectively in the <5% ASCVD risk group, such as those with a family history of premature CAD (91).
2018 U.S. Preventive Services Task Force draft guideline on nontraditional risk factors	In asymptomatic adults, the current evidence is insufficient to assess the balance of benefits and harms of adding CAC score to traditional risk assessment for CVD prevention. Class I (123).

ACC — American College of Cardiology; AHA — American Heart Association; ASCVD — atherosclerotic cardiovascular disease; other abbreviations as in Table 1.

CENTRAL ILLUSTRATION: Proposed Decision-Making Approach to Selective Use of Coronary Artery Calcium Measurement for Risk Prediction

Using 10-year ASCVD risk estimate plus coronary artery calcium (CAC) score to guide statin therapy				
Patient's 10-year atherosclerotic cardiovascular disease (ASCVD) risk estimate:	<5%	5–7.5%	>7.5–20%	>20%
Consulting ASCVD risk estimate alone	Statin not recommended	Consider for statin	Recommend statin	Recommend statin
Consulting ASCVD risk estimate + CAC				
If CAC score =0	Statin not recommended	Statin not recommended	Statin not recommended	Recommend statin
If CAC score >0	Statin not recommended	Consider for statin	Recommend statin	Recommend statin
Does CAC score modify treatment plan?	✗ CAC not effective for this population	✓ CAC can reclassify risk up or down	✓ CAC can reclassify risk up or down	✗ CAC not effective for this population

Greenland, P. et al. J Am Coll Cardiol. 2018;72(4):434–47.

Take Home Message

- ✓ **Akute Thoraxschmerzen:**
  - ✓ EKG, Herzenzyme → invasive Koronarangiographie
  - ✓ Bei low-risk Koronar-CT erwägen

- ✓ **Abklärung von stabilen Thoraxschmerzen: nichtinvasive Bildgebung**
  - ~~"One size fits all"~~
  - Eher tiefe Likelihood→ Koronar-CT
  - Eher intermdiäre Likelihood oder bekannte KHK→ funktioneller Test
  - Wahl des Test richtet sich nach Ko-Morbiditäten + Expertise des Untersuchers/ Zentrums

- ✓ **Asymptomatische Patienten:**
  - Risikostratifizierung ab 40 Jahren nach ESC Guidelines (SCORE)
  - Kalziumscore oder Koronar-CT bei selektionierten intermediär-höher Risiko Patienten

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HOPITAL UNIVERSITAIRE DE BERNE
BERN UNIVERSITY HOSPITAL

Vielen Dank für die Aufmerksamkeit

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