

Coronary interventions and imaging

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v. 2020

Fascination by HEART... for a long time

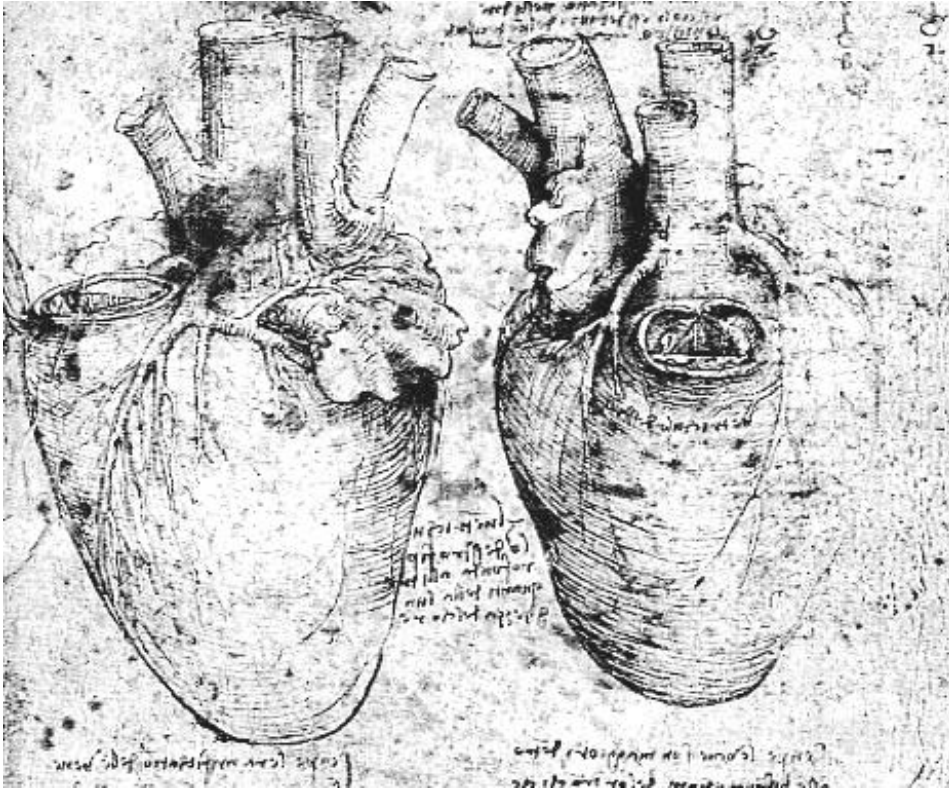
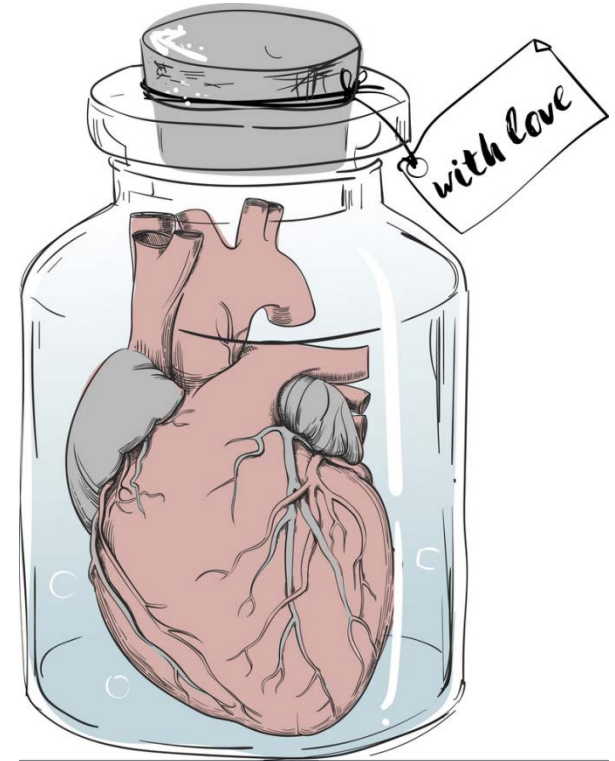
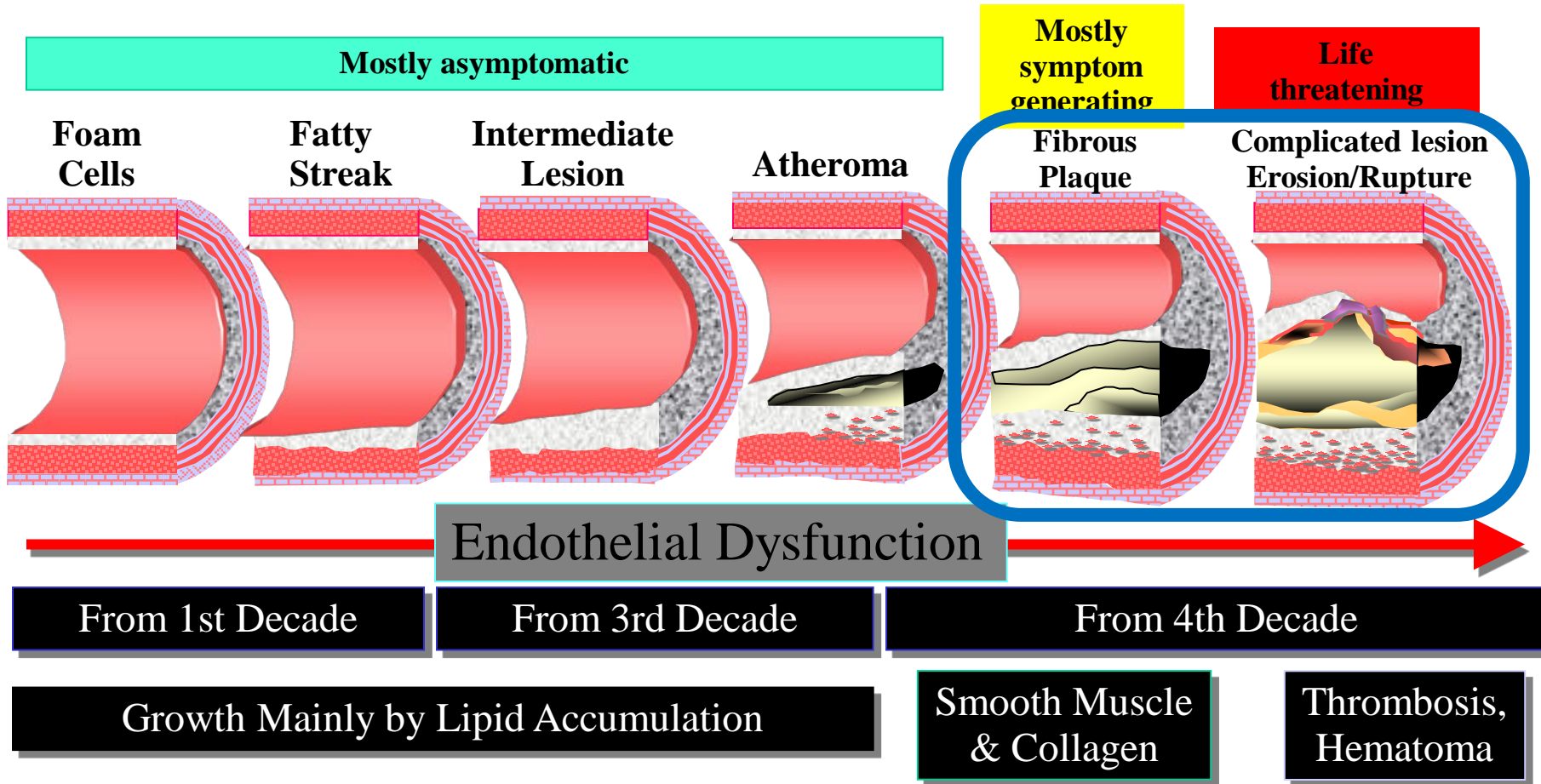


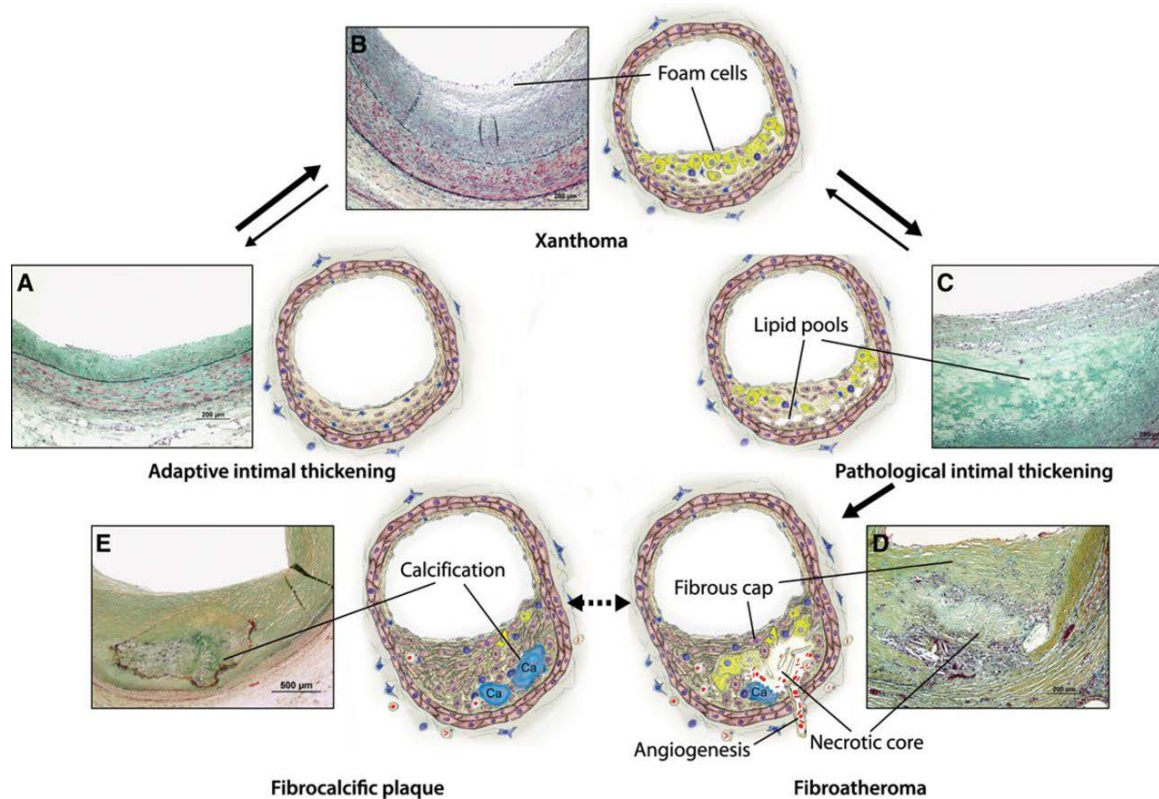
Image source: <https://leonardodavinci.stanford.edu/projects/anatomy/heart1.jpg>



The Evolution of Atherosclerosis



Mechanism of plaque formation



Coronary artery disease (CAD)

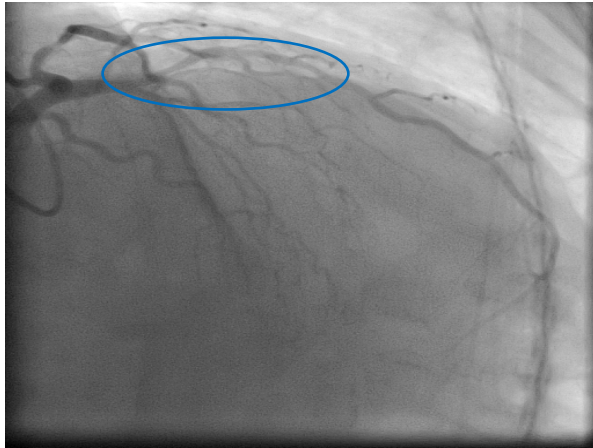
- Myocardial ischemia mainly due to the atherosclerosis
- Definition is based on the angiography
 - Stenoses $\geq 50\%$ (*i.e. the „old“ definition though still broadly accepted*)
 - respecting the limitations of angiography, more appropriate is to divide the lesions in two groups
 - 40-70% moderate or borderline lesions
 - $>70\%$ significant lesions (..mostly)
 - Total occlusions
 - Acute
 - Chronic (>3 months)

Woman, 71yo

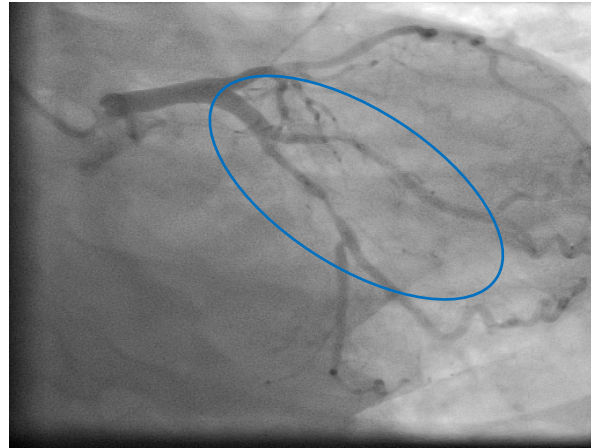
CAD for 3 months with progression in Unstable angina, NYHA II-III

Risk factors: Hypertension, Hyperlipidemia

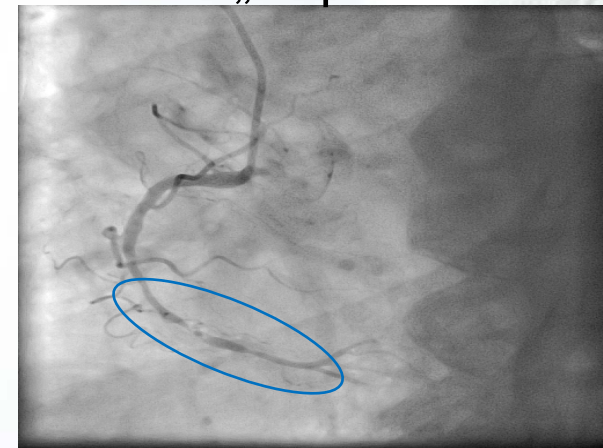
LAD



LCX - OM



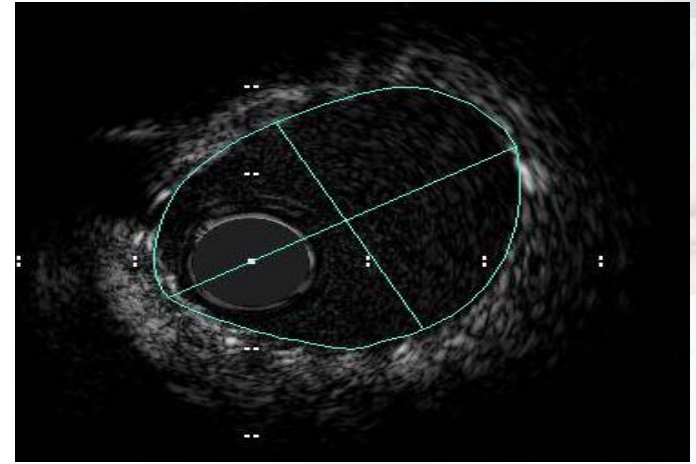
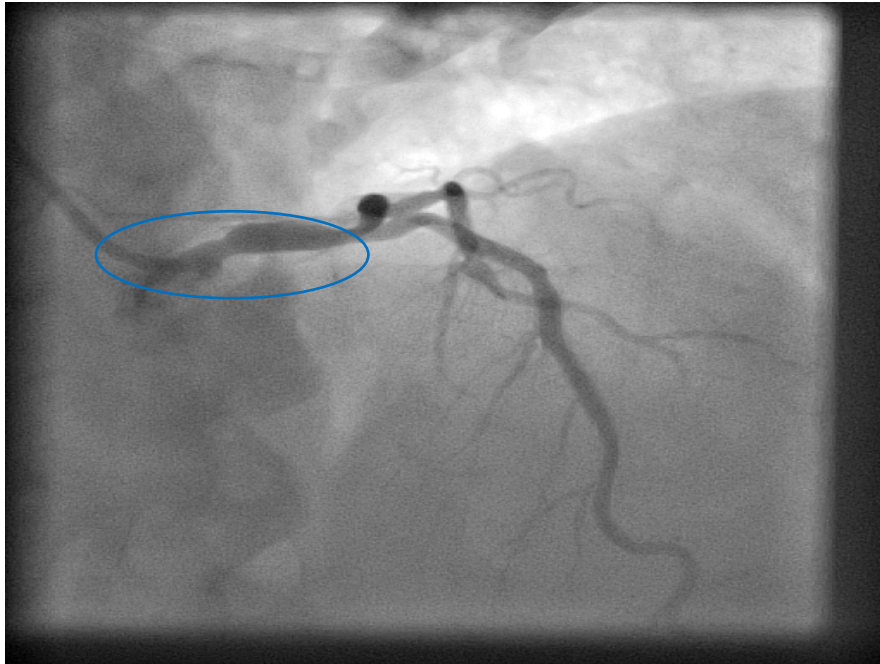
RCA – „culprit“ lesion



- 3VD, normal LVEF → HEARTteam → FAME 3 trial → patient was randomized in FFR-guided PCI (cut-off for revascularization 0.80)

Woman, 68yo

CAD w/o angina, dyspnea NYHA III, LVEF 67%, history of PCI + DES of LAD, LCx, RCA

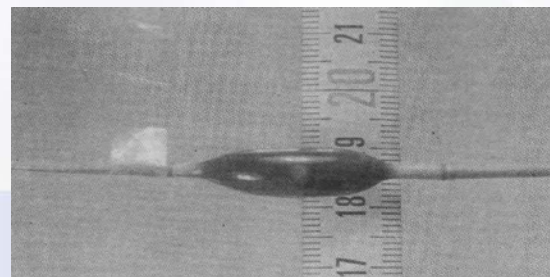
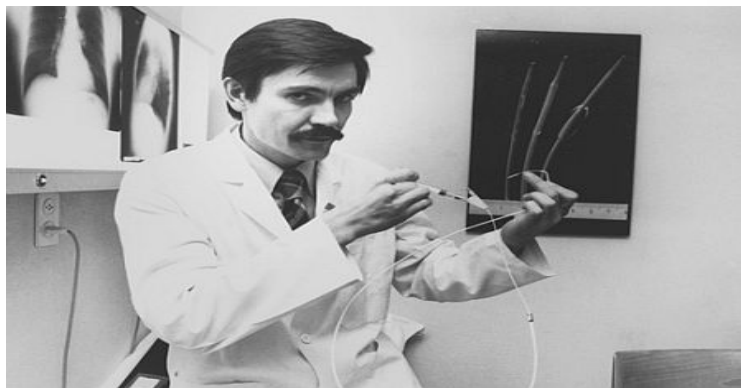


Intravascular ultrasound - IVUS

MLA - Minimal lumen area of the Left main stem (LM) = 7,1 mm² = conservative Tx
(cut-off for revascularization of LM \leq 6mm²)



Sones - 1958 Gruentzig - 1977

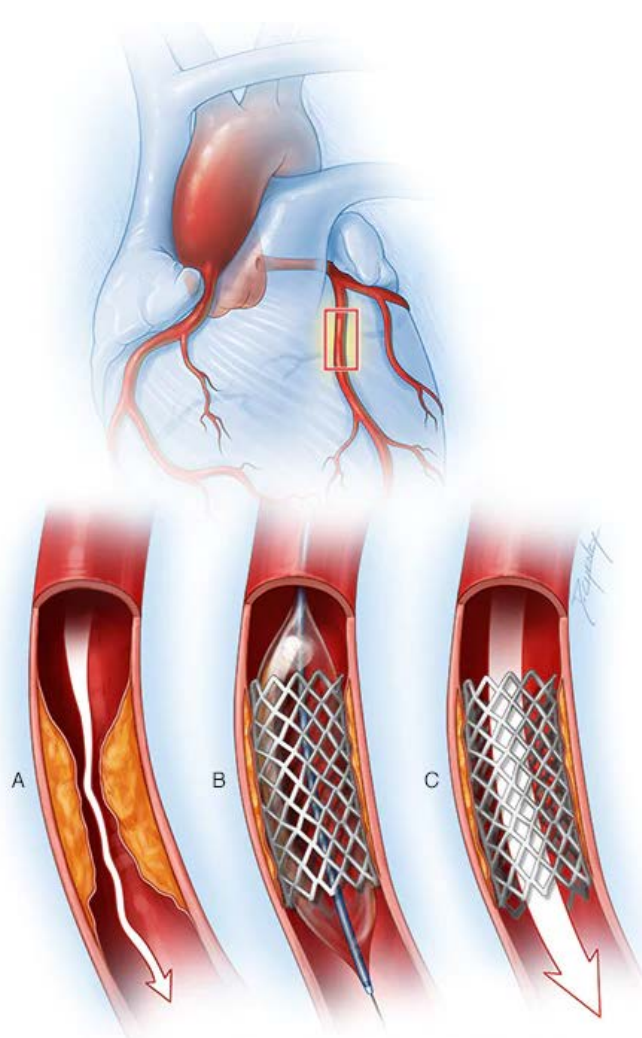


History of PCI/PTCA

**(PCI = percutaneous coronary intervention;
PTCA = percutaneous transluminal coronary angioplasty)**

- 1958 - selective coronary angiography
- **1977 - balloon angioplasty (POBA)**
- **1983 – mechanical reperfusion in acute myocardial infarction (AMI)**
- **1986 – intracoronary stenting**
- **1995 – stenting in AMI**
- **2001 – drug-eluting stents**

Coronary stenting



Coronary interventions

Types of lesions and techniques

1-3 diseased coronary arteries may be treated by PCI

Types of lesions:

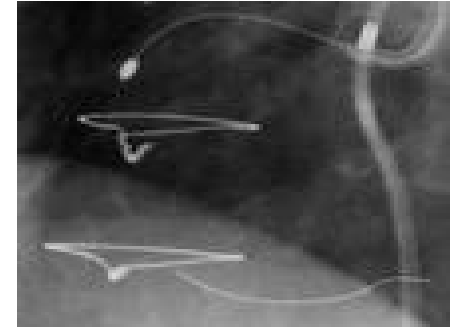
A, B1, B2, C (i.e. from simple, discrete to long, diffuse and/or chronic total occlusions)

CAD forms:

Chronic Coronary Syndrome - stable angina, silent ischemia

Acute Coronary Syndrome (ACS) - unstable angina (UA), acute myocardial infarction (AMI) with or without ST elevations = STEMI or NSTEMI

- **Stenting (>90-95%)**
- **Ballooning**
- **Atherectomy**
 - Rotational
 - Direct
- **Laser, ultrasound**



Coronary interventions

Pharmacotherapy

Antiplatelet Tx

- **acetylosalicylic acid (ASA)** (chronic+acute..)
- **P2Y12 blockers** for oral administration
 - Ticlopidin
 - **Clopidogrel** (chronic..)
 - **Prasugrel** (acute..)
 - **Ticagrelor** (acute..)
- **P2Y12 blocker for i.v. administration**
 - Cangrelor (acute..)
- **Gp IIb/IIIa i.v. platelet blockers** (complications..)

Anticoagulation

- **Heparin**
 - Unfractionated
 - Low-mollecular weight
- **Bivalirudin**

PCI - Primary success rate and complications

- **Primary success in the cathlab = at the end of the procedure**
 - Stenoses > 90%
 - Acute occlusions > 85-90%
 - Chronic occlusions > 50% (up to 90% in dedicated centres)
- **Complications** (more often in acute patients)
 - Local 0.5 - 5% (radial vs. femoral approach)
 - Cardiac 0.5 - 2%

PCI - Cardiac complications

Acute (relatively rare and mostly well manageable in the cathlab)

- Distal embolization
- Slow-flow, no-reflow phenomenon
- Thrombosis
- Coronary vessel closure
- Arterial wall dissection

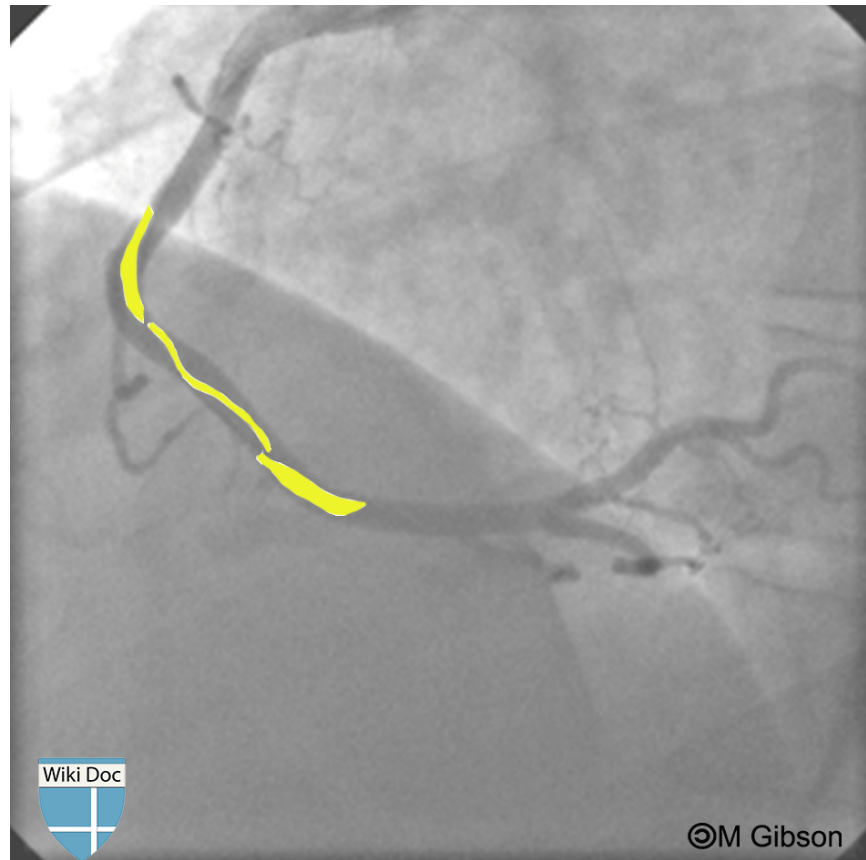
Late

- **Restenosis**
 - clinically 10-50% after POBA, 5-30% after bare-metal stenting and around 5% after DES)
 - anatomic rate is higher (based on the detection of $\geq 50\%$ stenosis)

Coronary dissection



©M Gibson

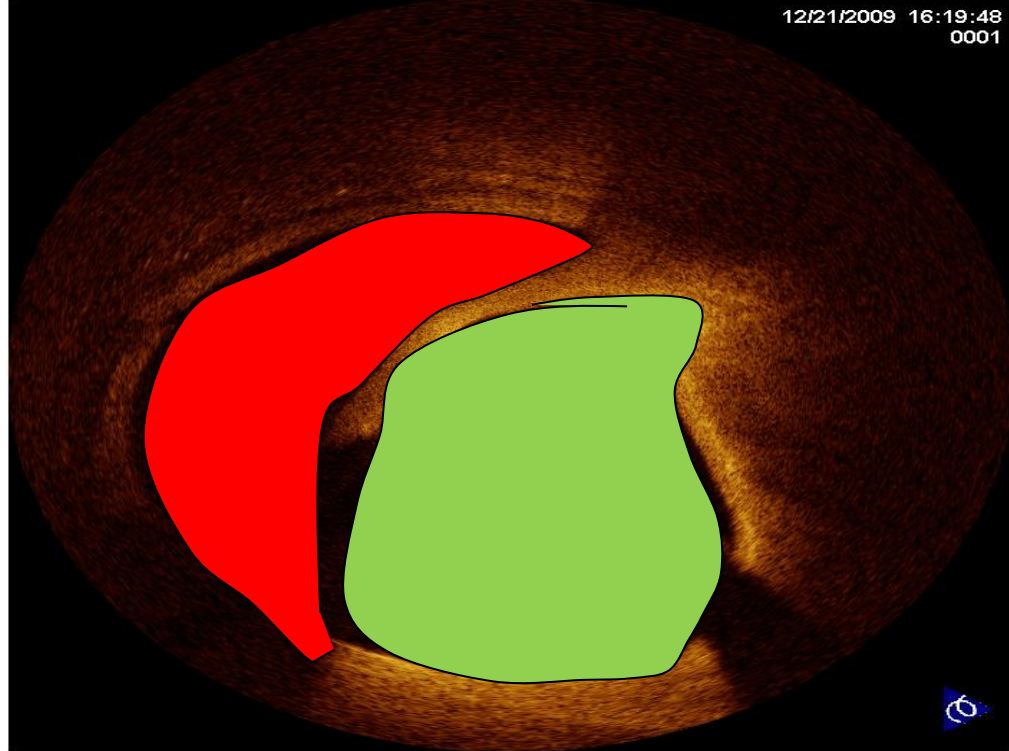
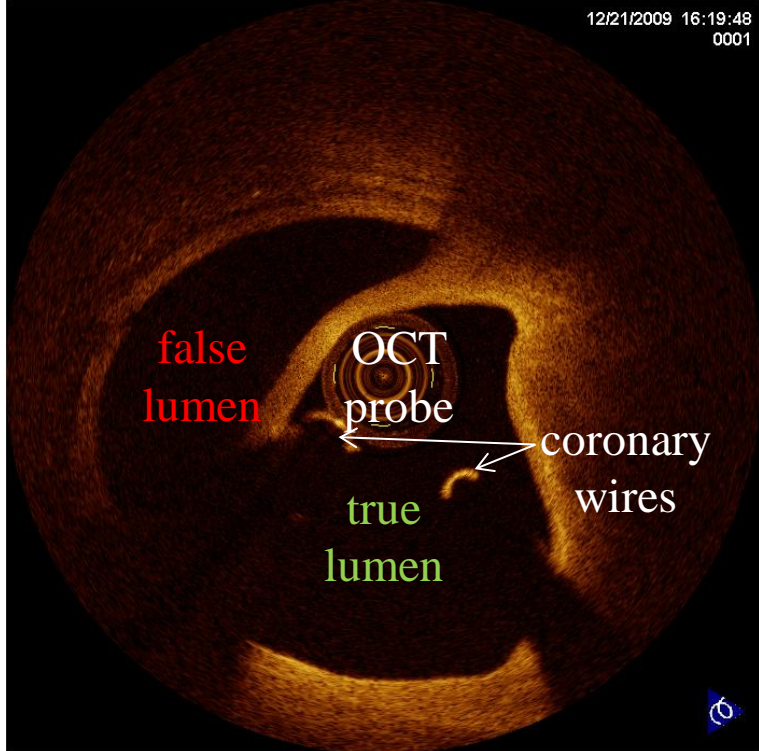


©M Gibson

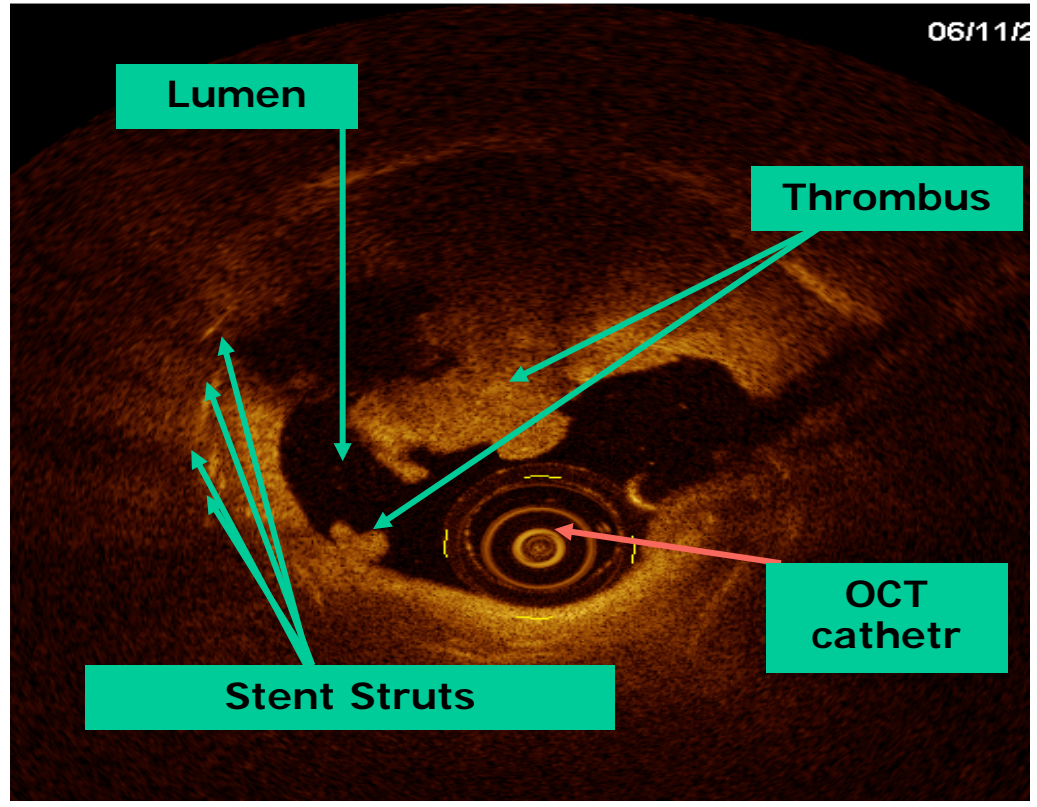
Courtesy: M. Gibson

Coronary dissection

OCT – optical coherent tomography: cross-sectional view



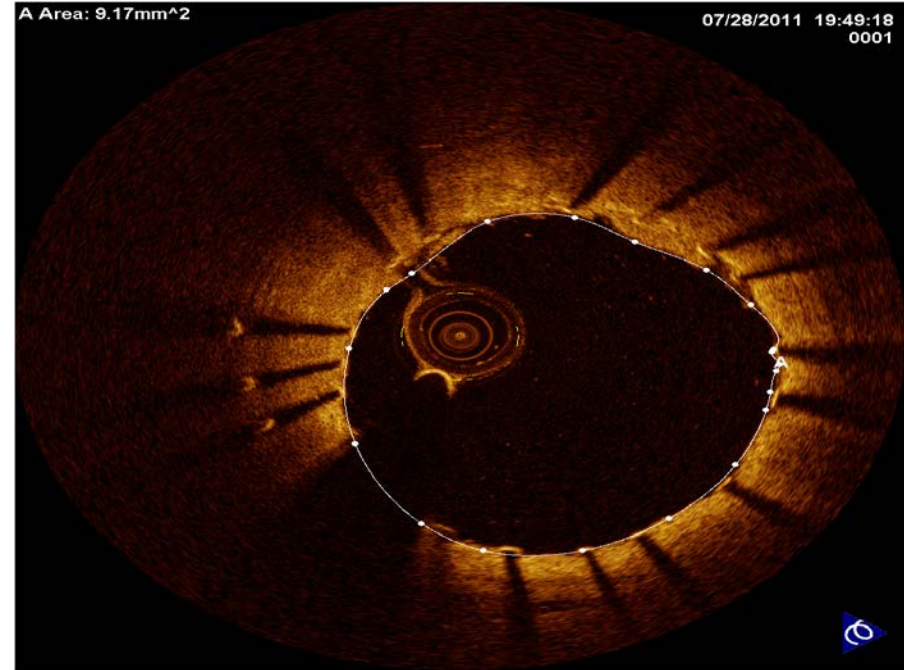
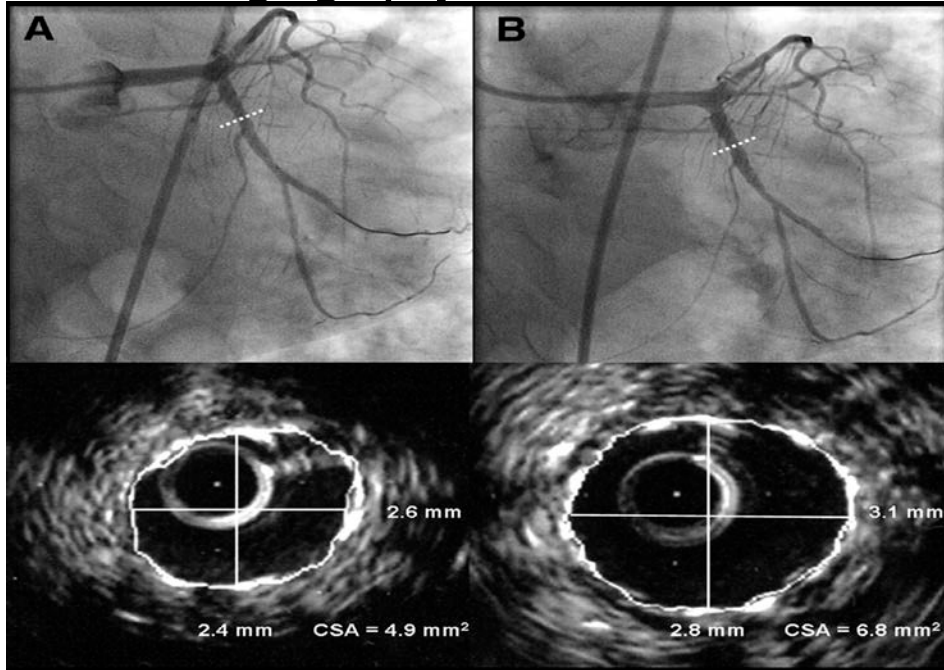
Acute in-stent thrombosis on OCT



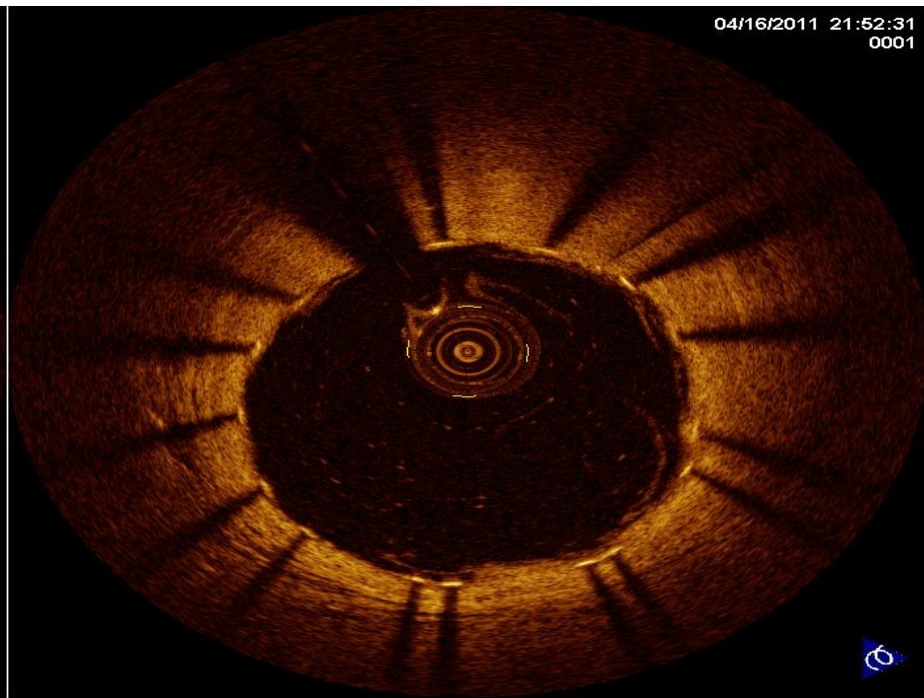
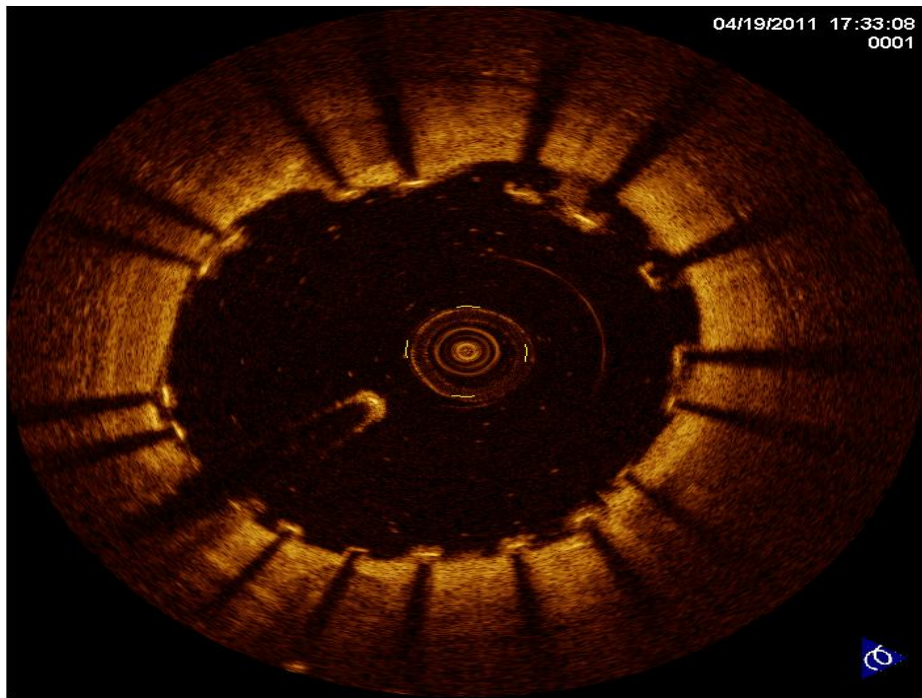
Optimal result after stenting avoids restenosis

Angiography and IVUS

OCT



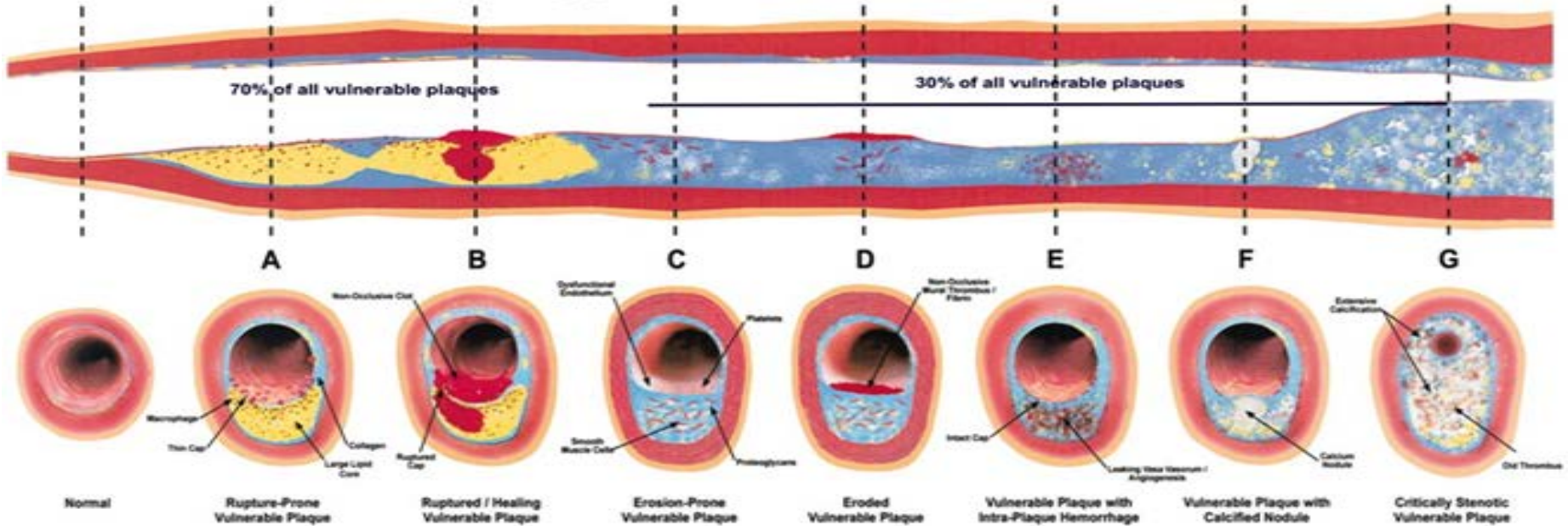
Incomplete vs. complete stent apposition on OCT

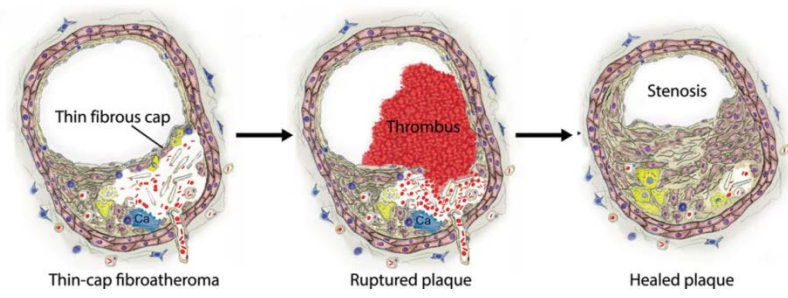


ACS - Acute Coronary Syndrome

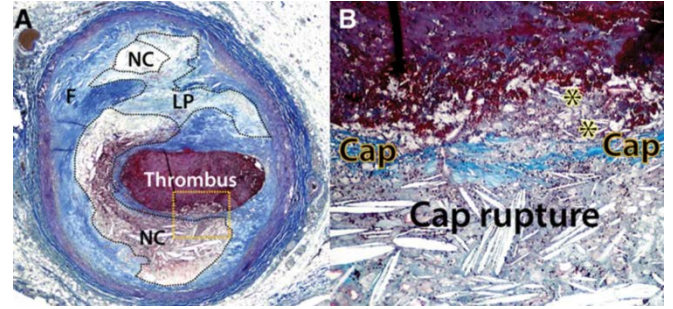
Typy nestabilního plátu

Different Types of Vulnerable Plaque

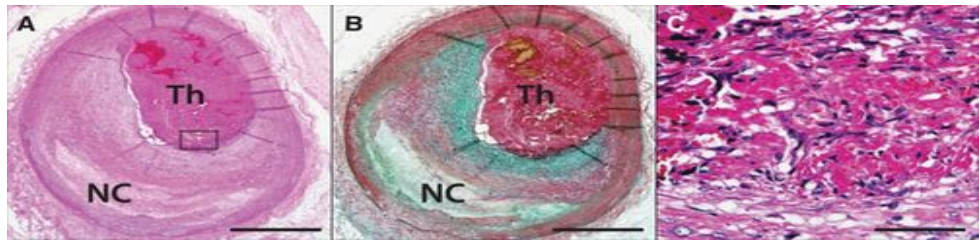




Plaque rupture and healing



Thrombosis caused by plaque rupture



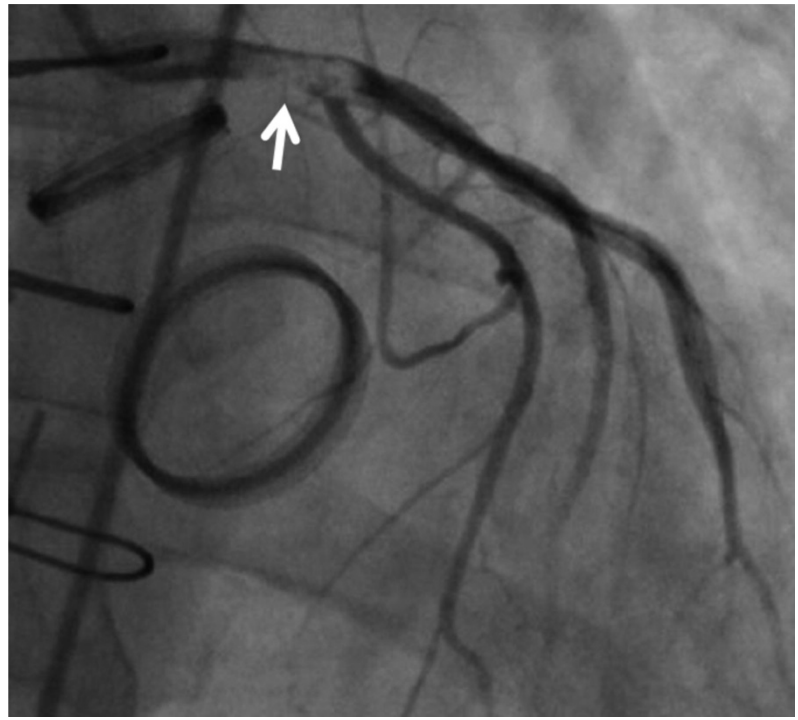
Plaque erosion



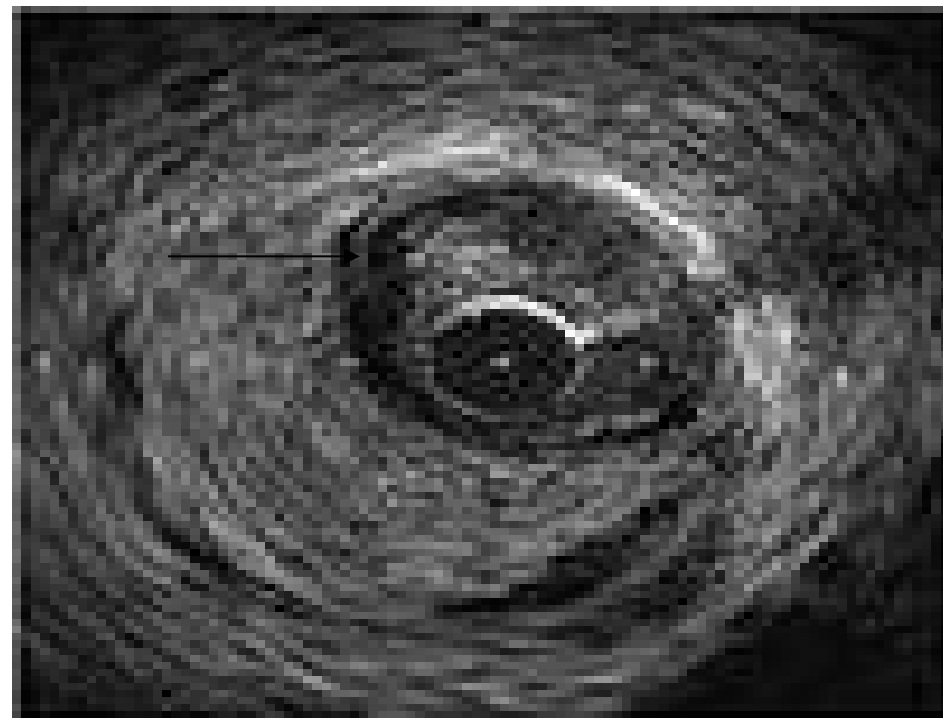
Jacob Fog Bentzon. Circulation Research. Mechanisms of Plaque Formation and Rupture, Volume: 114, Issue: 12, Pages: 1852-1866, DOI: (10.1161/CIRCRESAHA.114.302721)

Coronary thrombus

Coronary angiography




IVUS



UA and NSTEMI-ACS

Unstable Angina and non-STEMI Acute Coronary Syndrome

NSTE-ACS Risk stratification scores



ACS Risk Model

At Admission (in-hospital/to 6 months)
At Discharge (to 6 months)

Age

HR

SBP

Creat.

CHF

Cardiac arrest at admission

ST-segment deviation

Elevated cardiac enzymes/markers

Probability of	Death	Death or MI
In-hospital	<input type="text" value="--"/>	<input type="text" value="--"/>
To 6 months	<input type="text" value="--"/>	<input type="text" value="--"/>

[Calculator](#) |
 [Instructions](#) |
 [GRACE Info](#) |
 [References](#) |
 [Disclaimer](#)

GRACE Risk Score

Interpretation

Risk Score for NSTE-ACS
 Probability of In Hospital Death

Risk Category (tertiles)	GRACE Risk Score	Probability of Death In-Hospital (%)
Low	1 – 108	<1
Intermediate	109 – 140	1 – 3
High	141 – 372	>3

Probability of Death Post Discharge to 6 Months

Risk Category (tertiles)	GRACE Risk Score	Probability of Death Post-discharge to 6 Months (%)
Low	1 – 88	<3
Intermediate	89 – 118	3 – 8
High	119 – 263	>8

Risk Score for STE-ACS
 Probability of In Hospital Death

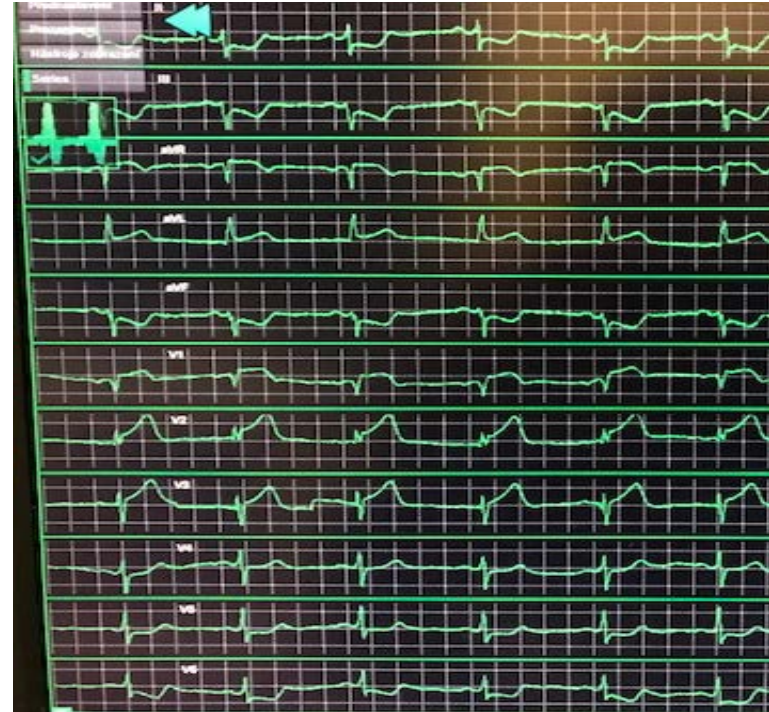
Risk Category (tertiles)	GRACE Risk Score	Probability of Death In-Hospital (%)
Low	1 – 88	<3
Intermediate	89 – 118	3 – 8
High	119 – 263	>8

Home
Calculation
Interpretation

STE-ACS = STEMI
ST-Elevation Acute Myocardial
Infarction

F, 71 yo, AW STEMI

- STEMI as first presentation of CAD
 - Symptom onset: Time 0
 - EMS call: 63 mins
 - Lifenet telemedicine – AW STEMI
 - **UFH 5000 IU + ASA 250mg i.v.,**
 - **Fentanyl 2cc i.v.**
 - Transport to CCU: 47 mins
 - Cathlab+20mins! puncture +8mins; wire+17min
 - End of primary PCI in 70 mins from the CCU admission
 - Killip III ... progression in Killip IV in the cathlab = Cardiogenic shock
 - History: Hypertension on **ACEI + BB**



F, 71 yo, AW STEMI

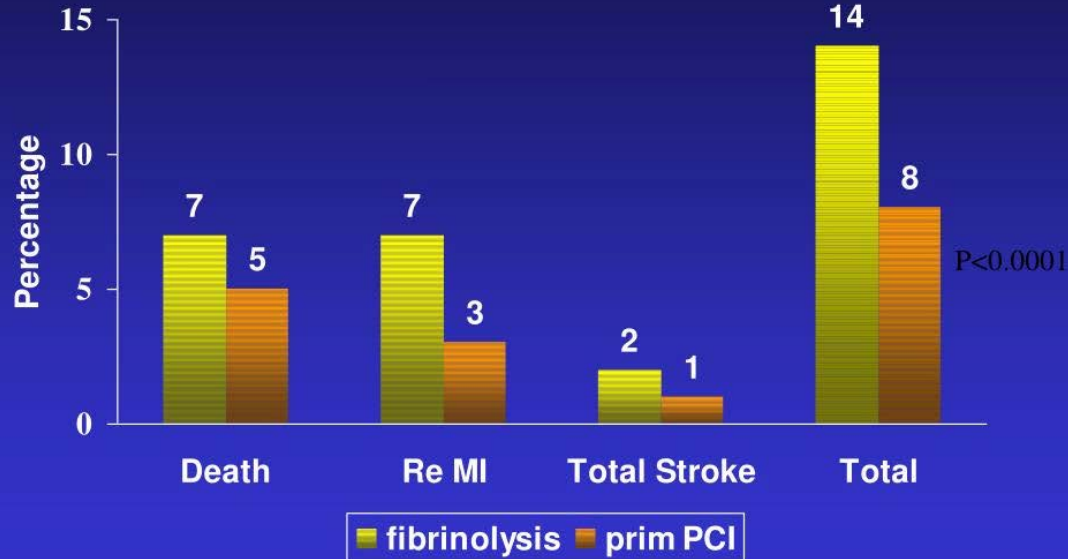
- **RADIAL** approach – 6F
- **MANUAL THROMBOASPIRATION**
- **DES**
- **HIGH-PRESSURE POSTDILATATION**
- **STENTING of LAD and LCx during the index procedure in patient with multi-vessel disease who was scheduled for staged non-culprit PCI of RCA in several weeks**
- **Adjunctive pharmacotherapy – Ticagrelor LD 180mg, GPI (abciximab bolus i.v.), furosemid, Noradrenalin**
- *Patient was discharged home after 5 days in good clinical status*

- Further Qs during the acute phase
 - Mechanical circulatory support? Timing? (IABP vs Impella vs ECMO?)
 - Imaging?



Primary PCI vs. fibrinolysis

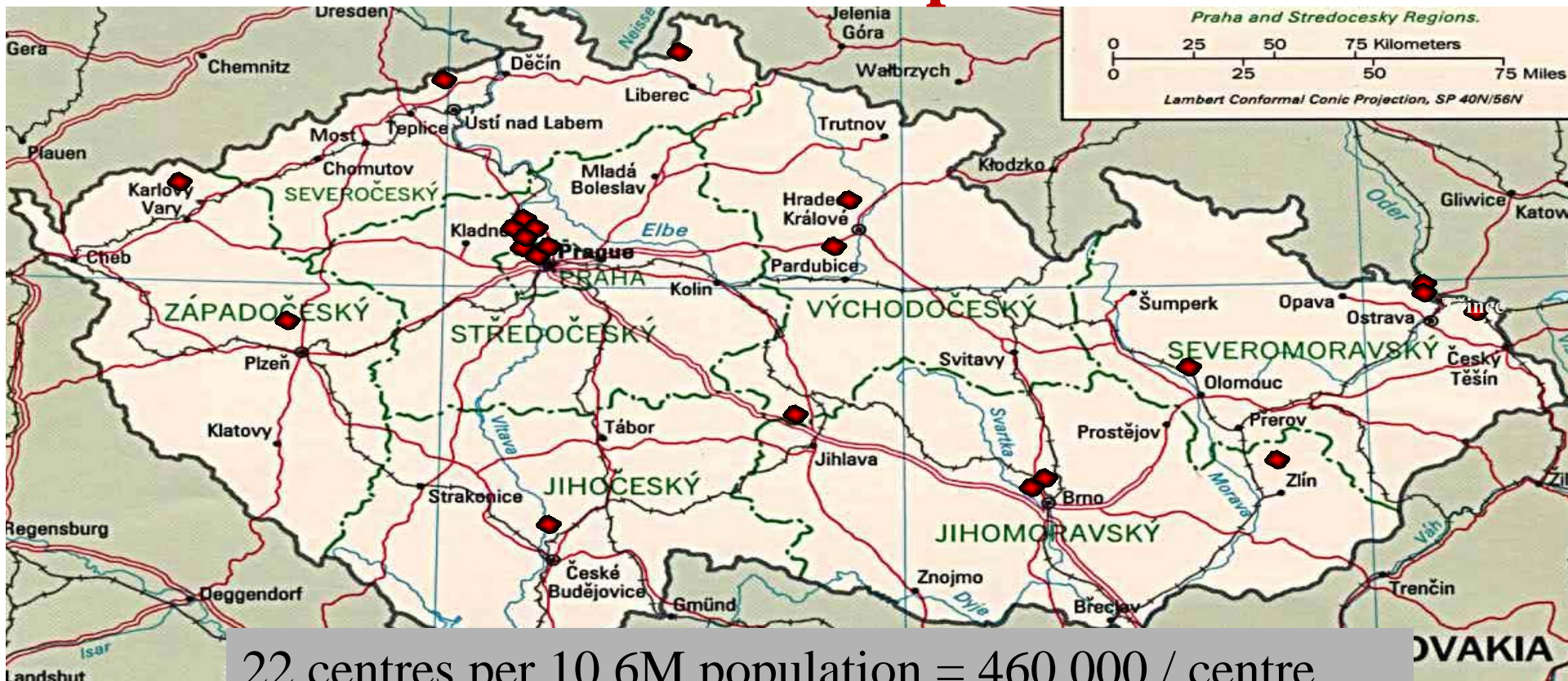
Primary PCI versus fibrinolysis for MI
Meta analysis of 23 trials



ESC guidelines on STEMI

Algorithm of reperfusion Tx and the time intervals

Non-stop (24/7) PCI centres in the Czech Republic



22 centres per 10.6M population = 460.000 / centre

Stent for Life INITIATIVE

To improve the delivery and patient access to the life saving indications of PCI thereby reduce the mortality and morbidity of patients suffering from acute coronary syndromes.



Stent for Life Initiative Phase I

Situation Mapping & Data Collection

2008 - 2009



Stent for Life Initiative Phase II

Learning the experience from the best practice countries

2009



EuroIntervention

How to set up an effe network: lessons lear

Steen D. Kristensen¹, MD, DMSc, Jean Fajadet², MD, Carlo Di Mario³, MD, Zsuzsanna Kallós-Zsuzsanna⁴, MD, Kristina Garsburg Landt⁵, MPh, Dora Delencu⁶, MD, Mervan Gilani⁷, MD, PhD, Gábor Greguss⁸, MD, Omer Gulakbay⁹, MD, Julia Jurgens¹⁰, MD, PhD, FESC, FACC, Julia Kusubick¹¹, MD, Miroslav Ostojic¹², MD, PhD, FESC, FACC, FISCAL, Hubert Perrot¹³, MD, FESC, FACC, FISCAL, Mamed Sahaj¹⁴, MD, PhD, Mohammad Sahaj¹⁵, MD, FACC, FESC, Christian Vinter¹⁶, MD, PhD, William Wijaya¹⁷, MD, PhD, Paw Włodarczyk¹⁸, MD, DSc, FESC

Stent for Life Initiative Phase III

Implementation in Countries

2009 - 2013



■ EuroIntervention 2012;8:35-42

Implementation of primary angioplasty in Europe: Stent for Life initiative progress report

Steen D. Kristensen¹, MD, DMSc, Jean Fajadet², MD, Carlo Di Mario³, MD, Zsuzsanna Kallós-Zsuzsanna⁴, MD, Kristina Garsburg Landt⁵, MPh, Dora Delencu⁶, MD, Mervan Gilani⁷, MD, PhD, Gábor Greguss⁸, MD, Omer Gulakbay⁹, MD, Julia Jurgens¹⁰, MD, PhD, FESC, FACC, Julia Kusubick¹¹, MD, Miroslav Ostojic¹², MD, PhD, FESC, FACC, FISCAL, Hubert Perrot¹³, MD, FESC, FACC, FISCAL, Mamed Sahaj¹⁴, MD, PhD, Mohammad Sahaj¹⁵, MD, FACC, FESC, Christian Vinter¹⁶, MD, PhD, William Wijaya¹⁷, MD, PhD, Paw Włodarczyk¹⁸, MD, DSc, FESC

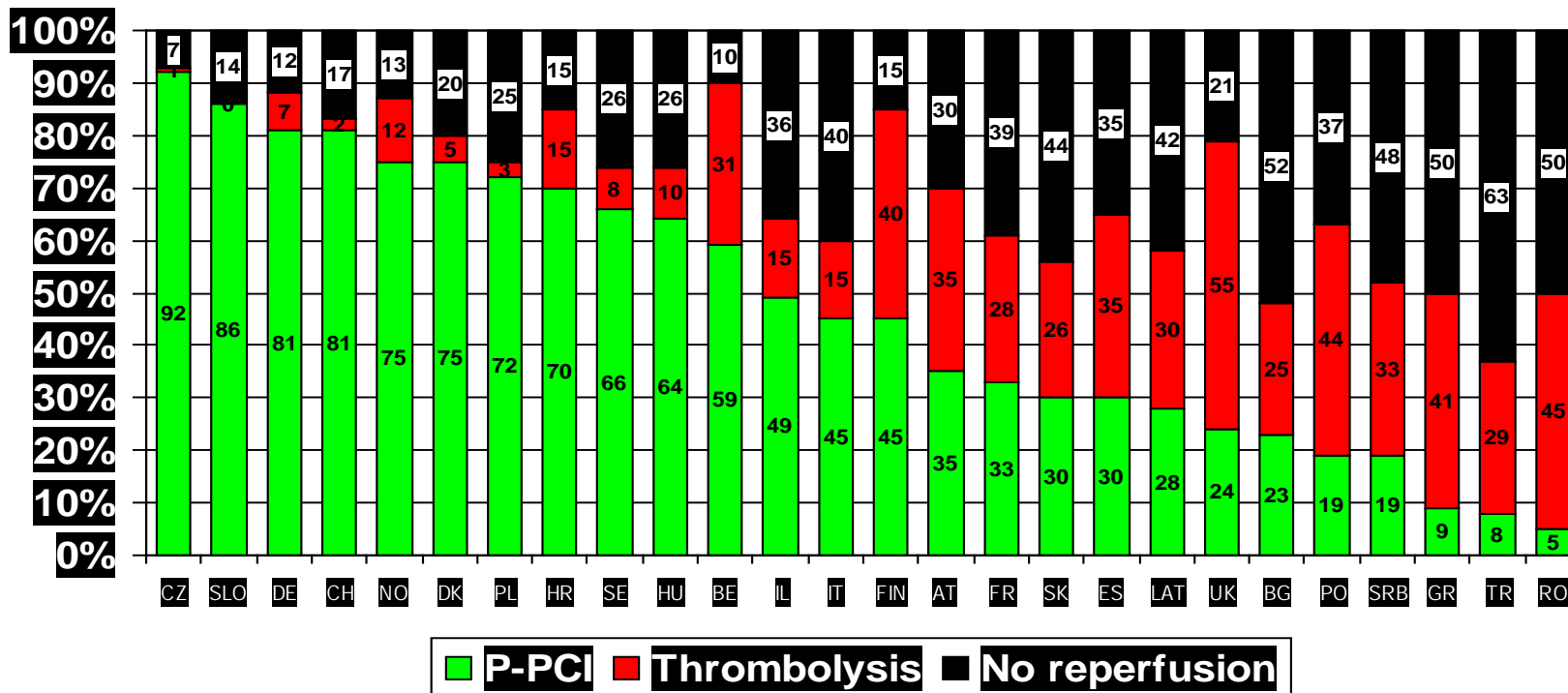


Stent for Life is a joint initiative between the European Association of Percutaneous Cardiovascular Interventions (EAPCI) and EuroPCR

Stent for Life is a joint initiative between the European Association of Percutaneous Cardiovascular Interventions (EAPCI) and EuroPCR



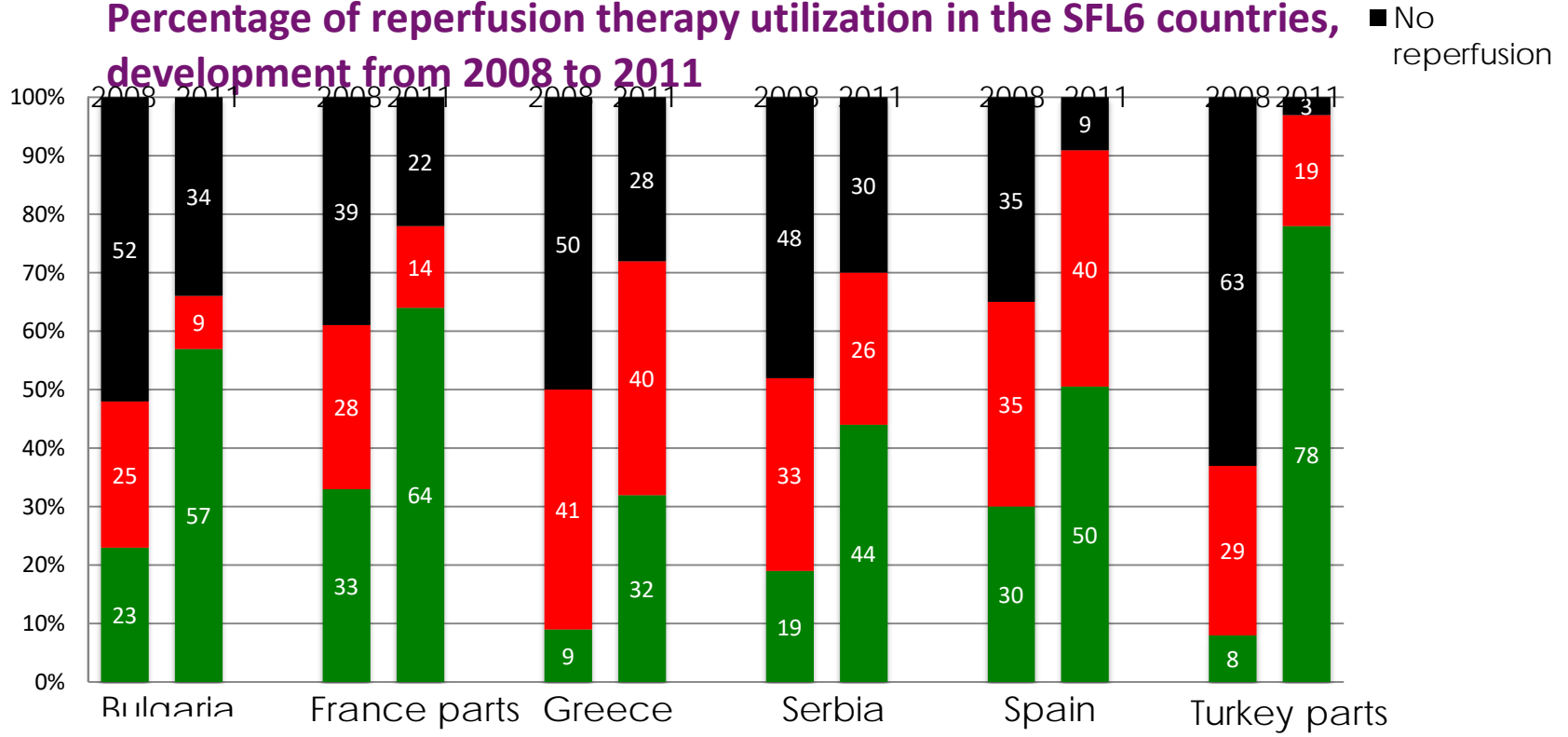
Reperfusion Therapies and Mortality Differ among Countries



Widimsky P....Kala P. et al. Eur. Heart.J. 2010. doi:10.1093/eurheartj/ehp492

SFL Impact on Access to PPCI – what can be achieved within several years..

Percentage of reperfusion therapy utilization in the SFL6 countries, development from 2008 to 2011





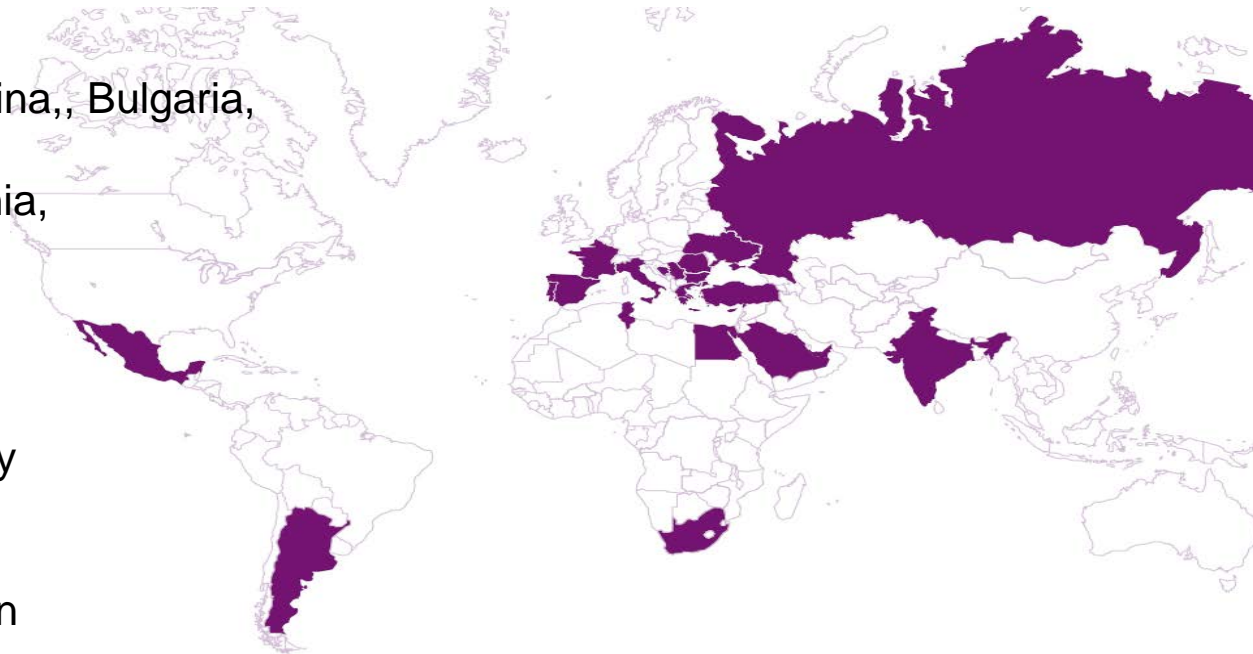
21 countries from 5 continents were actively participating in SFL Initiative

SFL Member Countries

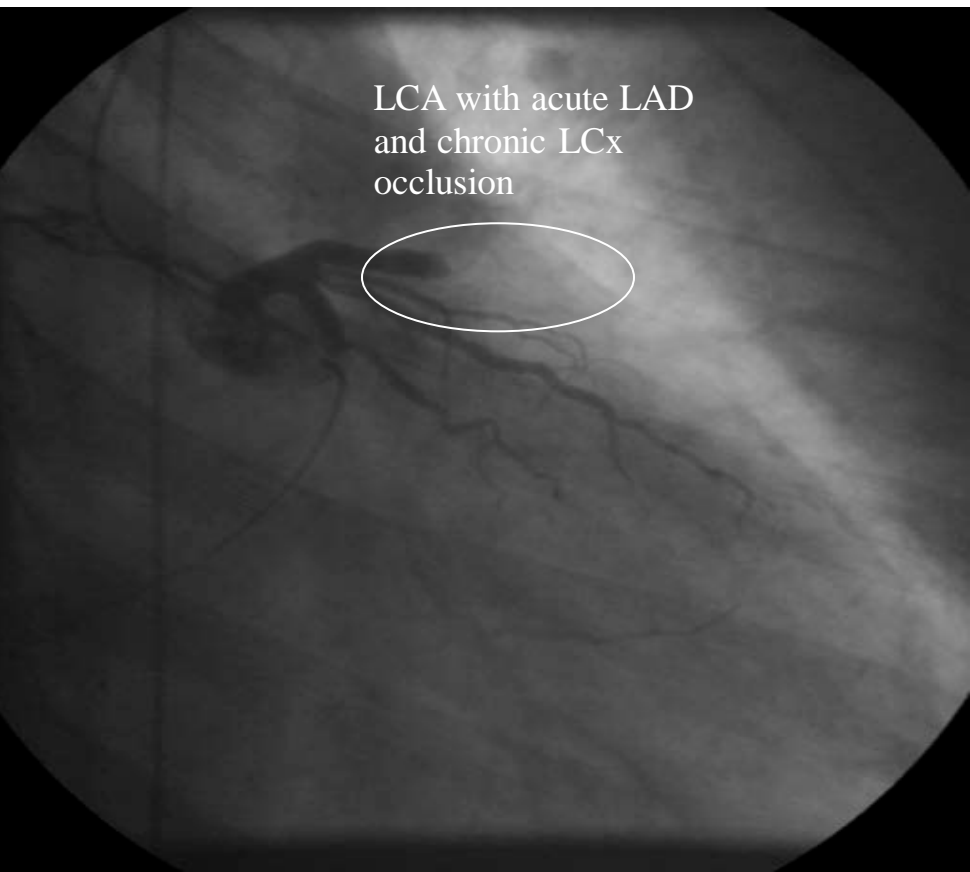
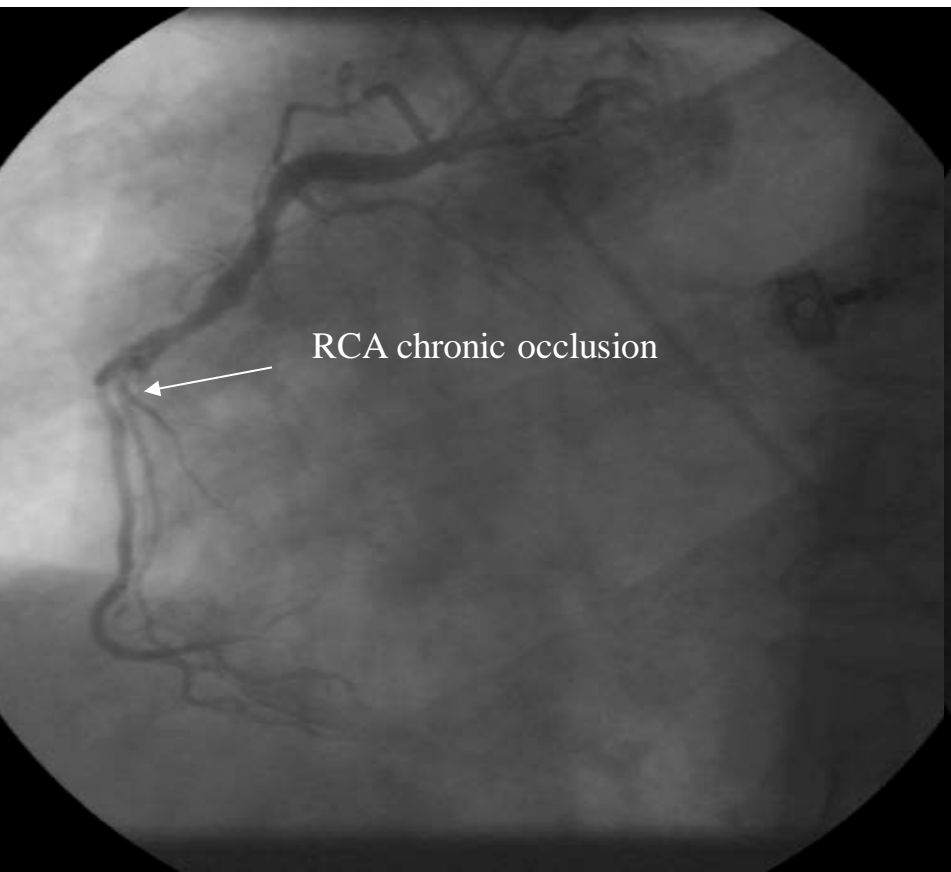
Belarus, Bosnia and Herzegovina,, Bulgaria, Cyprus, Egypt, France, Greece, Italy, Portugal, Romania, Russia, Serbia, Spain, Tunisia, Turkey, Ukraine

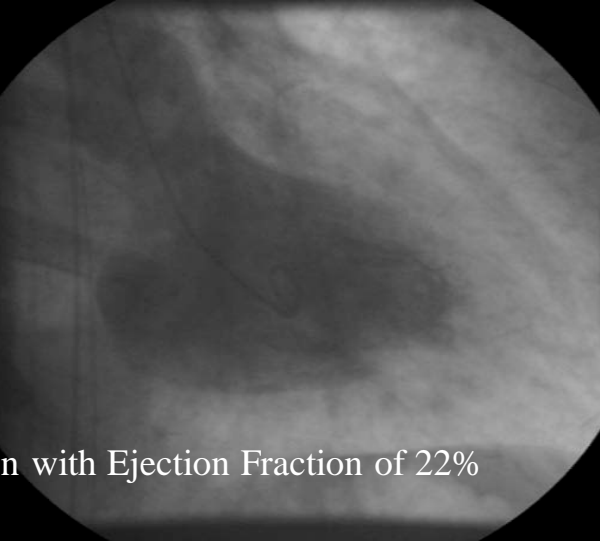
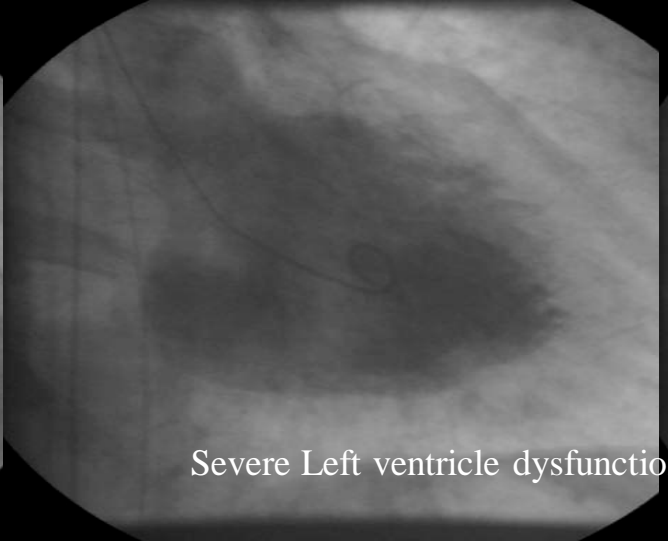
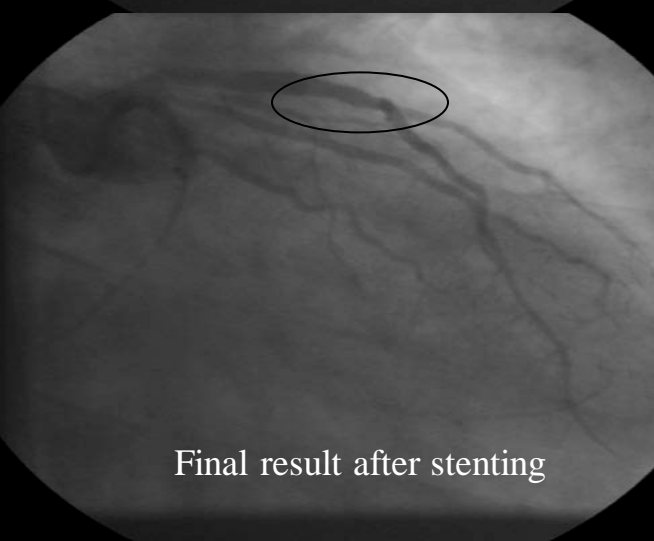
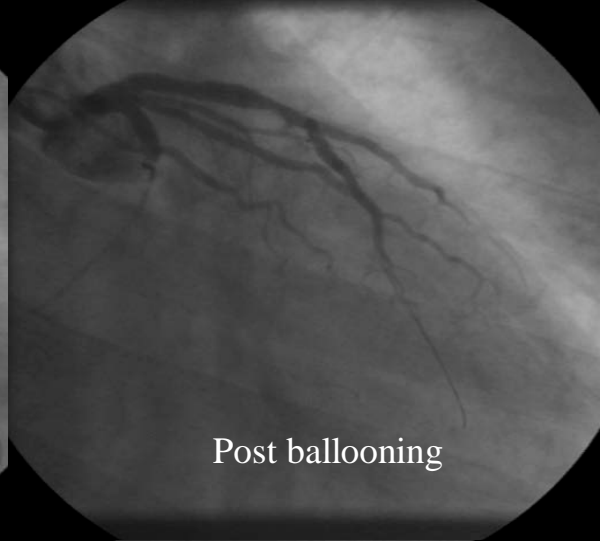
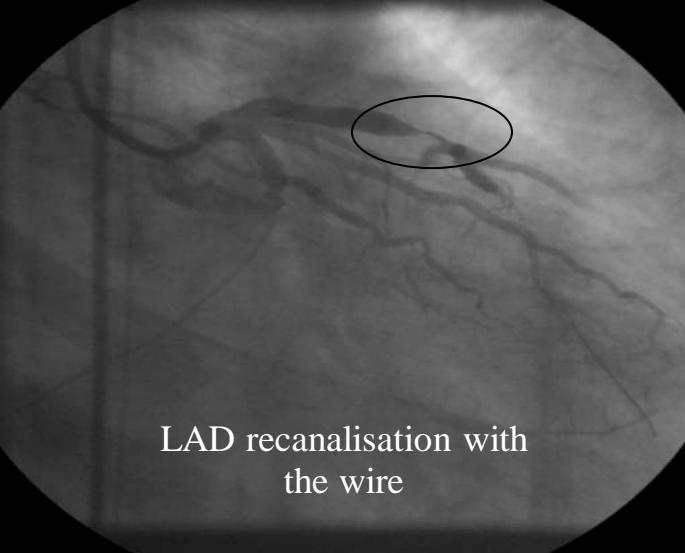
SFL Affiliate Organizations

Argentine Society of Cardiology
Saudi Heart Association
SOCIME (Mexico)
South African Heart Association
STEMI INDIA



Male, 51 yo in Cardiogenic Shock due to the anterior wall STEMI with chronic occlusion of RCA



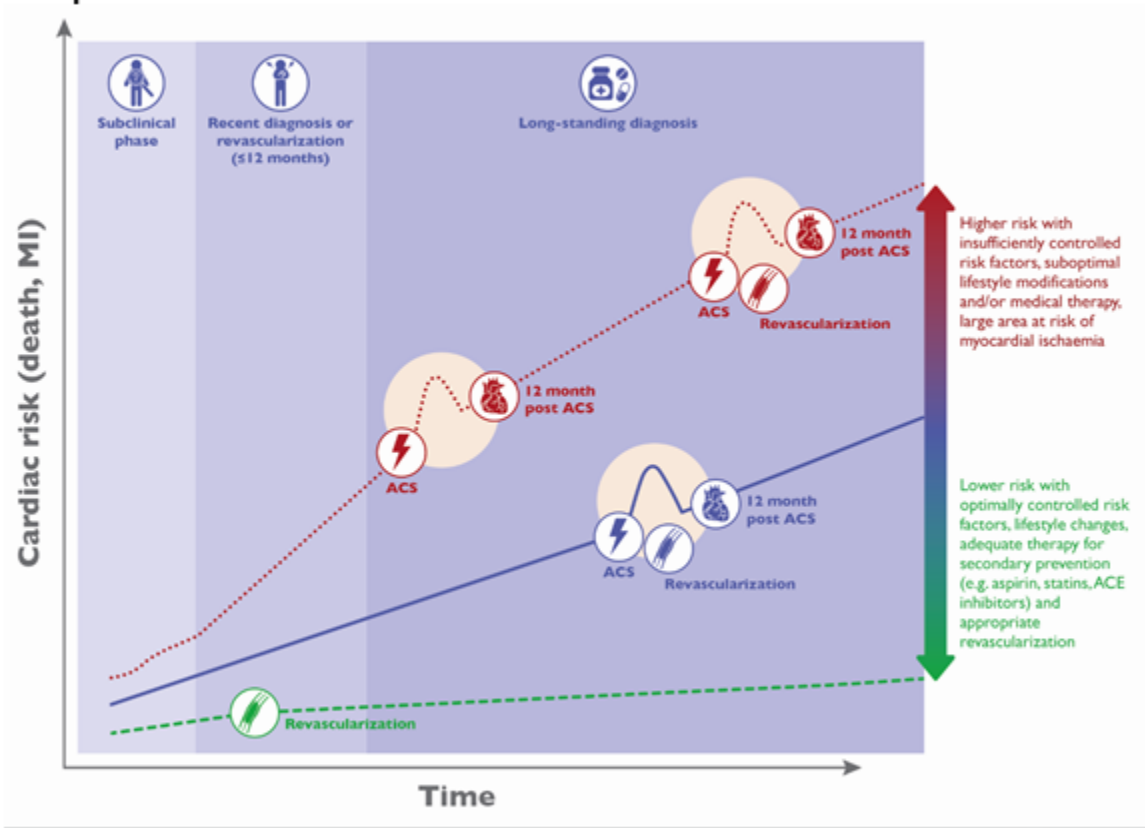


Chronic CAD

*newly known as CCS = Chronic Coronary
Syndrome*

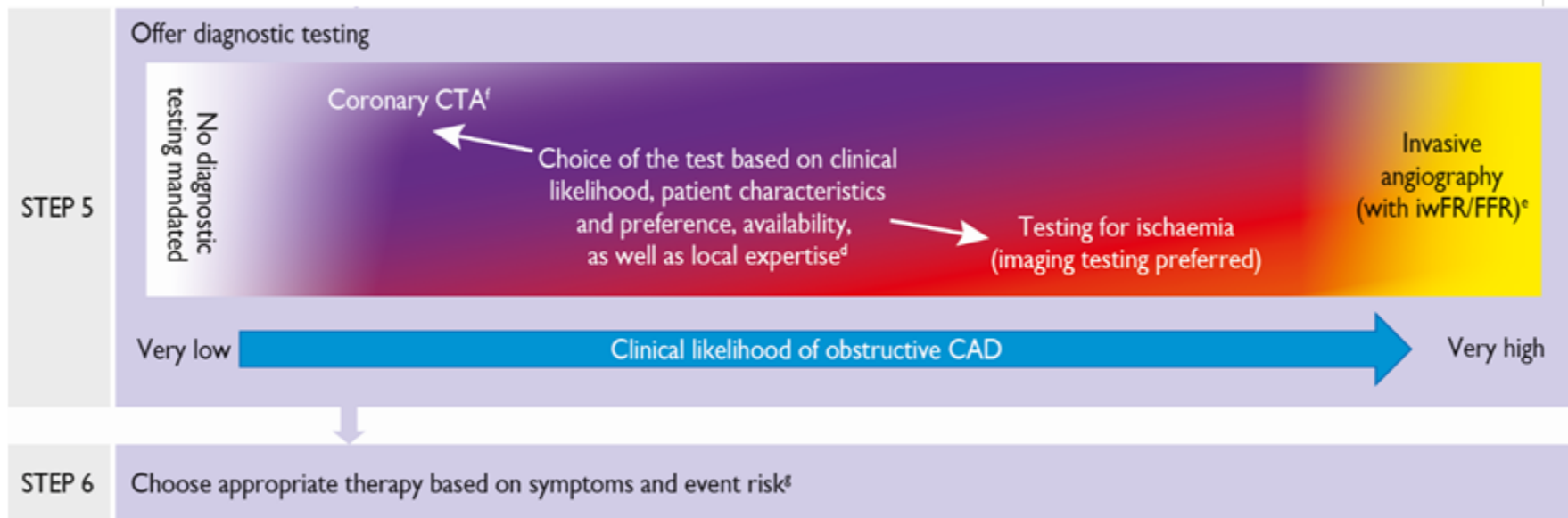
Natural history of chronic coronary syndromes

A dynamic process



Patients with angina and/or dyspnoea and suspected coronary artery disease

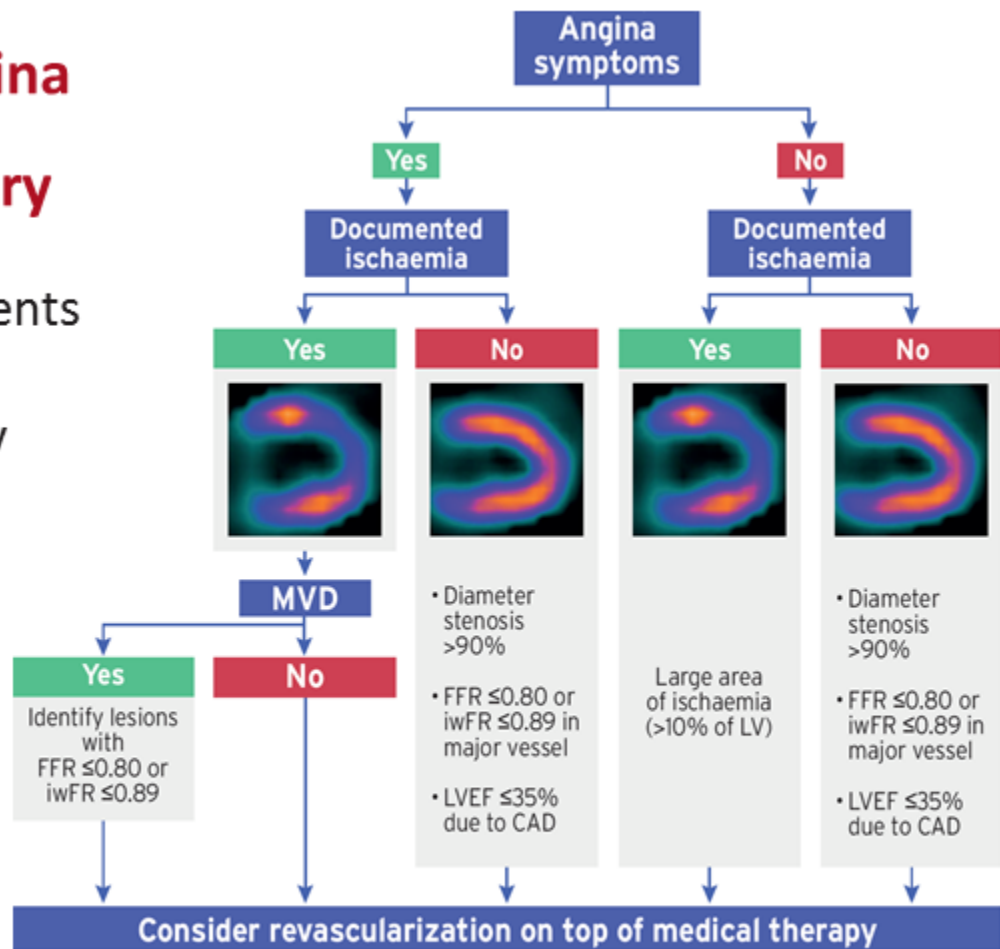
Diagnostic approach (2)



^d Ability to exercise, individual test-related risks, and likelihood of obtaining diagnostic test result. ^e High clinical likelihood and symptoms inadequately responding to medical treatment, high event risk based on clinical evaluation (such as ST-segment depression, combined with symptoms at a low workload or systolic dysfunction indicating CAD), or uncertain diagnosis on non-invasive testing. ^f Functional imaging for myocardial ischaemia if coronary CTA has shown CAD of uncertain grade or is non-diagnostic. ^g Consider also angina without obstructive disease in the epicardial coronary arteries (see section 6 of full text).

Patients with angina and/or dyspnoea and coronary artery disease

Decision tree for patients undergoing invasive coronary angiography



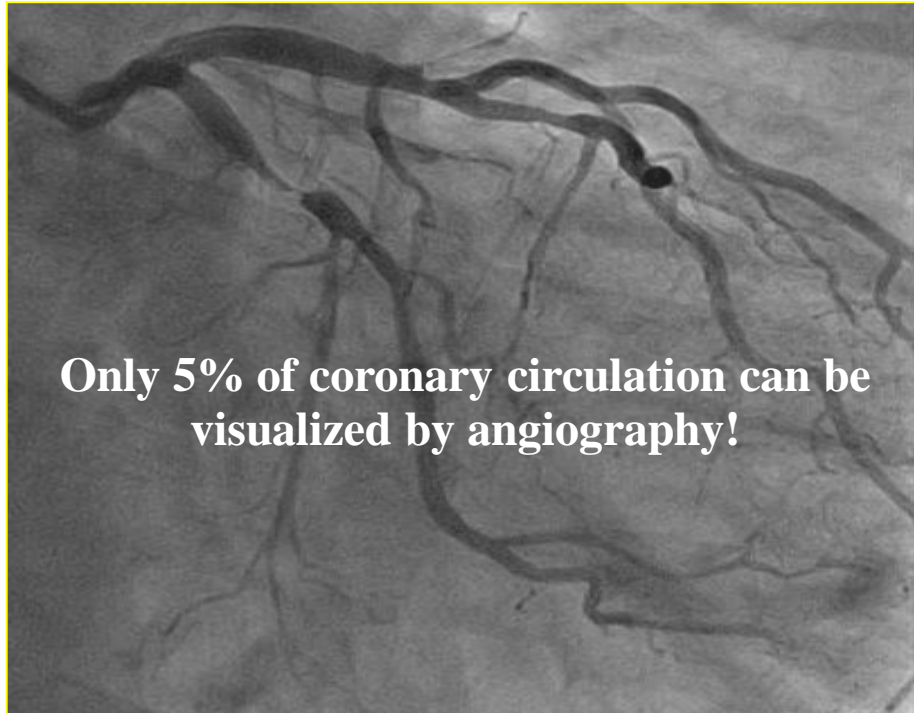
CAD = coronary artery disease;
FFR = fractional flow reserve;
iwFR = instantaneous wave-free ratio;
LV = left ventricle;
LVEF = left ventricular ejection fraction;
MVD = multivessel disease.

ESC Guidelines on Revascularization

PCI vs CABG

From morphology to coronary physiology

Two-Compartment Model of the Coronary Circulation



Coronary morphology - summary

- Coronary angiography = luminography – the gold standard in ACS patients though suffering several limitations.
- IVUS and virtual histology provide better knowledge of the artery and plaque distribution/composition.
- OCT provides the highest resolution at present and becomes an important imaging technique complementary to IVUS.

but...there is a BUT

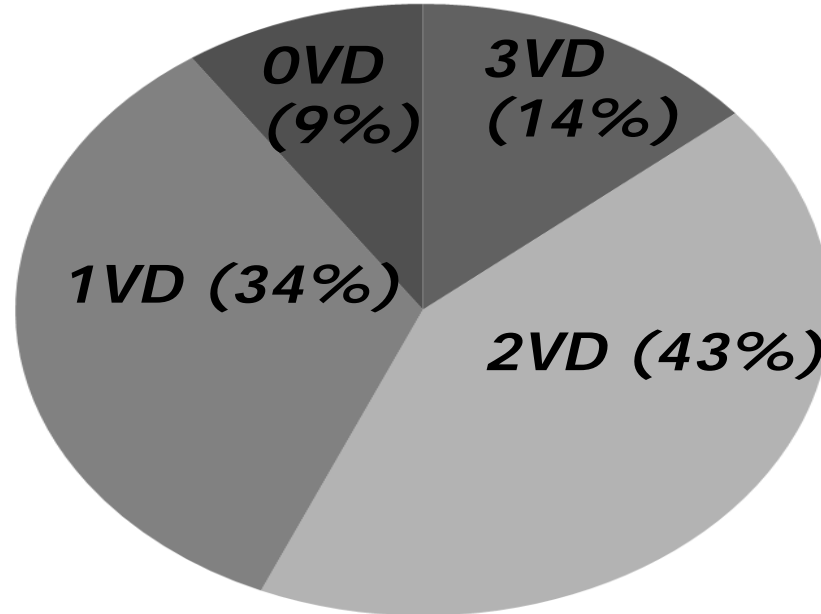
Anatomic vs. Functional CAD

Patients with angiographically 3VD (N=115), proportions per number of diseased vessels after assessment by FFR

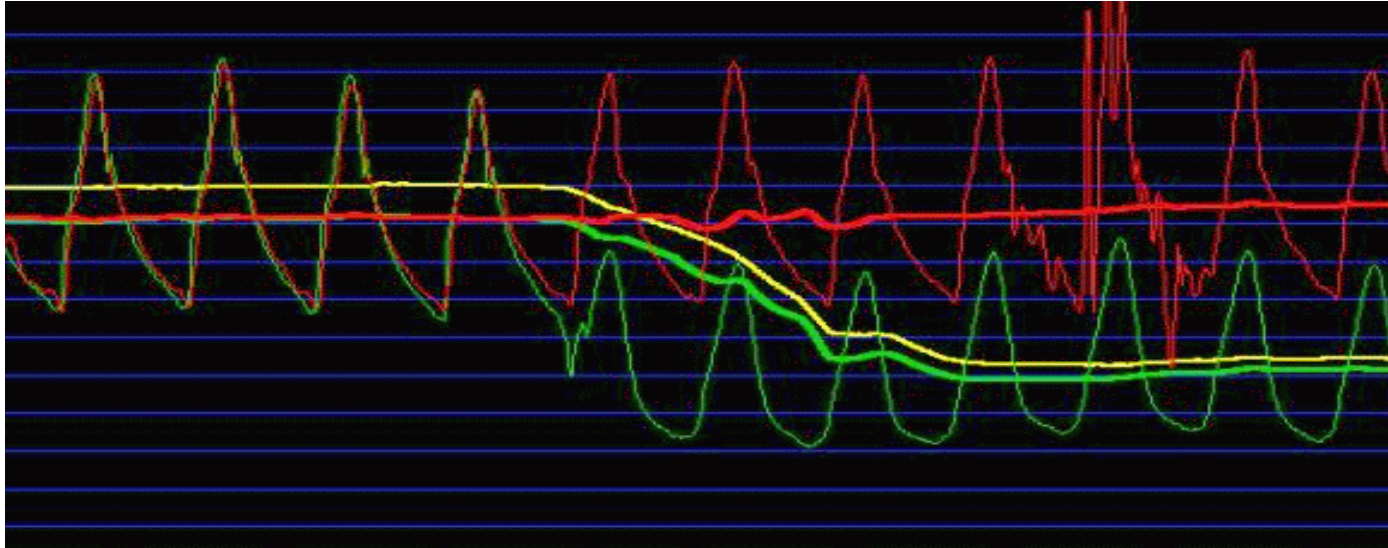
*Angiographic
3 Vessel
Disease*

Anatomic vs. Functional CAD

Patients with angiographically 3VD (N=115), proportions per number of diseased vessels after assessment by FFR



Fractional flow reserve - FFRmyo



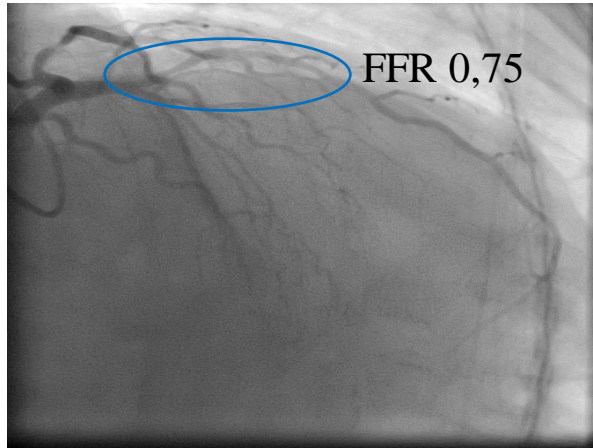
**1993 – Dr. Nico Pijls, Catharina Hospital, Eindhoven
Dr. Bernard De Bruyne, Cardiovascular Center, Aalst**

Woman, 71yo

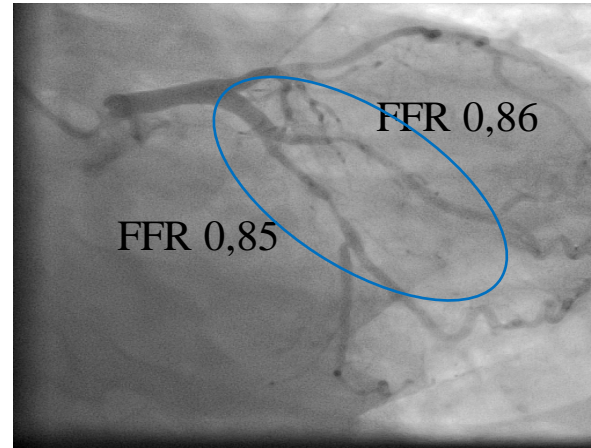
CAD for 3 months with progression in Unstable angina, NYHA II-III

Risk factors: Hypertension, Hyperlipidemia

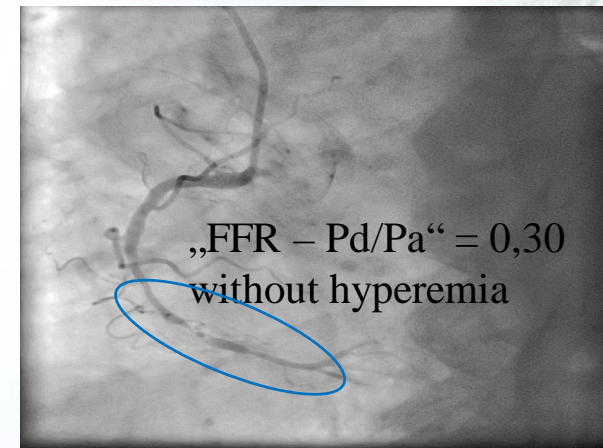
LAD



LCX - OM

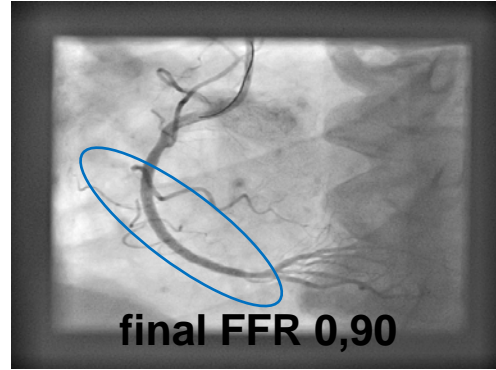
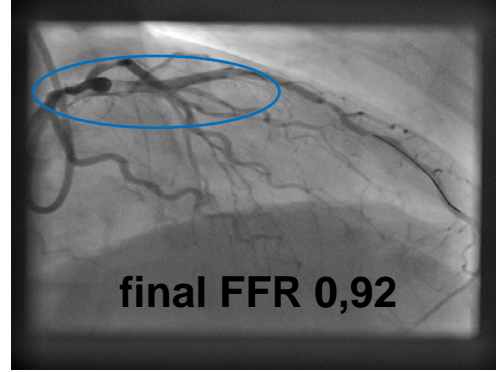
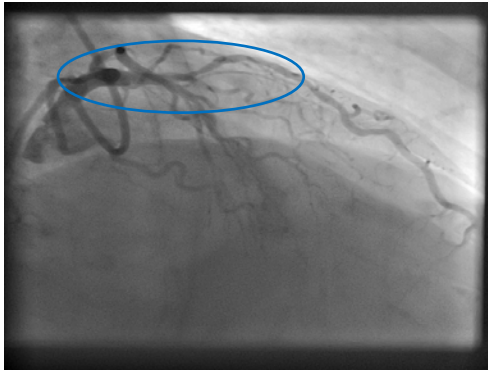


RCA



- 3VD, normal LVEF → HEARTteam → FAME 3 trial → patient was randomized in FFR-guided PCI (cut-off for revascularization 0.80)

Woman, 71yo, FINAL RESULT after STENTING of LAD and RCA



Enjoy your healthy, full-sized aortic pump 😊

