IPS-Symposium Stadtspital Zürich

Komplikationen in der Herzmedizin

Komplikationen nach PCI

Raban Jeger
Kardiologie Herzzentrum Universitätsspital Basel

Koronarangiographie und PCI

Interventionelle Kardiologie Schweiz 2020

Universitätsspital Basel

CA

53’088

coronary angiographies

TRANSRADIAL

65%

transradial access

PCI

25’933

percutaneous coronary interventions

48.8% of all coronary angiographies

SETTING

39%

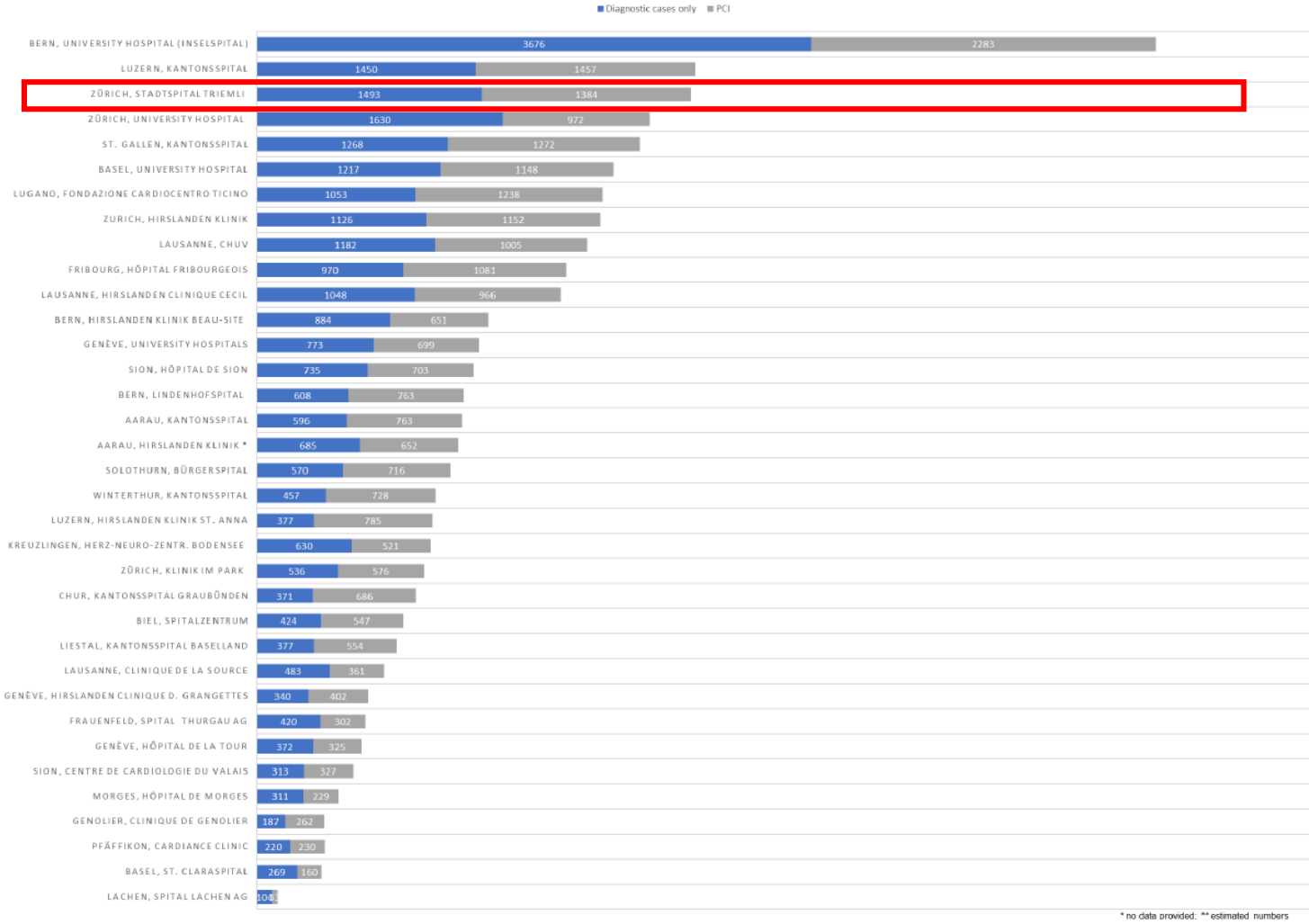
Emergency PCIs

OUTCOME

1.36%

overall in-hospital mortality after PCI

0.08% elective | 1.6% in NSTE-ACS | 4.1% in STEMI | 42% in shock



Boeddinghaus J et al, submitted

Koronarangiographie und PCI

Indikationen für Koronarangiographie

Coronary artery disease (CAD)

- *Stable CAD*
  - Suspected CAD
  - Known CAD
- *Unstable CAD*
  - Acute coronary syndrome with unstable hemodynamics or rhythm
  - Unstable angina and non-ST elevation myocardial infarction
  - ST elevation myocardial infarction
  - Out of hospital cardiac arrest
- *Special considerations*
  - Congestive heart failure
  - Preoperative assessment for non-cardiac surgery

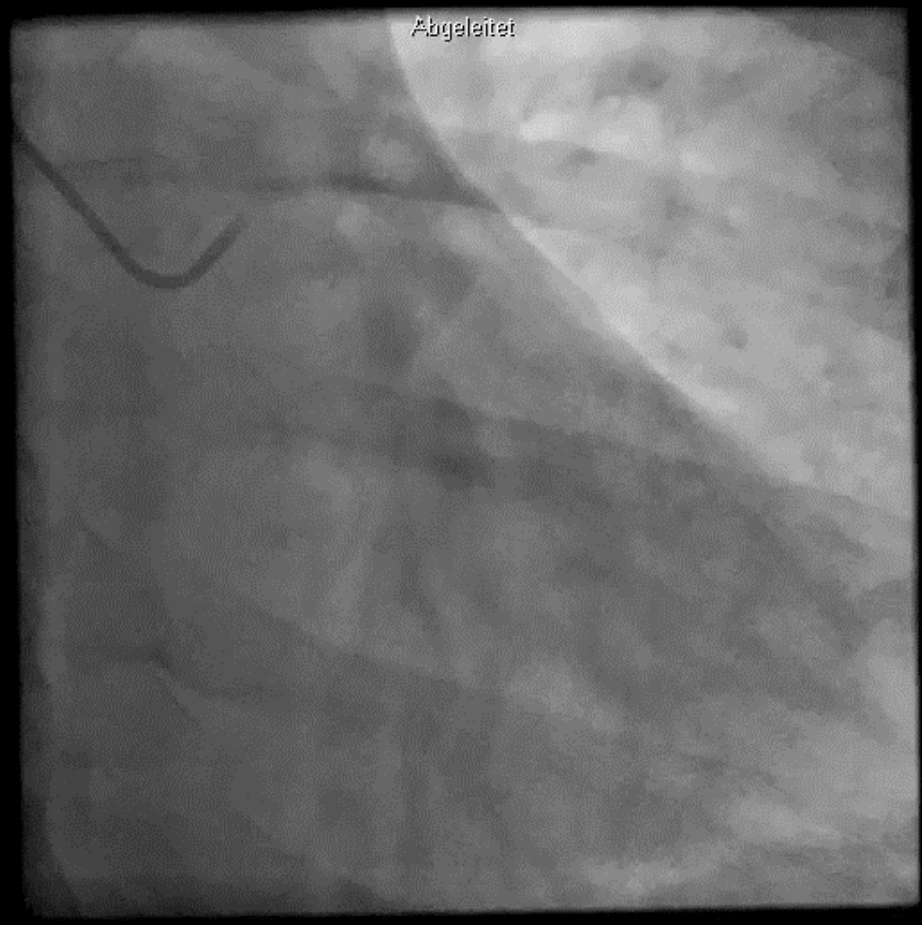
Structural cardiac disease/valvular heart disease interventions

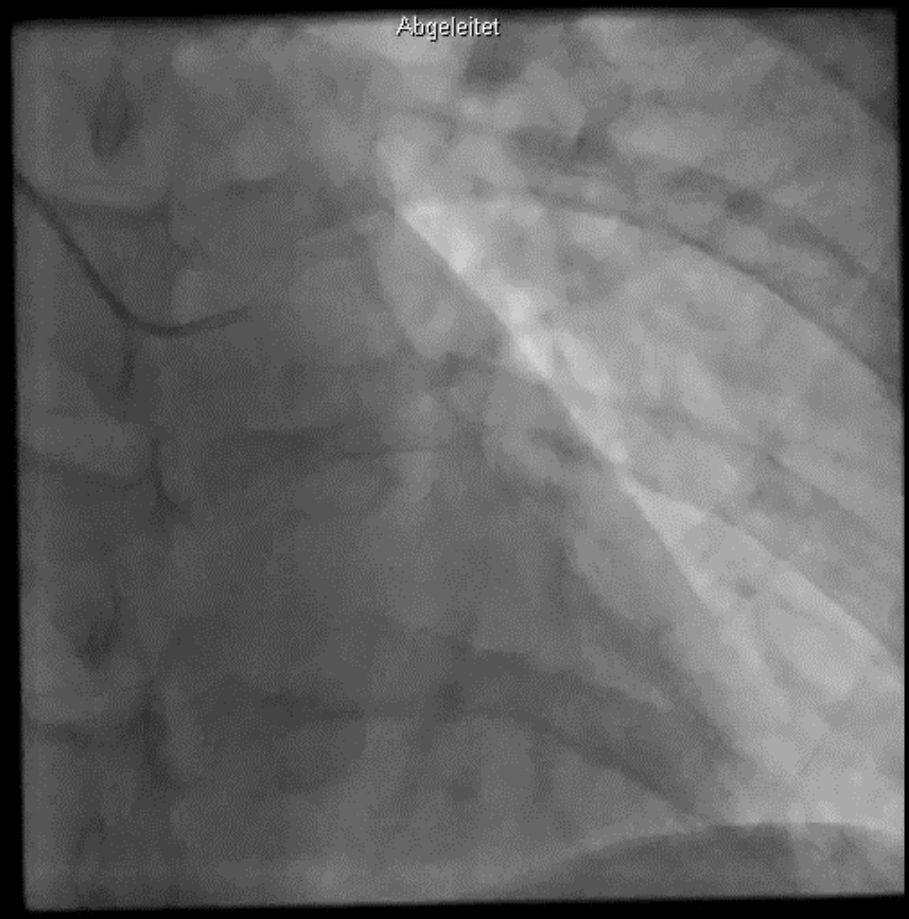
- *Prior to valvular surgery*
- *Prior to percutaneous valve implant*

Adapted from Karl Poon and Darren Walters (2011). Indications for Coronary Angiography, Advances in the Diagnosis of Coronary Atherosclerosis, Prof. Suna Kirac (Ed.), ISBN: 978-953-307-286-9, InTech

Koronarangiographie: 47-jährige Frau

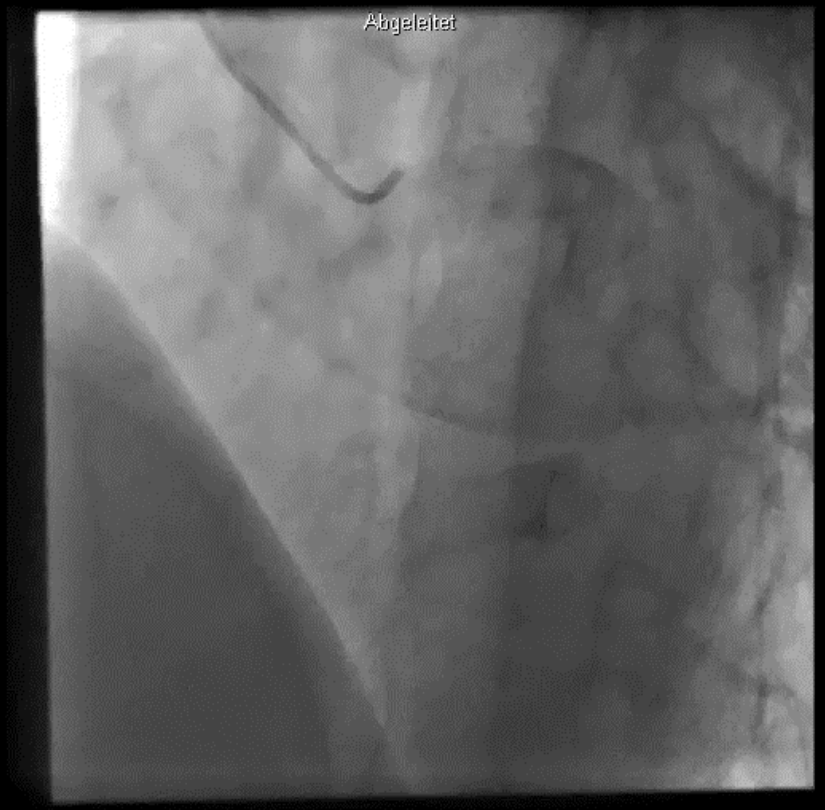
Unklare Thoraxschmerzen und erhöhte Herzenzyme

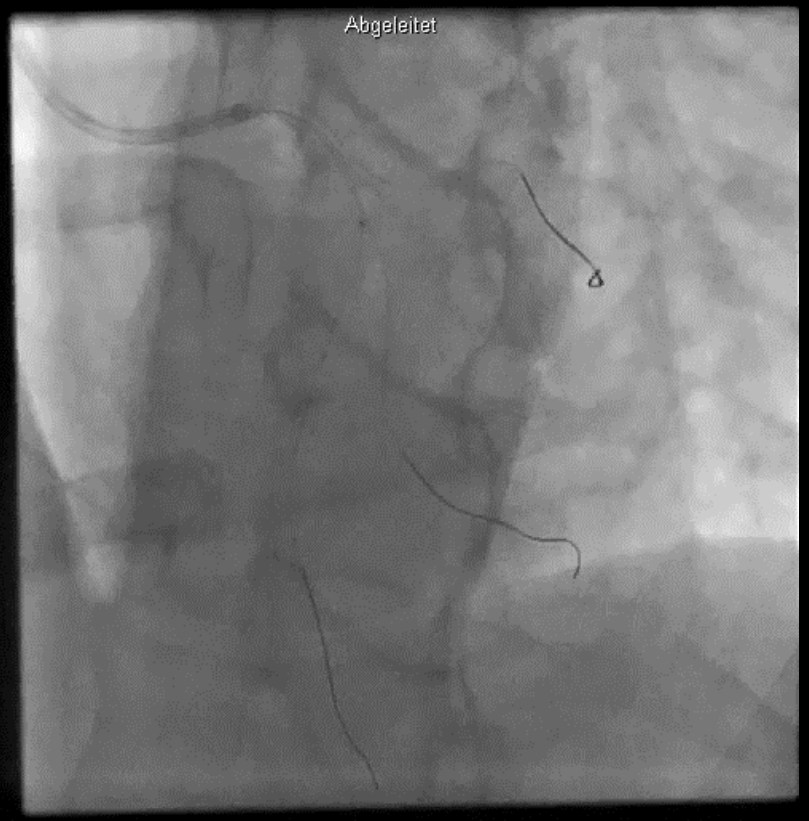


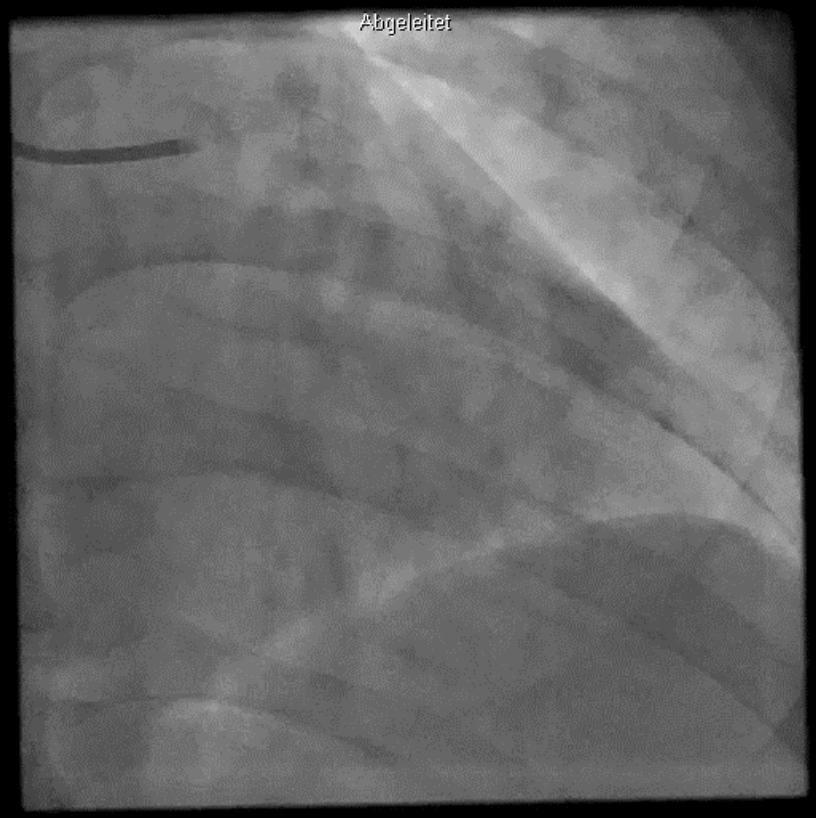


Hauptstammdissektion

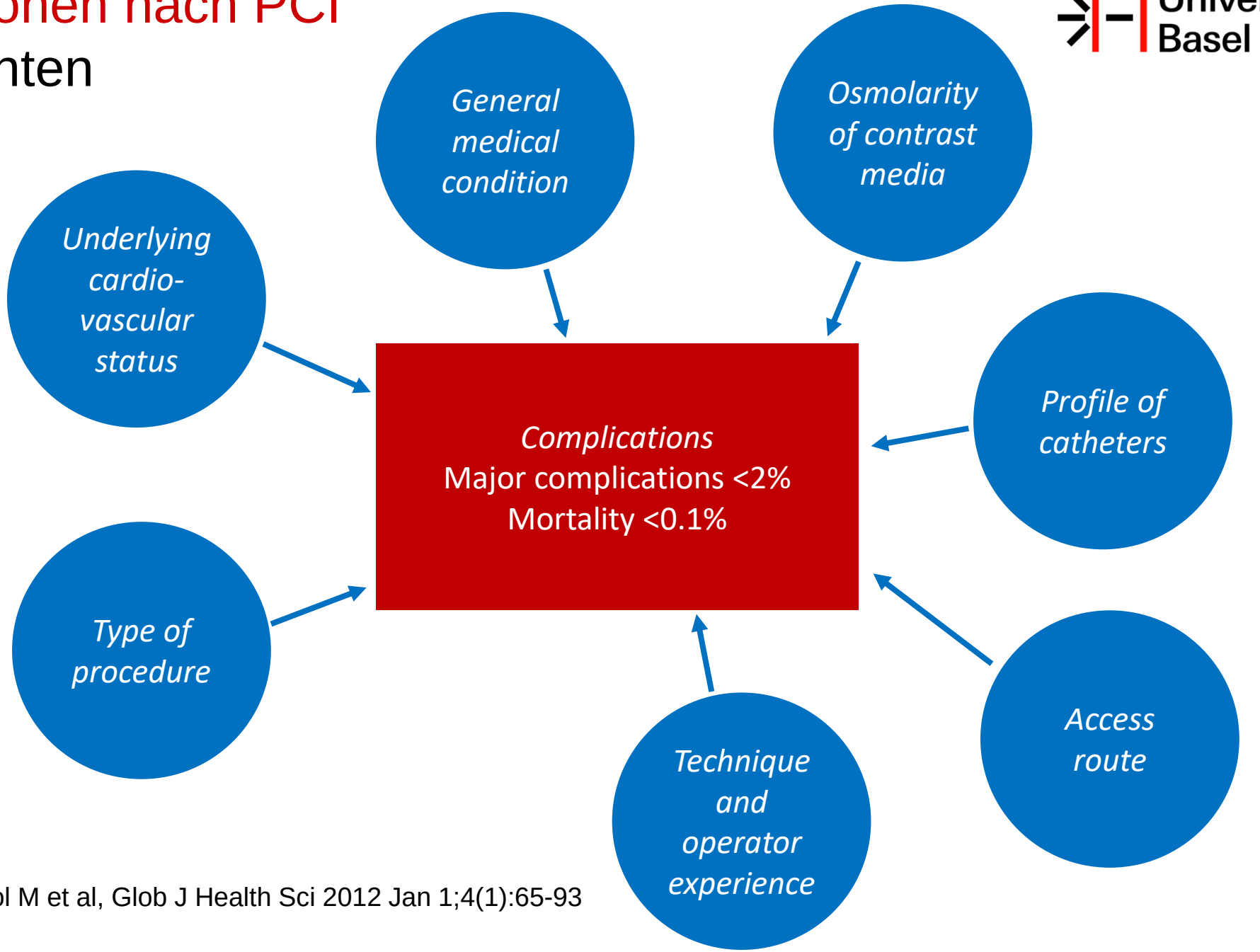
Perkutane Koronarintervention







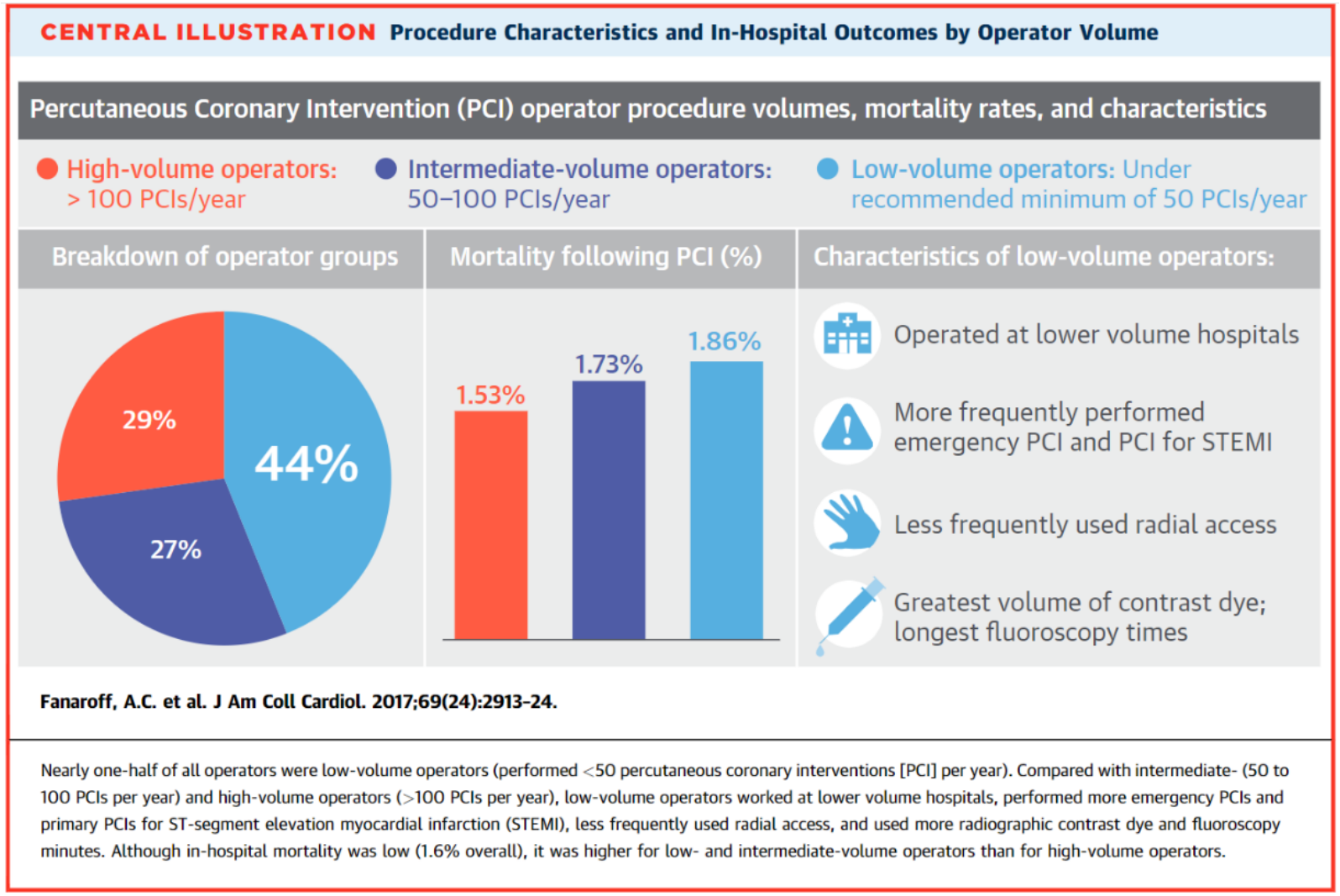
Komplikationen nach PCI
Determinanten



Adapted from Tavakol M et al, Glob J Health Sci 2012 Jan 1;4(1):65-93

Komplikationen nach PCI

Zusammenhang Erfahrung und Mortalität



Fanaroff AC et al, J Am Coll Cardiol 2017;69:2913–24

Komplikationen nach PCI
Einteilung

Universitätsspital Basel

Non-cardiac Complications
- Contrast-induced nephropathy (3-17%, depending on underlying risk)
- Local vascular injury (hematoma, retroperitoneal hemorrhage, pseudoaneurysm, AV fistula, dissection, thrombosis and embolism, vascular closure devices) (0.2-2% for CA, 1-3% for PCI)
- Cholesterol emboli (<2%)
- Allergic and adverse reactions (local and general anesthesia, contrast media, heparin-induced thrombocytopenia) (<1%)
- Infections (<1%)
- Cerebrovascular complications (<0.1%)

Cardiac Complications
- Conduction disturbances (bradyarrhythmia, tachyarrhythmia)
- Myocardial infarction (<1% for CA, 5-30% for PCI)
- Death (<0.1%)
- Dissection and perforation of great vessels (<0.1%)

Lesion Complications
- Instent restenosis
- Stent thrombosis
- Vessel perforation

Adapted from Tavakol M et al, Glob J Health Sci 2012 Jan 1;4(1):65-93

Komplikationen nach PCI

Häufigkeit (CathPCI Registry 2010-2011)

Universitätsspital Basel

Procedure-related complications in patients without STEMI

	PCI Patients Without STEMI (n = 787,980)	Diagnostic Catheterization Only Patients Without STEMI (n = 1,091,557)
Complications (%)		
Any adverse event	4.53	1.35
Cardiogenic shock	0.47	0.24
Heart failure	0.59	0.38
Pericardial tamponade	0.07	0.03
CVA/stroke	0.17	0.17
% of total strokes that were hemorrhagic	15.6	9.16
New requirement for dialysis	0.19	0.14
In-hospital mortality		
Non–risk-adjusted	0.65	0.72
Non–risk-adjusted excluding CABG patients	0.62	0.60
CABG performed during admission	0.81	7.47
CABG status		
Salvage/emergency	0.01/0.17	0.01/0.27
Urgent/elective	0.47/0.16	5.27/1.92
CABG indication		
PCI failure without clinical deterioration	0.26	
PCI complication	0.14	
Bleeding complications (%)		
Any bleeding event within 72 h of procedure	1.40	0.49
Any other vascular complication requiring treatment	0.44	0.15
RBC/whole-blood transfusion	2.07	N/R

Patients with STEMI

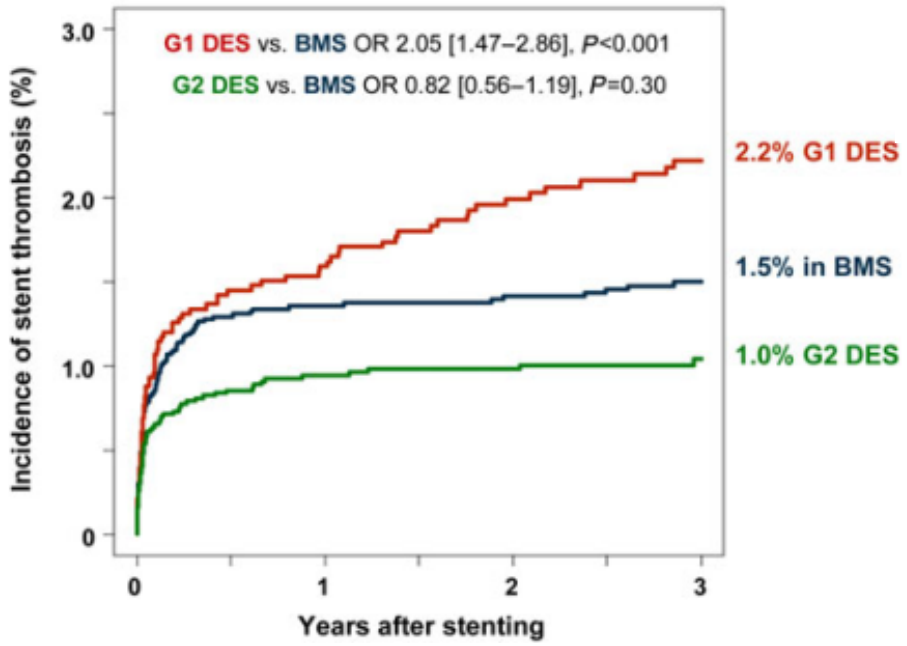
	Incidence (%)
PCI complications during admission: STEMI patients (n = 153,268)	
Any adverse event	12.4
Cardiogenic shock	3.87
Heart failure	3.46
Pericardial tamponade	0.15
CVA/stroke	0.56
% of total strokes that are hemorrhagic	19.7
New requirement for dialysis	0.63
CABG performed during admission	
CABG status	
Salvage/emergency	0.05/0.87
Urgent/elective	2.08/0.43
CABG indication	
PCI failure without clinical deterioration	0.58
PCI complication	0.22
Bleeding complications	
Any bleeding event within 72 h of procedure	3.85
Any other vascular complication requiring treatment	0.62
RBC/whole-blood transfusion	5.61

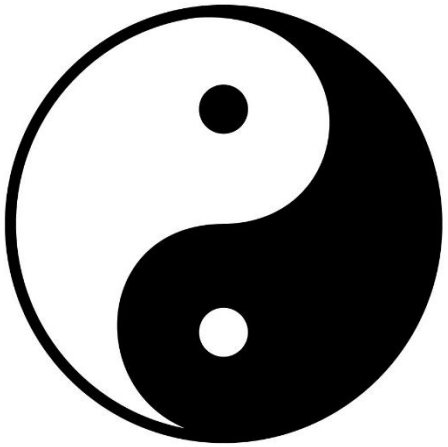
Dehmer GJ et al, J Am Coll Cardiol 2012;60:2017–31

Lokale Komplikationen

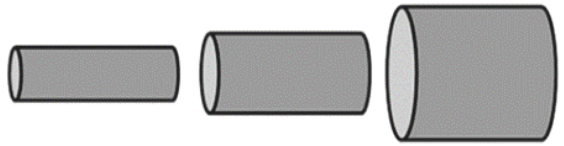
Stents: Thrombose und Restenose

Stent Thrombosis





Instent-Restenosis



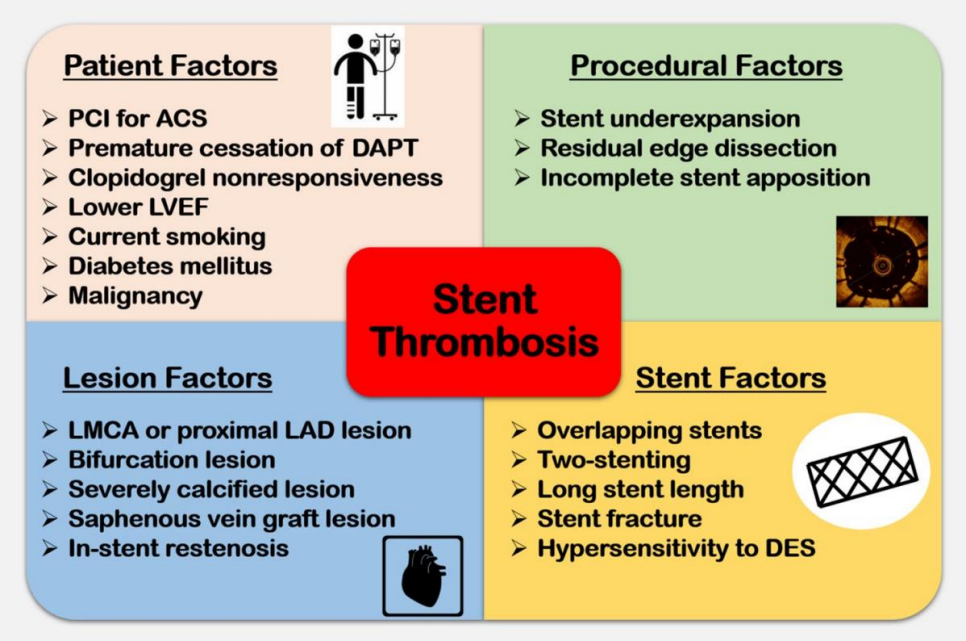
	SMALL (<2.75 mm)	MEDIUM (2.75-3.25 mm)	LARGE (>3.25 mm)
Balloon-only PTCA	35-55%	25-40%	20-35%
Bare-metal stents	25-50%	15-35%	15-20%
Drug-eluting stents with			
relatively high late loss (eg Endeavor™)	30-35%	20-30%	5-12.5%
medium late loss (eg Taxus™)	20-25%	10-20%	2.5-7.5%
low late loss (eg Cypher™ or Xience™)	10-15%	5-10%	0-5%

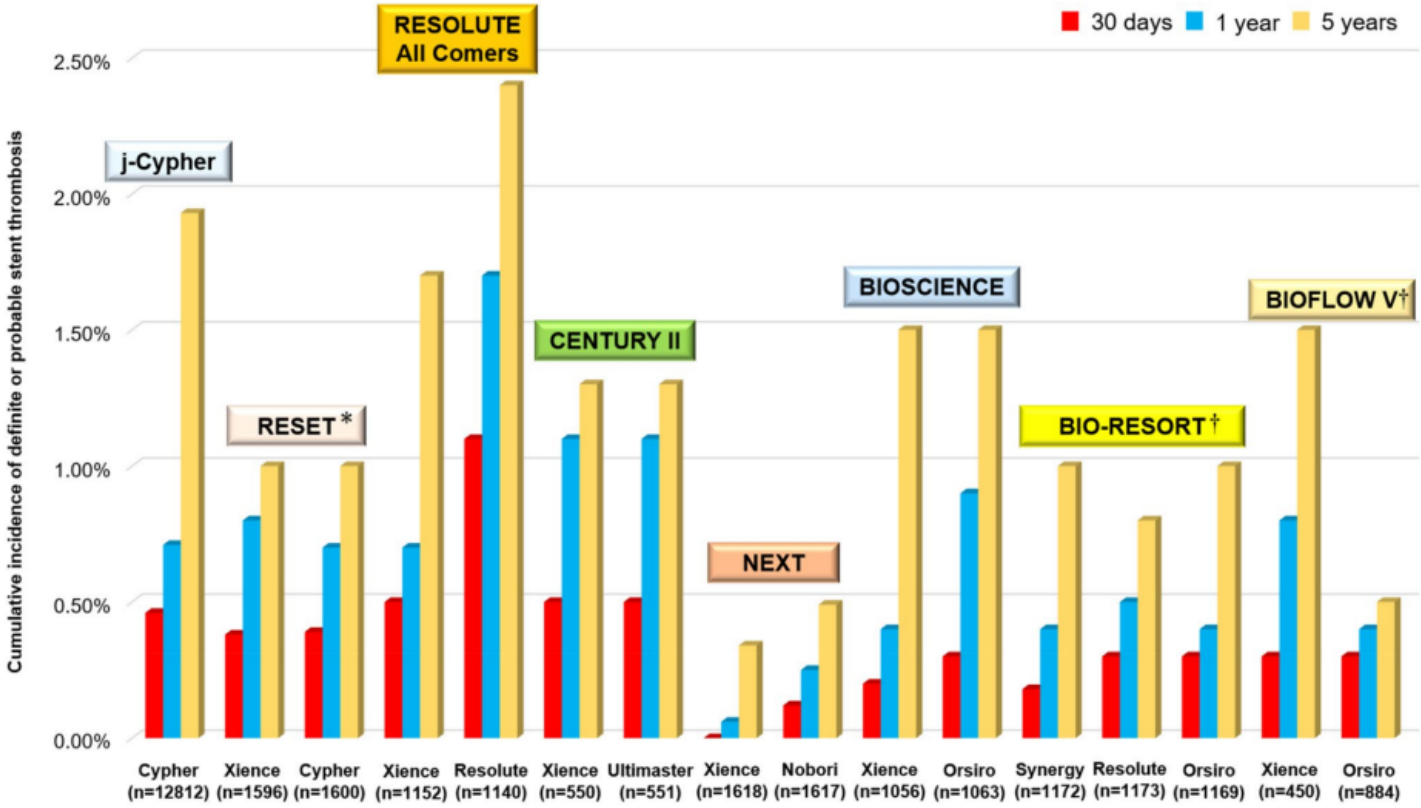
Byrne RA et al, Eur Heart J 2015; 36(47):3320-31

Biondi-Zoccai G et al. Cardiovascular Revascularization Medicine 11 (2010) 189–198

Lokale Komplikationen
Stent-Thrombose

- Häufigkeit 0.2-0.7%% nach PCI, seltener nach elektiver PCI
- Letalität 15-30%

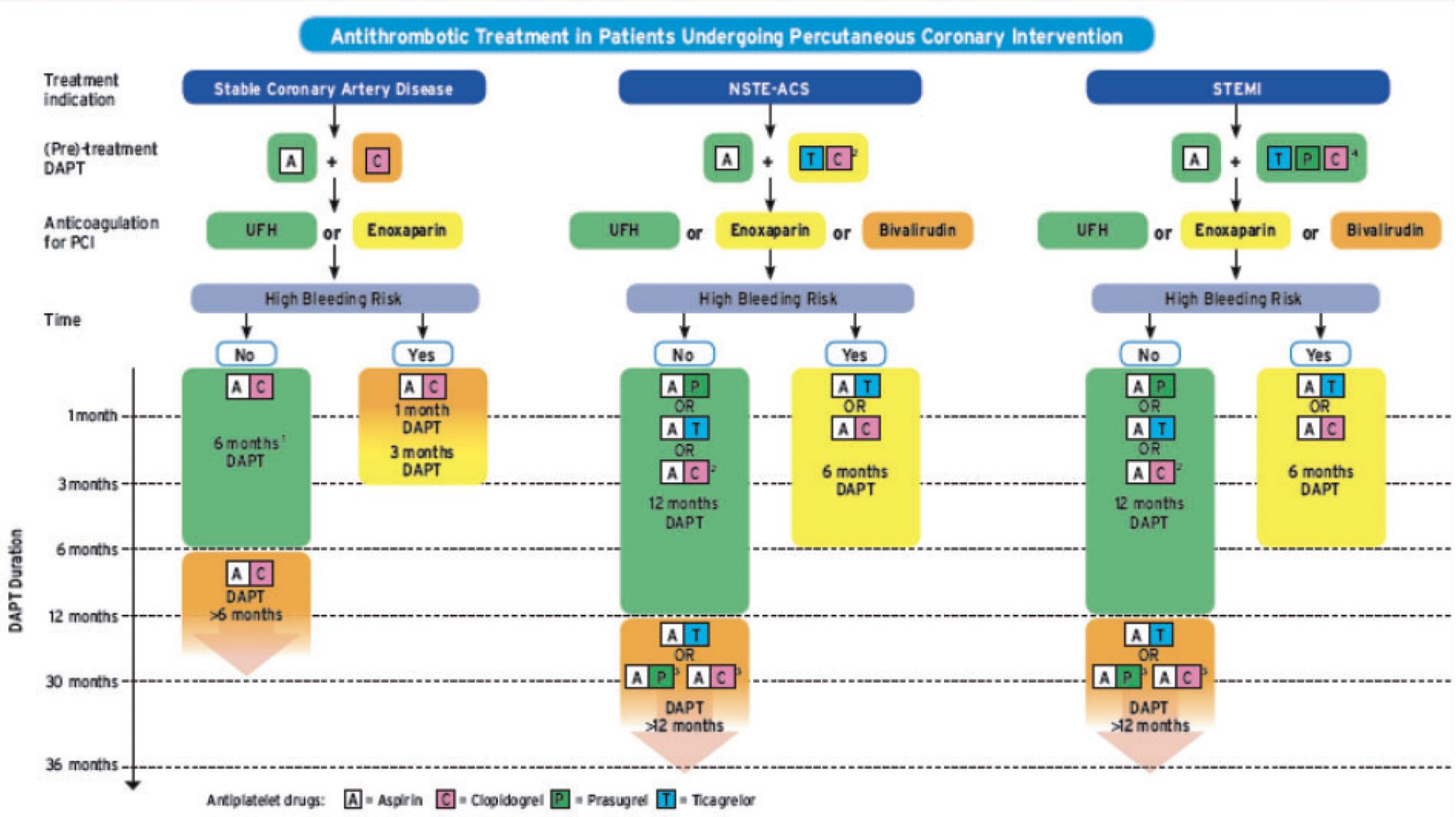




Kuramitsu S et al, Cardiovasc Interv Ther 2021 Apr;36(2):158-168

Lokale Komplikationen

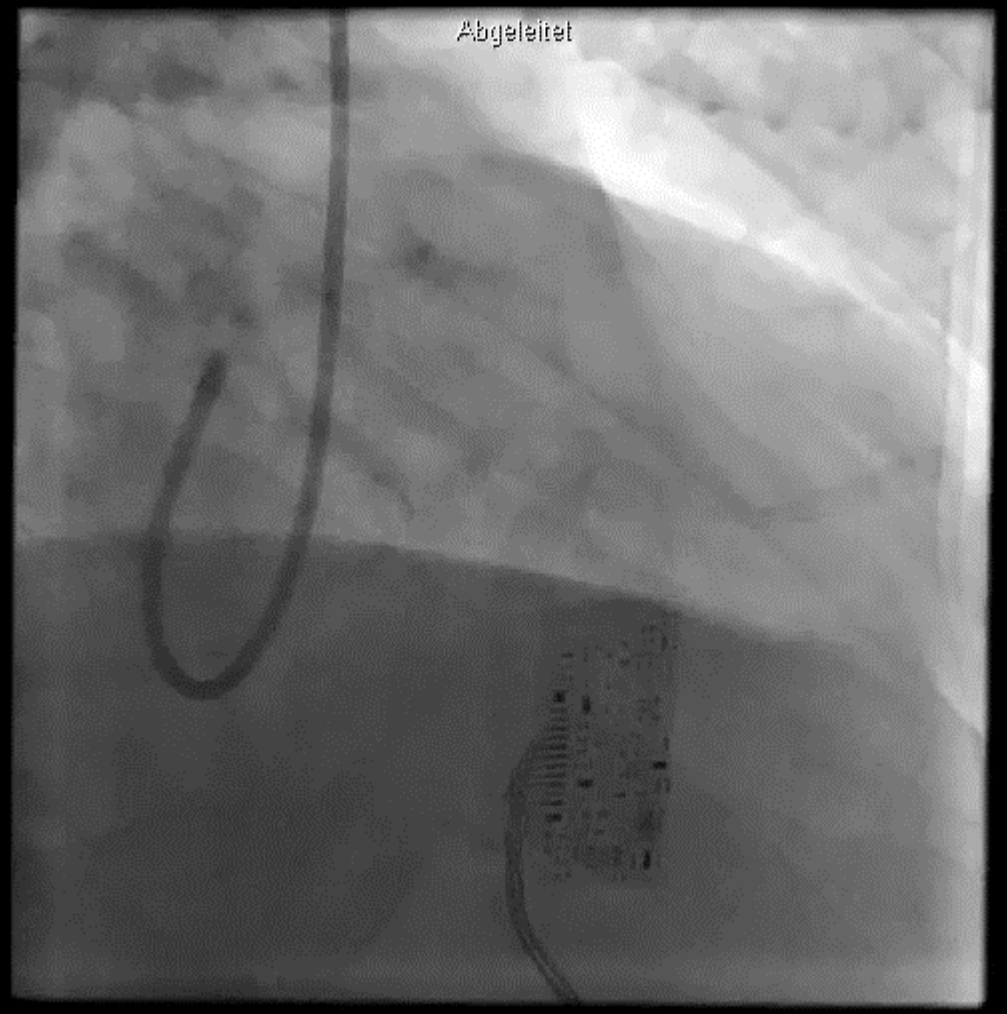
Dual antiplatelet Therapy (DAPT)

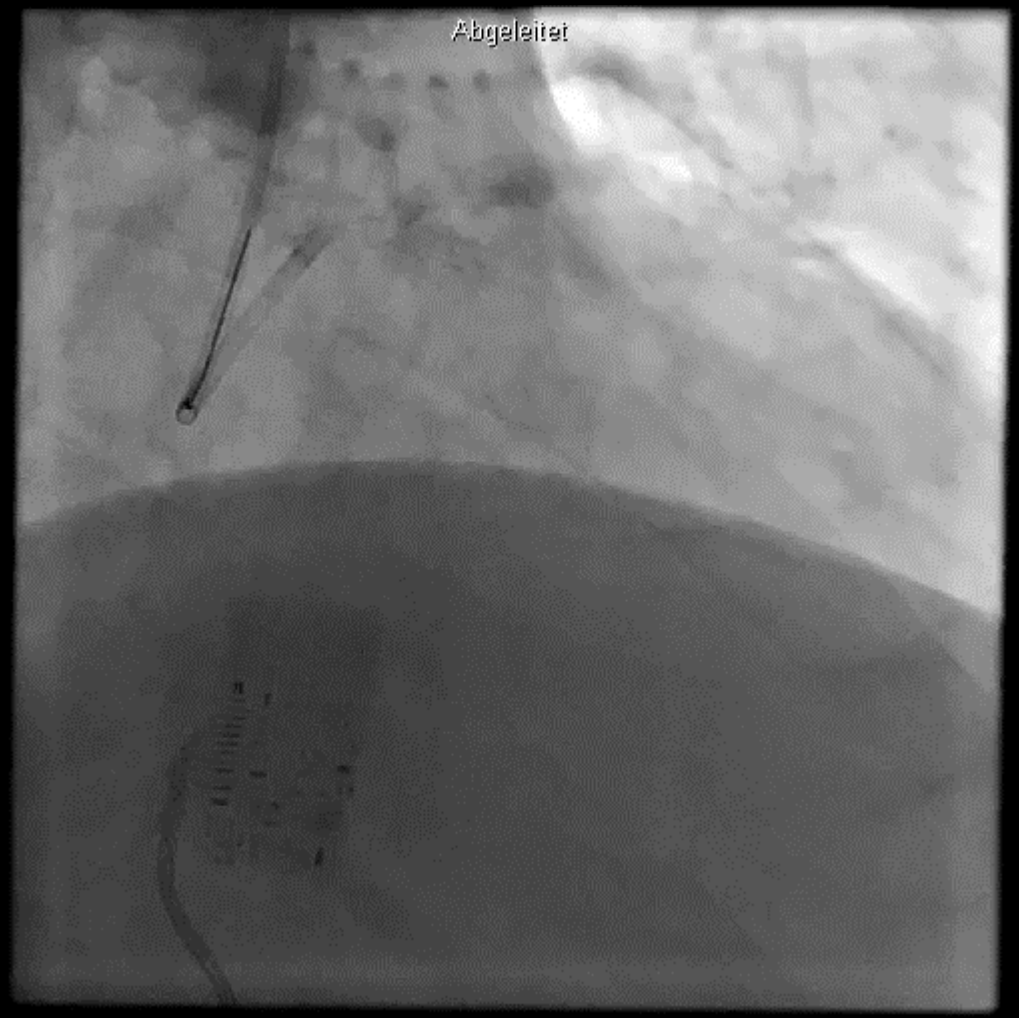


Neumann FJ et al, Eur Heart J 2019 Jan 7;40(2):87-165

Perkutane Koronarintervention: 54-jähriger Mann

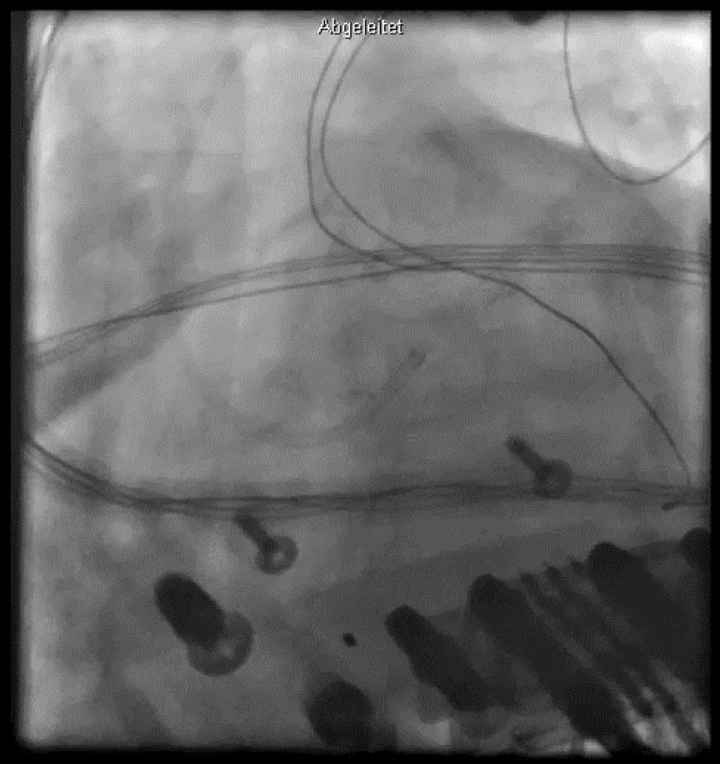
Out-of Hospital Reanimation, anteriorer STEMI

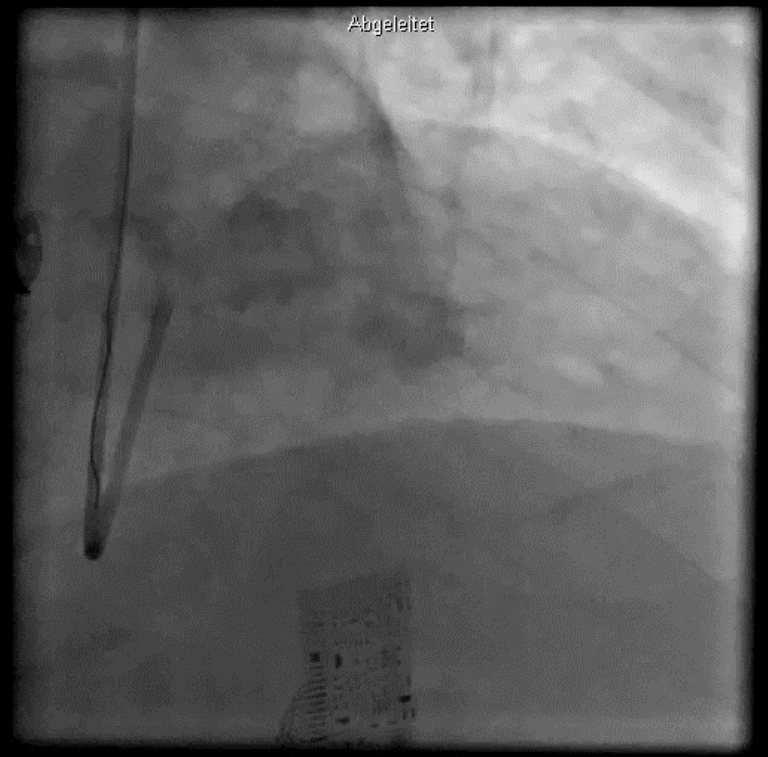




Akute Stentthrombose (DAPT)

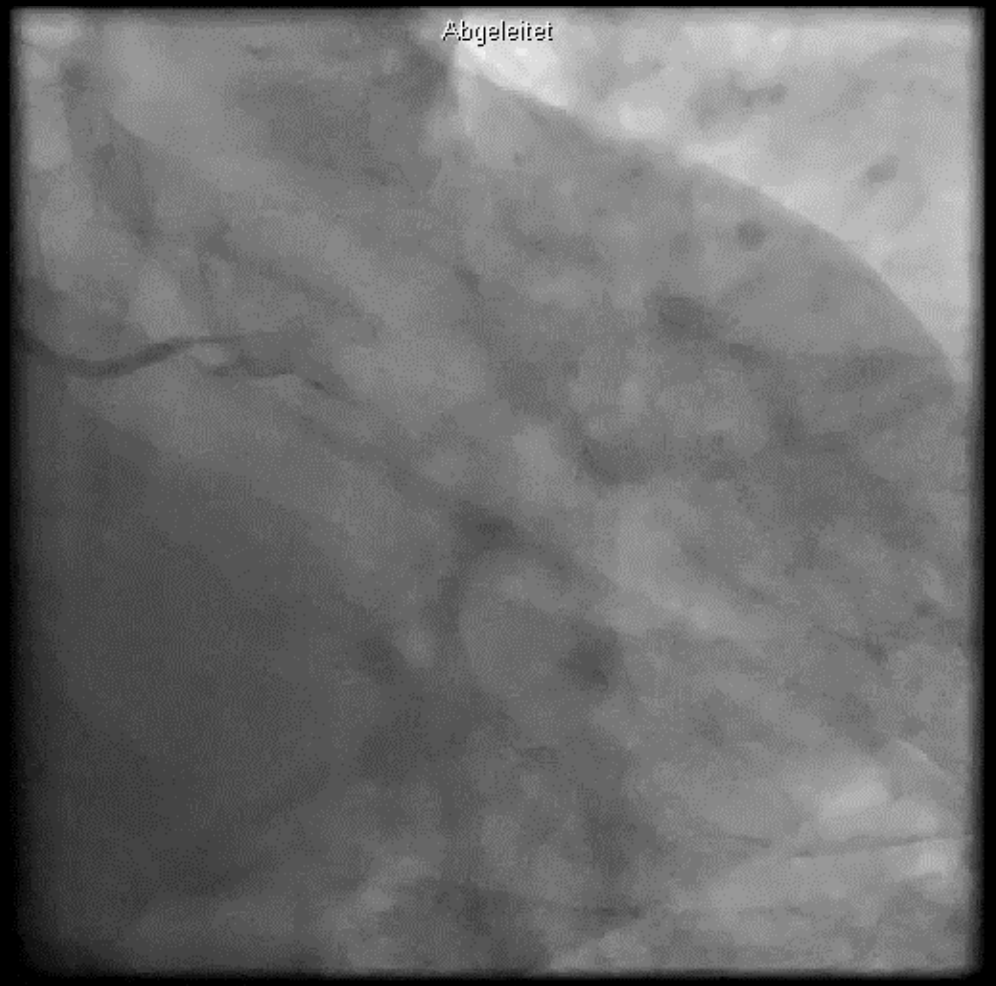
Akute hämodynamische Instabilität unmittelbar nach PCI

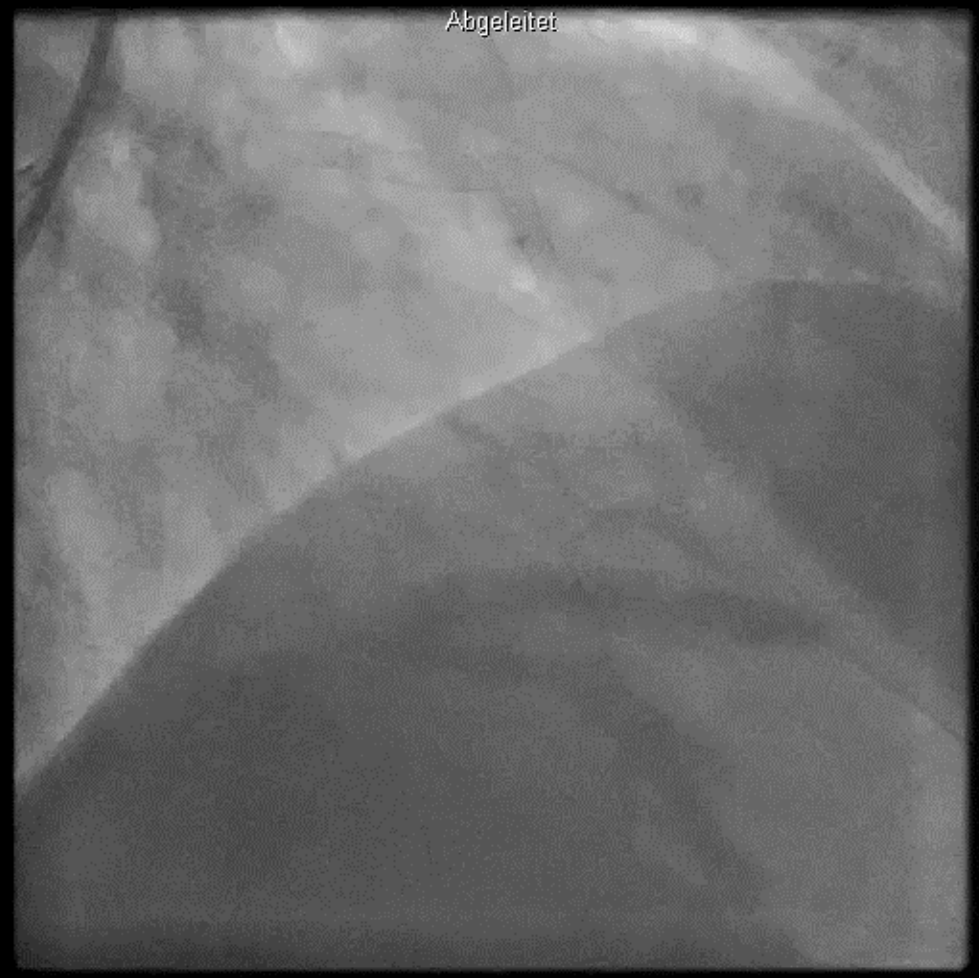




Perkutane Koronarintervention: 66-jähriger Mann

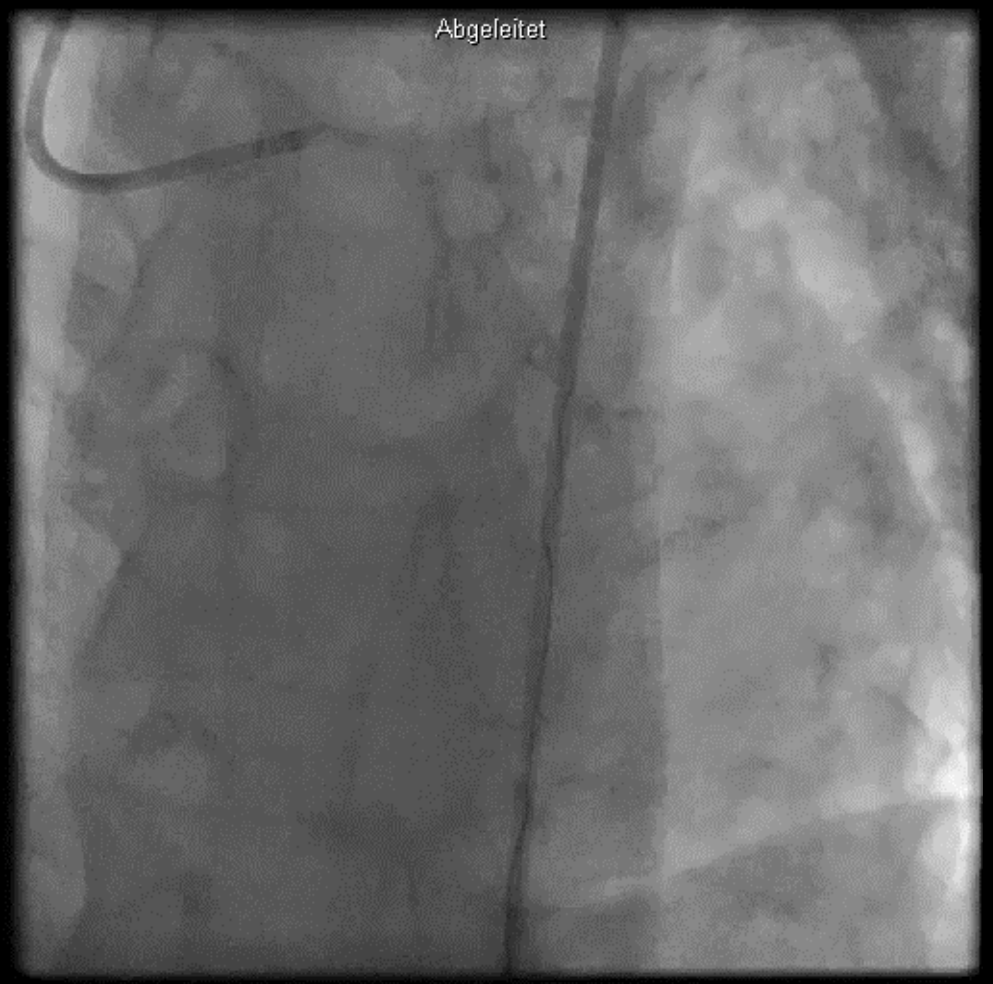
Vorderwandischämie, elektive PCI RIVA/erster Diagonalast





Akute Stentthrombose (Stentexpansion)

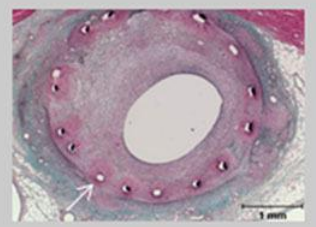
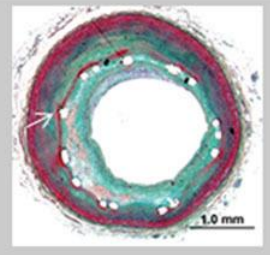
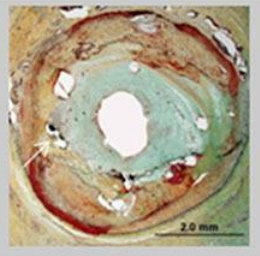
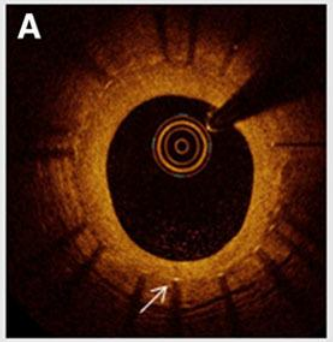
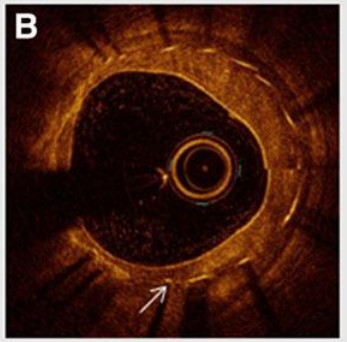
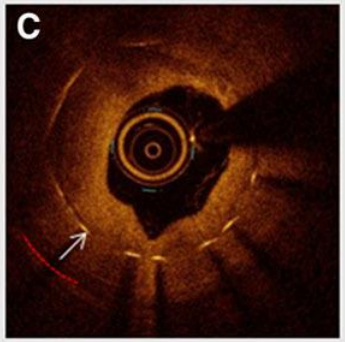
Plötzlicher Schmerz und ST-Hebung



Lokale Komplikationen

Instent-Restenose bei DES

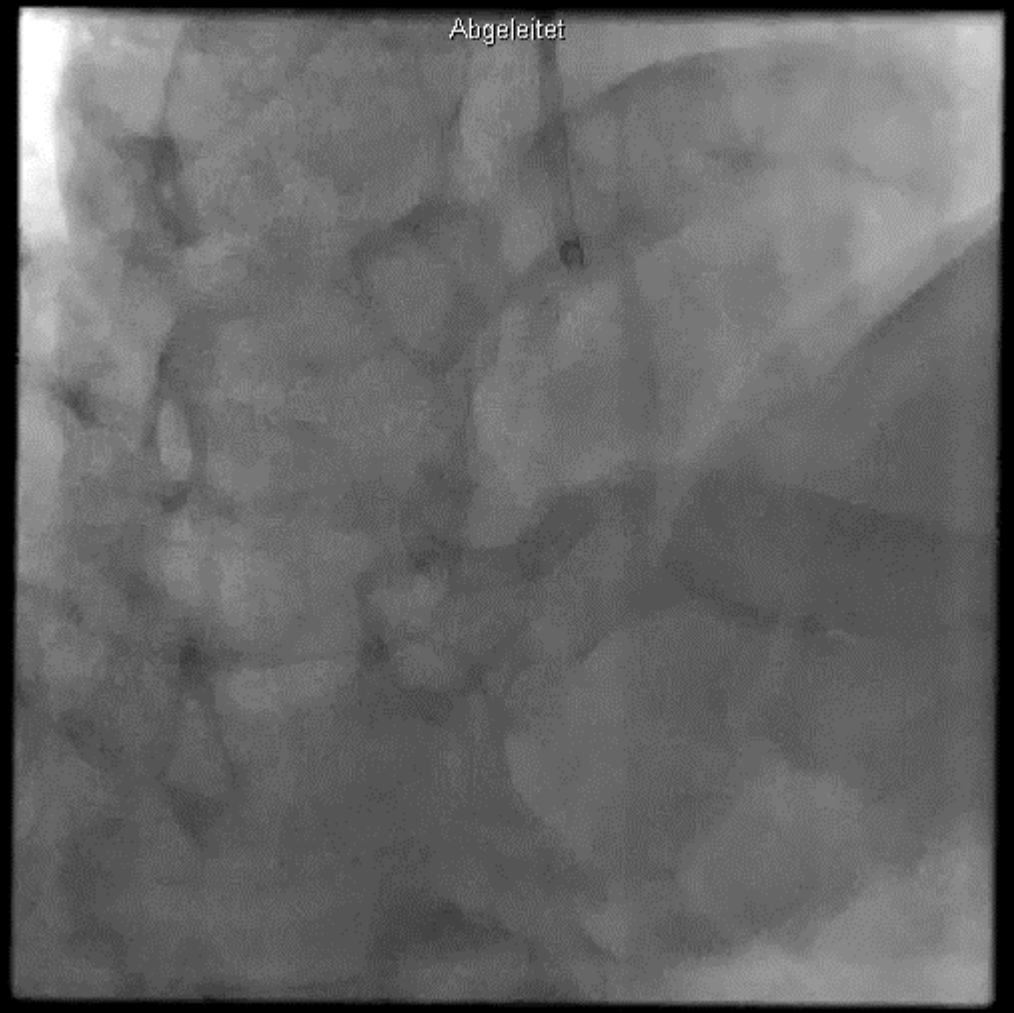
- Häufigkeit 2-10% nach PCI, seltener bei DES als bei BMS
- Erhöhte Morbidität (5-10% Myokardinfarkte)

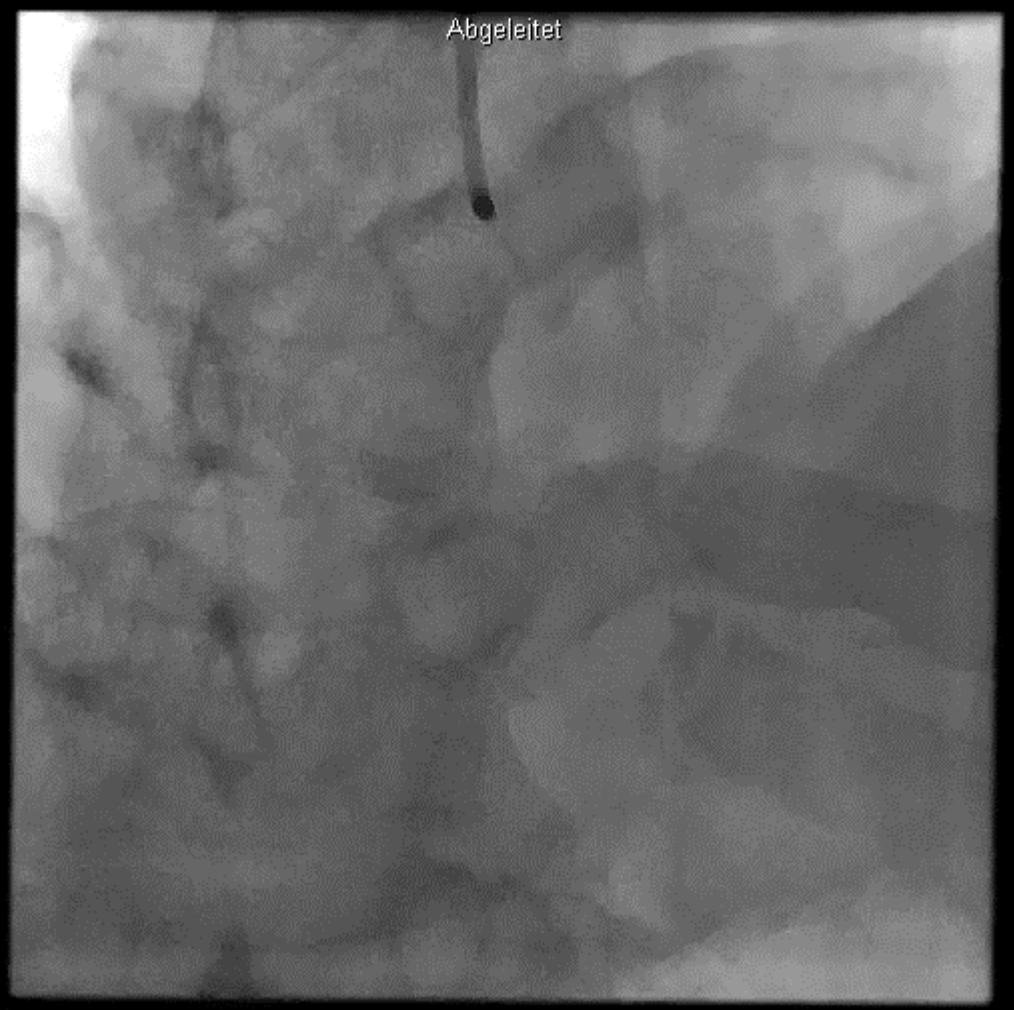
	Neointimal hyperplasia	Neoatherosclerosis	Stent underexpansion
Histopathology			
Representative OCT cross-section			
Characteristic features	Homogenous, bright, uniform layer	Heterogenous composition with in-stent necrotic core with thin fibrous cap, lipid or calcification and foamy macrophage accumulation	Stent area significantly smaller than vessel area

Shlofmitz E et al, Circ Cardiovasc Interv. 2019;12:e007023.

Instent-Restenose: 61-jähriger Mann

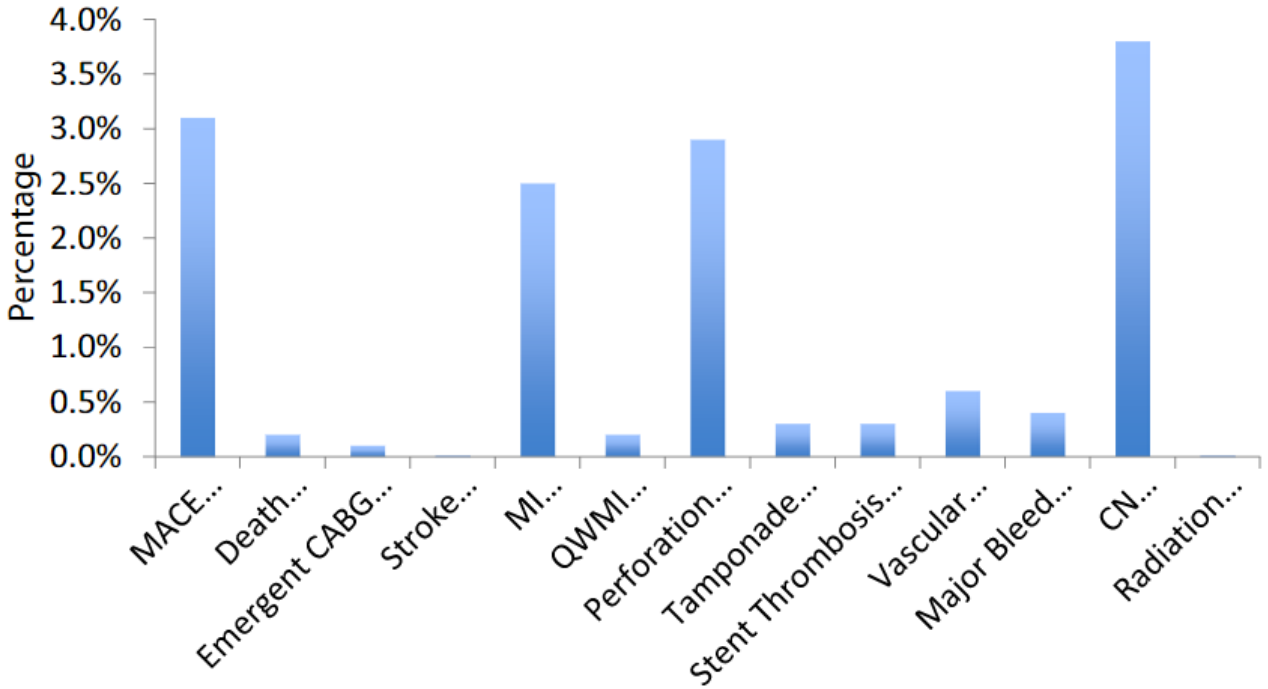
Diabetes und chronische Angina Pectoris

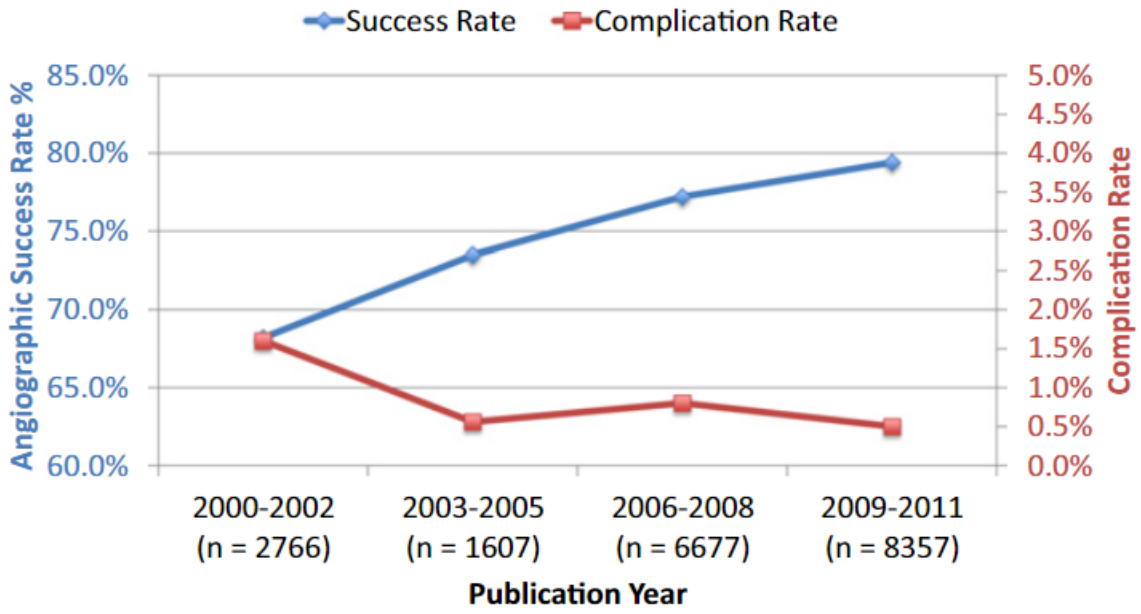




Lokale Komplikationen

CTO und Komplikationen



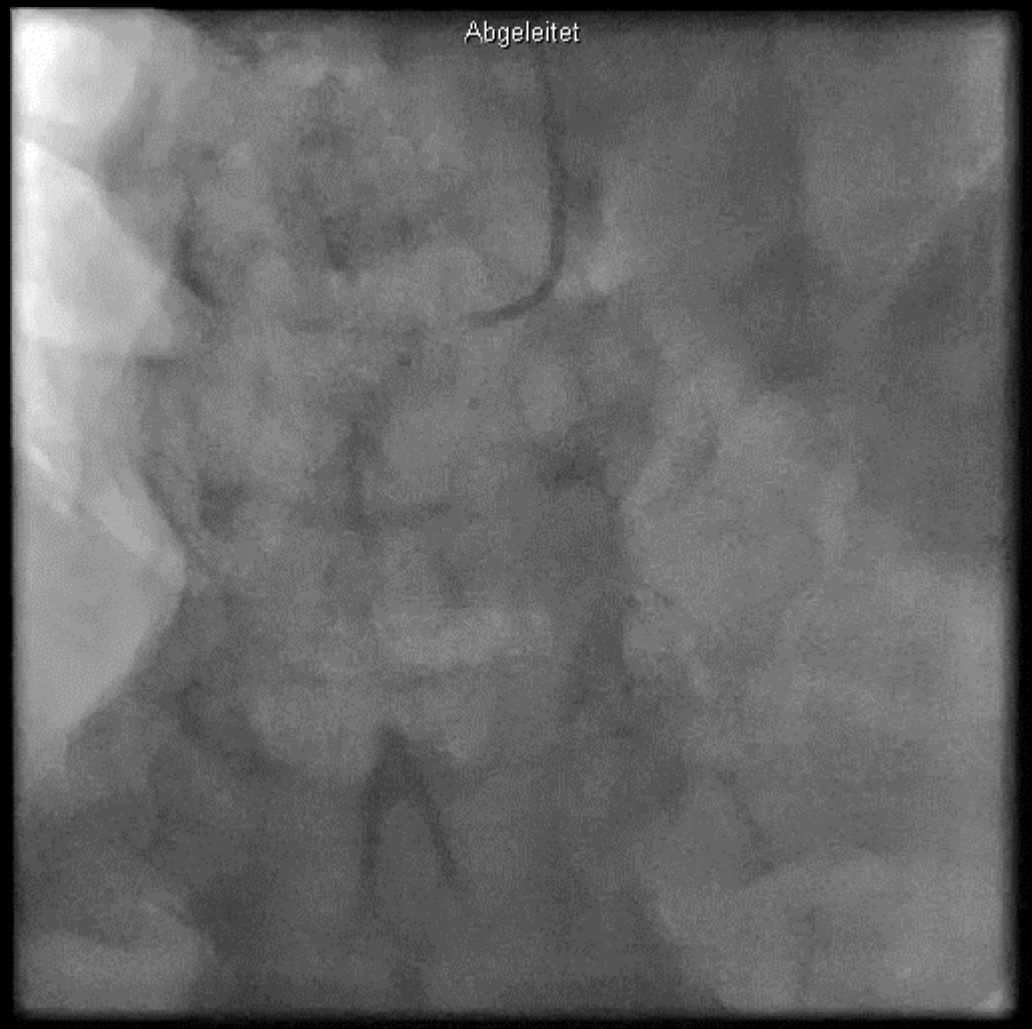


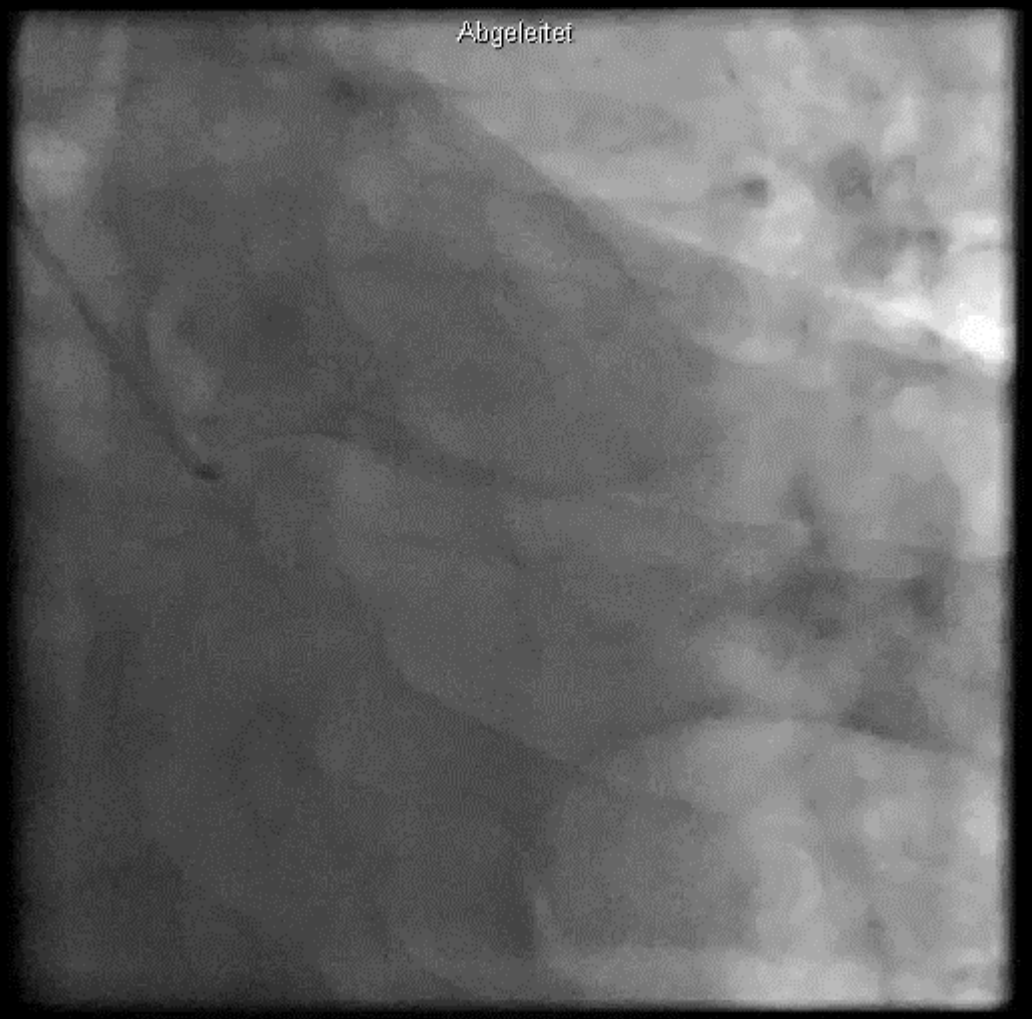
CABG=coronary artery bypass graft; CN=contrast nephropathy;MACE=major adverse cardiac events;
MI=myocardial infarction; QWMI=Q-wave myocardial infarction

Patel VG et al, J Am Coll Cardiol Intv 2013;6:128–36

Koronarangiographie: 66-jähriger Mann

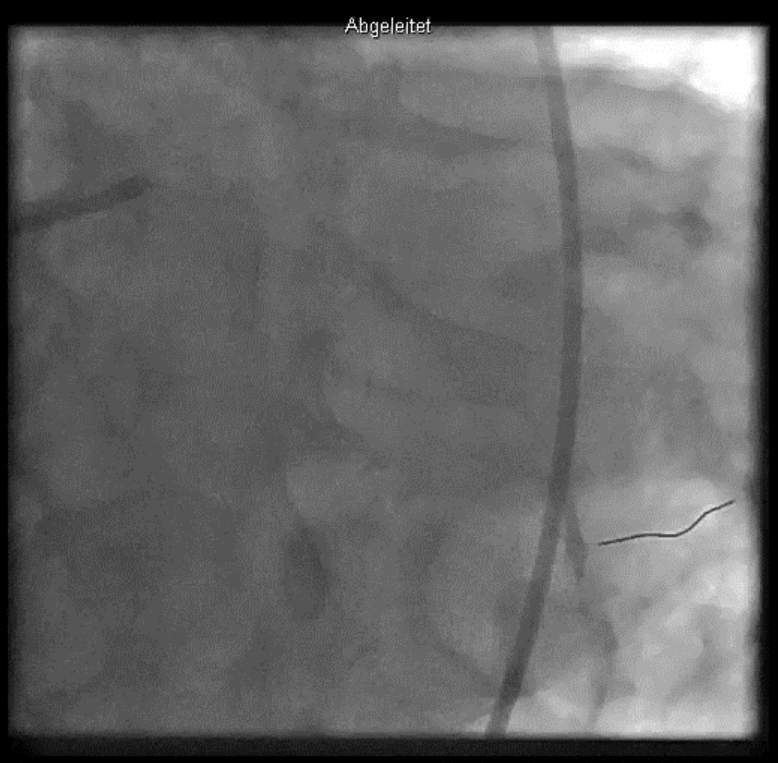
Unklarer Thoraxschmerz und pathologisches Stress-MRI





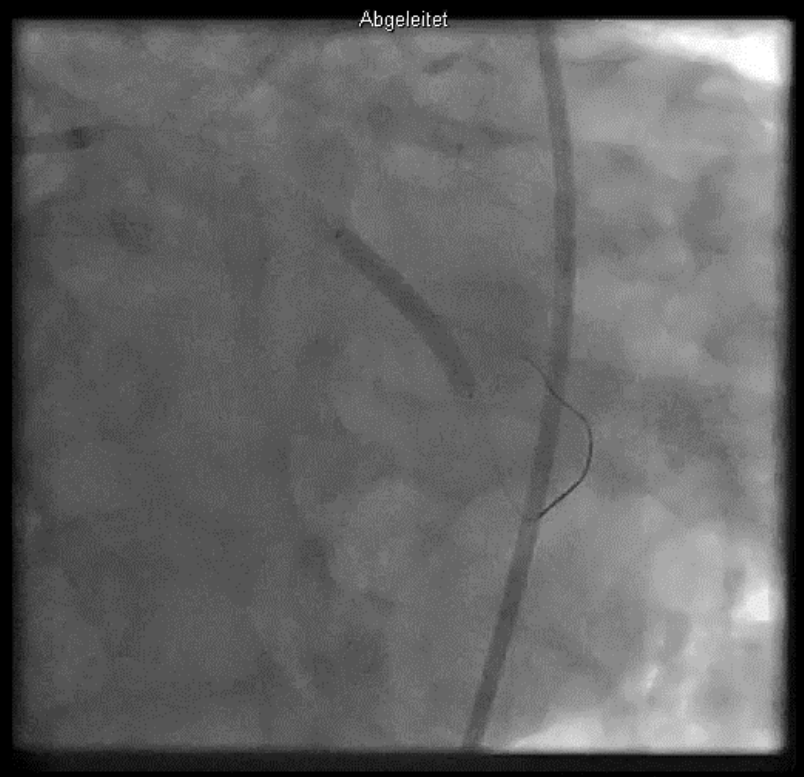
Perkutane Koronarintervention

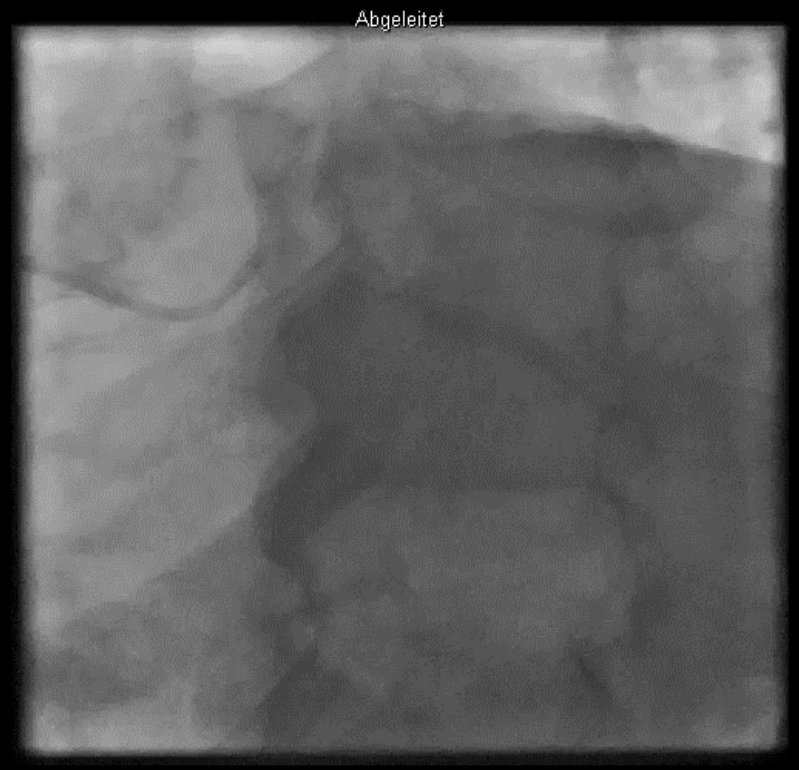
Stark verkalktes Gefäss, Rotablation

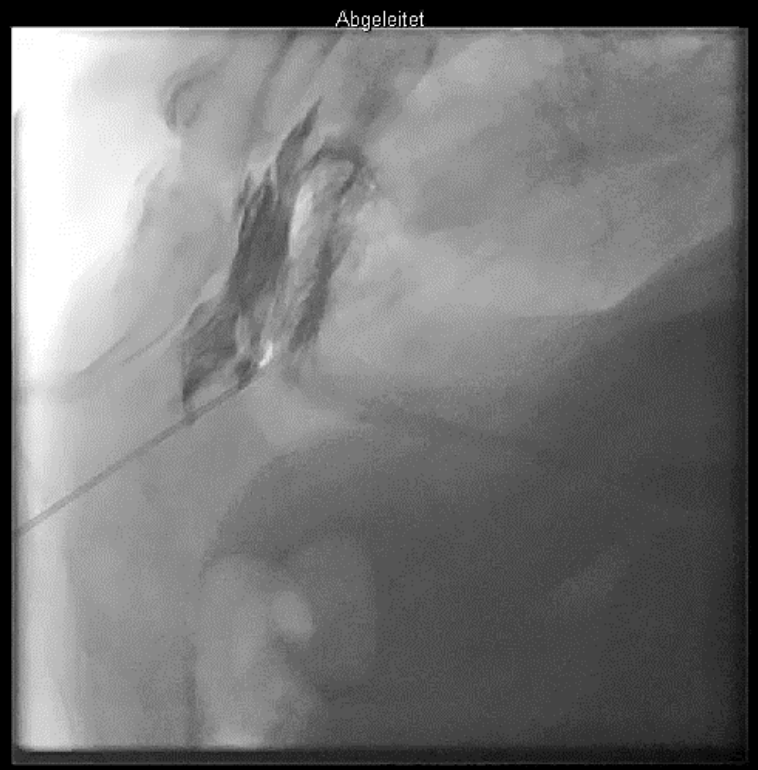


Gefässperforation

Covered Stent (B-Graft) und Perikardiozentese

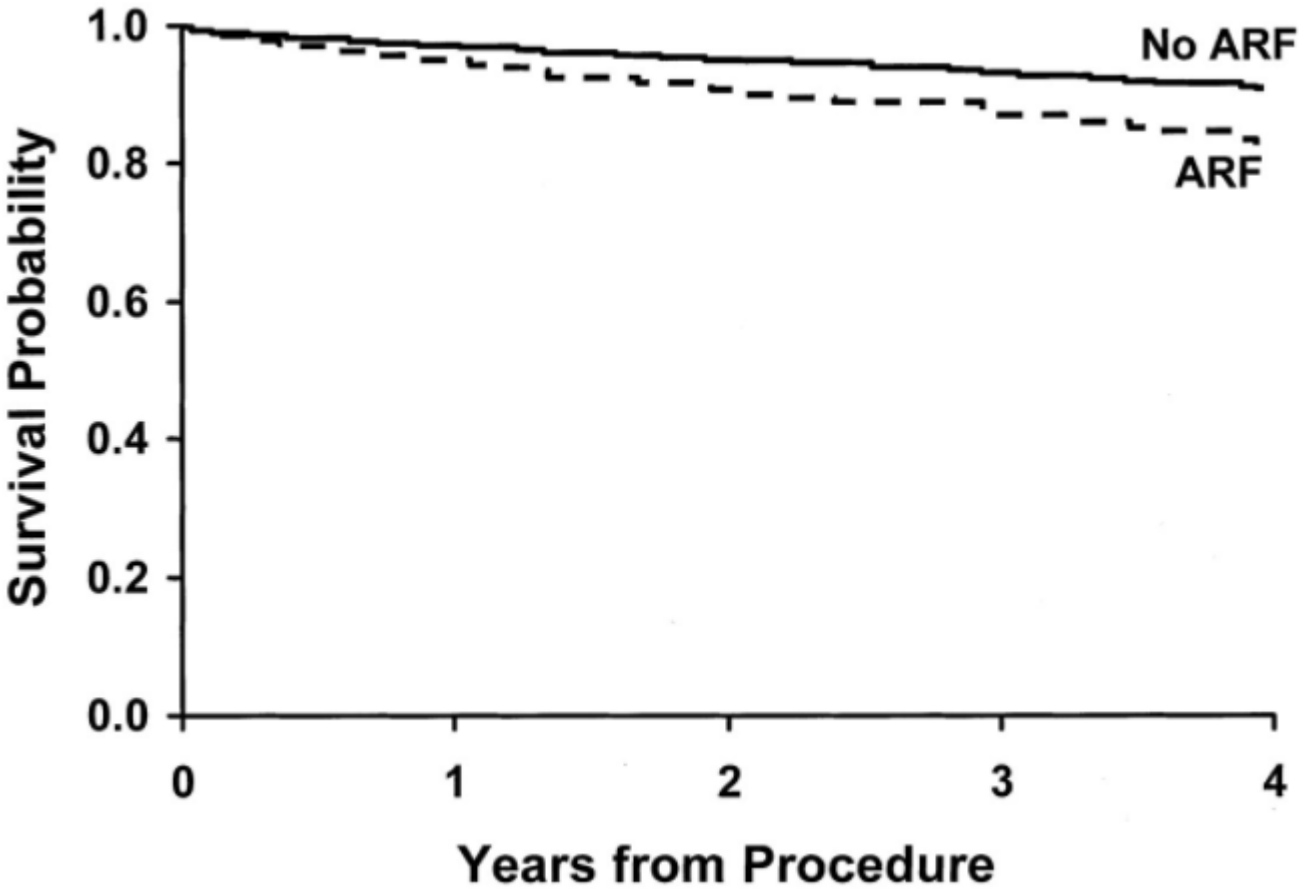






Nicht-kardiale Komplikationen

Kontrastmittel-induzierte Nephropathie



Mayo Clinic Registry
PCI patients (n=7,586)
ARF = increase in serum creatinine [Cr] >0.5 mg/dL (44 µmol/L) from baseline

- Incidence of ARF 3.3%
- Risk factors for ARF: Diabetes or elevated creatinine
- ARF highly associated with death

Rihal CS et al, Circulation Volume 105, Issue 19, 14 May 2002; Pages 2259-2264

Nicht-kardiale Komplikationen

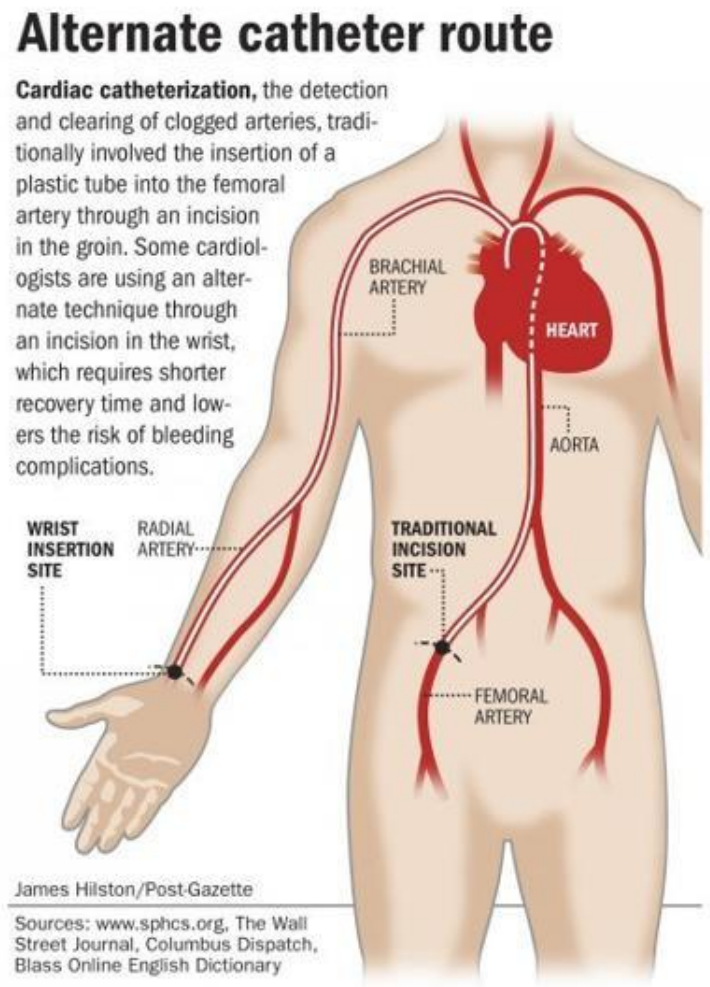
Kontrastmittel-induzierte Nephropathie

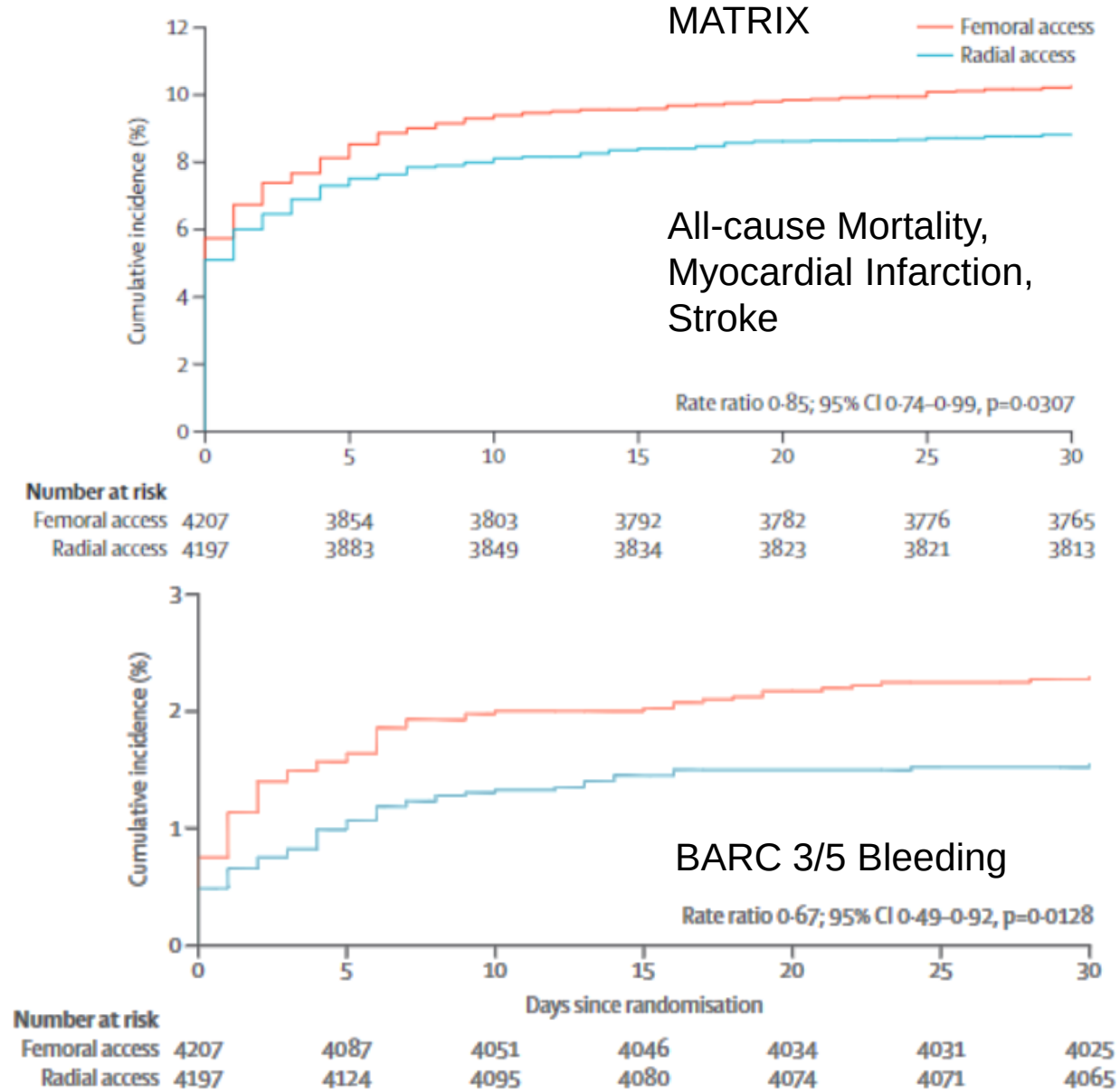
- **Definition:** impairment of renal function following intravenous contrast administration within 48-72 hours
  - 25% rise in serum creatinine from baseline
  - Increase of 0.5 mg/dL (44 µmol/L) in absolute serum creatinine value
- **Etiology:** pre-existing kidney disease and…
  - …a direct cytotoxic effect on the proximal tubules of the kidney
  - …enhanced cellular damage via reactive oxygen species
  - …increased resistance to blood flow in the kidney
  - …exacerbation of renal vasoconstriction, particularly in the medulla
- **Prevention/treatment**
  - Use of low osmolar contrast media
  - Metformin should be withheld for 48 hours and restarted if the renal function is normal
  - Periprocedural hydratation by intravenous (IV) fluid with 0.9% normal saline infusion at a rate of 1 ml/kg/hr for 6 to 12 hours before the procedure and continuing after the procedure
  - No effect of bicarbonate nor acetylcysteine

Modi K et al, StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan.2021 Aug 2.

Nicht-kardiale Komplikationen

Vaskulärer Zugang: Radial vs. femoral





Valgimigli M et al, Lancet 2015;385(9986):2465-76

Kardiale Komplikationen

Fourth Universal Definition of Myocardial Infarction

Universal definitions of myocardial injury and myocardial infarction

Criteria for myocardial injury

The term myocardial injury should be used when there is evidence of elevated cardiac troponin values (cTn) with at least one value above the 99th percentile upper reference limit (URL). The myocardial injury is considered acute if there is a rise and/or fall of cTn values.

Criteria for acute myocardial infarction (types 1, 2 and 3 MI)

The term acute myocardial infarction should be used when there is acute myocardial injury with clinical evidence of acute myocardial ischaemia and with detection of a rise and/or fall of cTn values with at least one value above the 99th percentile URL and at least one of the following:

- Symptoms of myocardial ischaemia;
- New ischaemic ECG changes;
- Development of pathological Q waves;
- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality in a pattern consistent with an ischaemic aetiology;
- Identification of a coronary thrombus by angiography or autopsy (not for type 2 or 3 MIs).

Post-mortem demonstration of acute athero-thrombosis in the artery supplying the infarcted myocardium meets criteria for *type 1 MI*.

Evidence of an imbalance between myocardial oxygen supply and demand unrelated to acute athero-thrombosis meets criteria for *type 2 MI*.

Cardiac death in patients with symptoms suggestive of myocardial ischaemia and presumed new ischaemic ECG changes before cTn values become available or abnormal meets criteria for *type 3 MI*.

Criteria for coronary procedure-related myocardial infarction (types 4 and 5 MI)

Percutaneous coronary intervention (PCI) related MI is termed *type 4a MI*.

Coronary artery bypass grafting (CABG) related MI is termed *type 5 MI*.

Coronary procedure-related MI ≤48 hours after the index procedure is arbitrarily defined by an elevation of cTn values >5 times for *type 4a MI* and >10 times for *type 5 MI* of the 99th percentile URL in patients with normal baseline values. Patients with elevated pre-procedural cTn values, in whom the pre-procedural cTn level are stable (≤20% variation) or falling, must meet the criteria for a >5 or >10 fold increase and manifest a change from the baseline value of >20%. In addition with at least one of the following:

- New ischaemic ECG changes (this criterion is related to *type 4a MI* only);
- Development of new pathological Q waves;
- Imaging evidence of loss of viable myocardium that is presumed to be new and in a pattern consistent with an ischaemic aetiology;
- Angiographic findings consistent with a procedural flow-limiting complication such as coronary dissection, occlusion of a major epicardial artery or graft, side-branch occlusion-thrombus, disruption of collateral flow or distal embolization.

Isolated development of new pathological Q waves meets the *type 4a MI* or *type 5 MI* criteria with either revascularization procedure if cTn values are elevated and rising but less than the pre-specified thresholds for PCI and CABG.

Other types of 4 MI include *type 4b MI* stent thrombosis and *type 4c MI* restenosis that both meet *type 1 MI* criteria.

Post-mortem demonstration of a procedure-related thrombus meets the *type 4a MI* criteria or *type 4b MI* criteria if associated with a stent.

Thygesen K et al, J Am Coll Cardiol 2018 Oct 30;72(18):2231-2264

Komplikationen nach PCI
Chirurgischer Backup?

Universitätsspital Basel

C-Port Registry (n=18,867)

Outcome	No On-Site Cardiac Surgery	On-Site Cardiac Surgery	Difference in Rate (Asymptotic One-Sided 95% CI)	P Value	
				Noninferiority	Superiority
	no./total no. (%)		*percentage points*		
Primary end point (intention-to-treat population)					
Death at 6 wk	132/14,149 (0.9)	46/4718 (1.0)	−0.04 (−0.31 to 0.23)	0.004	
9-mo outcomes					
Death	454/14,149 (3.2)	150/4718 (3.2)			
TVR	915/14,149 (6.5)	255/4718 (5.4)			0.01
Q-wave myocardial infarction	434/14,149 (3.1)	144/4718 (3.1)			
Major adverse cardiac event	1716/14,149 (12.1)	529/4718 (11.2)	0.92 (0.04 to 1.80)	0.05	

Aversano T et al, N Engl J Med 2012;366:1792-802

Komplikationen nach PCI

Take-home Messages

- Koronarangiographie und perkutane Koronarintervention sind sehr häufige kardiologische Untersuchungen und werden in der Schweiz in zunehmender Frequenz durchgeführt
- Koronarangiographie und perkutane Koronarintervention sind ausgereifte und sichere Eingriffe mit tiefen Komplikationsraten
- Eine gute Indikationsstellung zur invasiven Abklärung und Therapie ist zentral
- Zu den Komplikationen gehören lokale Komplikationen am Koronargefäss sowie kardiale und nicht-kardiale Komplikationen
- Zur Verhinderung von Komplikationen wichtig sind ein erfahrenes Team, das richtige Material, die richtige Technik und eine gute Antikoagulation
- Bei Auftreten von Komplikationen ist die rasche Reaktion eines erfahrenen Teams essentiell, wobei ein (herz-) chirurgischer Backup nicht notwendig ist

Vielen Dank für Ihre Aufmerksamkeit!

raban.jeger@usb.ch