

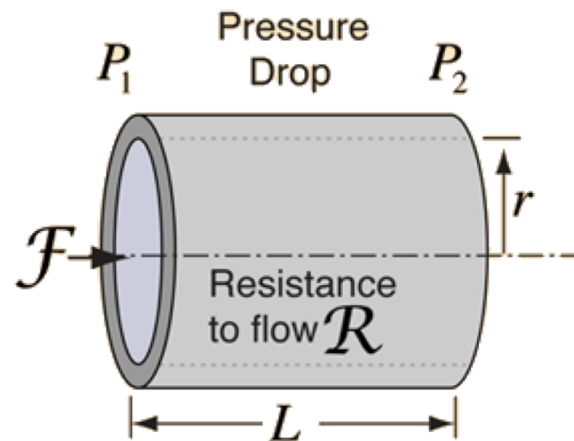
Go with the FLOW...

FFR en iFR: Drukmetingen in het kath-lab

Lieuwe H. Piers

Interventiecardioloog

September 2018



Indeling

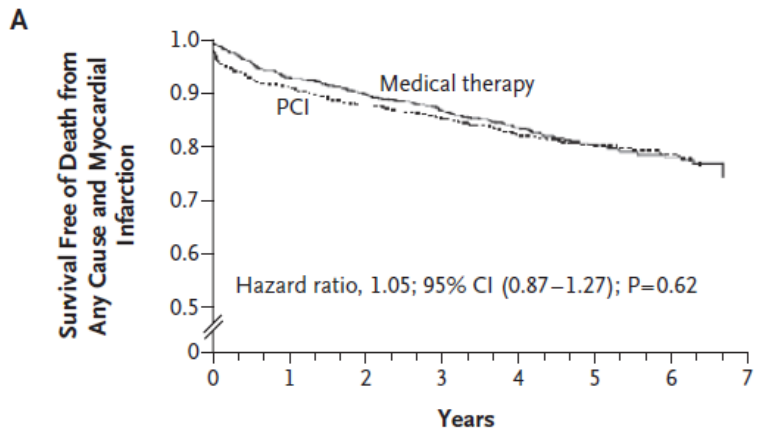
- Achtergrond
 - Waarom metingen uitvoeren?
 - Meten van flow.
 - Conceptueel verschil tussen FFR en iFR.
- Quiz: significant of niet?
 - 10 CAG's
- Correcte uitvoering van drukmeting
- FFR
- iFR
- Resultaten Quiz
- Relatie tussen FFR en iFR
- Conclusie

Take home messages

- Met FFR en iFR meten we druk en dat zegt iets over de bloedstroom.
- Schatten van ernst stenose met het oog bij angiografie is onbetrouwbaar.
- FFR en iFR meten niet precies hetzelfde.
- Op basis van FFR én iFR betrouwbaar beslissing te nemen over wel/niet dotteren.
- Bij twijfel over ernst stenose: doe een FFR of iFR.
- Verschil tussen FFR en iFR mogelijk te verklaren door (problemen in de) microvasculatuur.

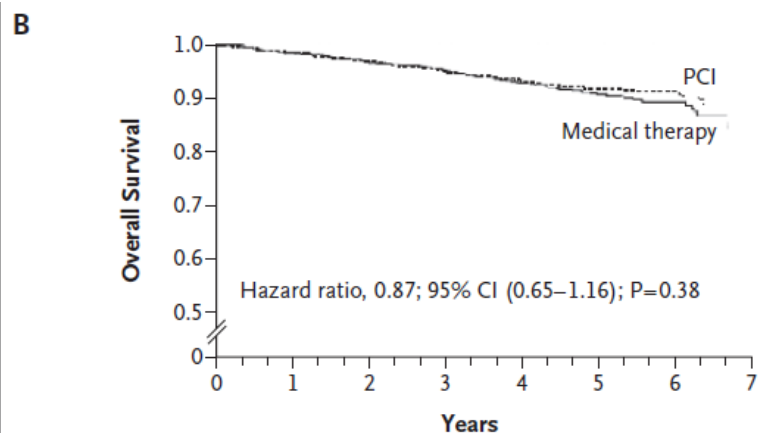
Achtergrond





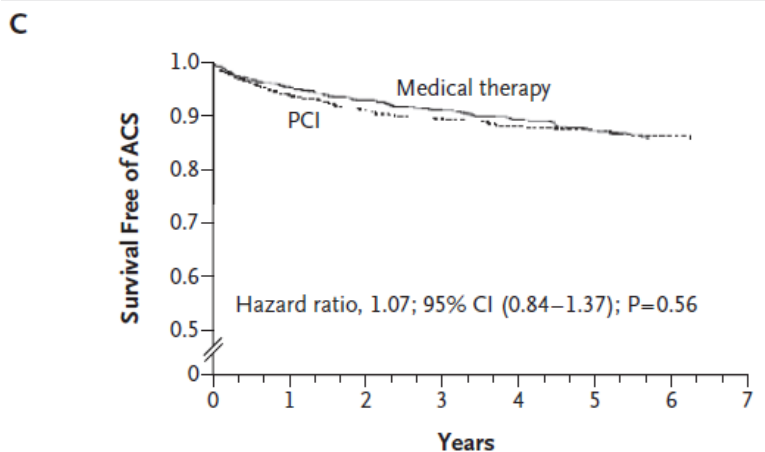
No. at Risk

Medical therapy	1138	1017	959	834	638	408	192	30
PCI	1149	1013	952	833	637	417	200	35



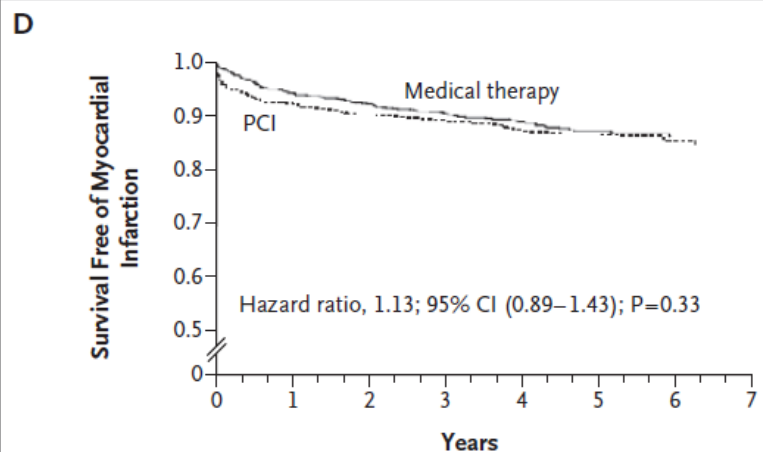
No. at Risk

Medical therapy	1138	1073	1029	917	717	468	302	38
PCI	1149	1094	1051	929	733	488	312	44



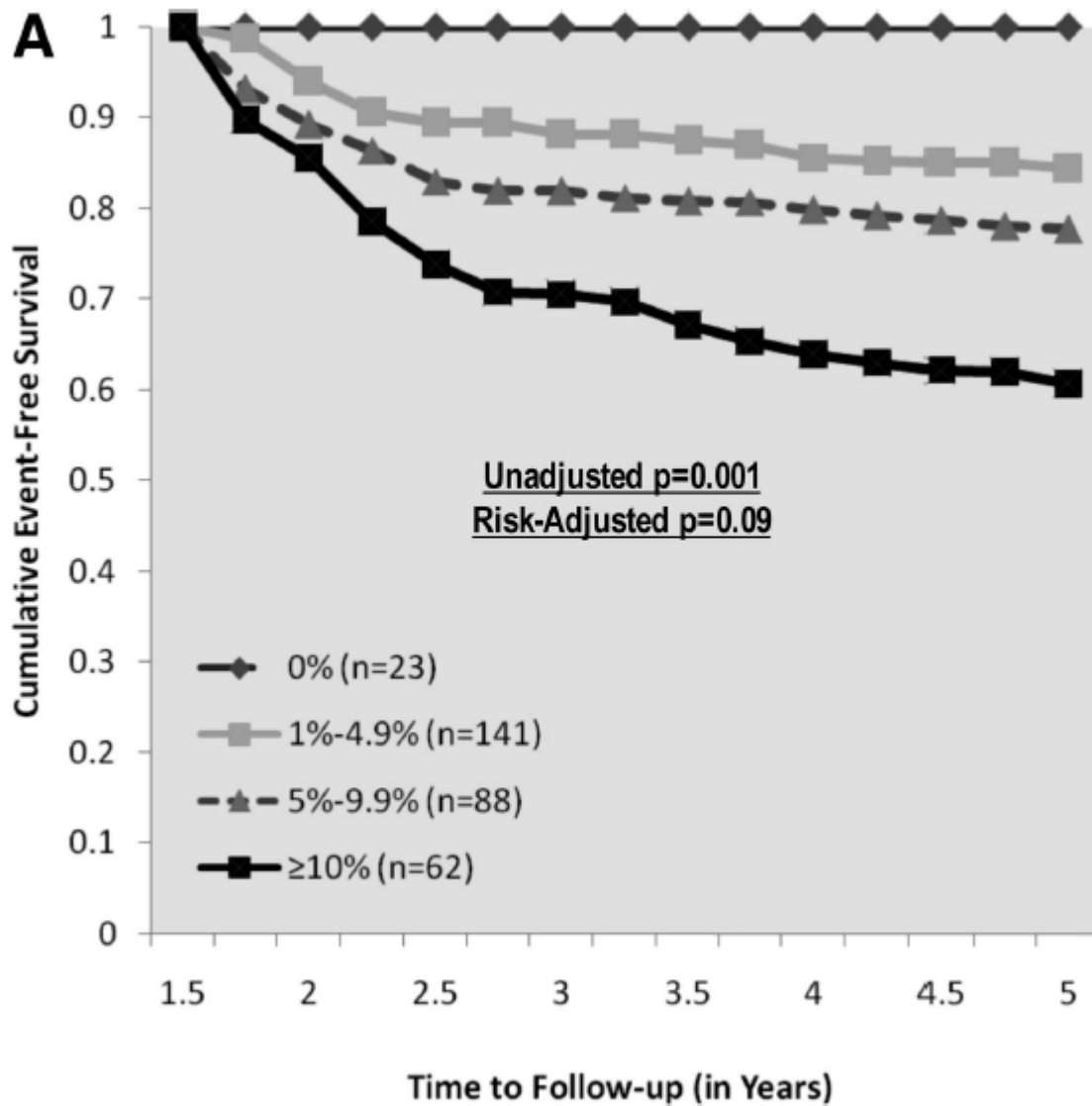
No. at Risk

Medical therapy	1138	1025	956	833	662	418	236	127
PCI	1149	1027	957	835	667	431	246	134

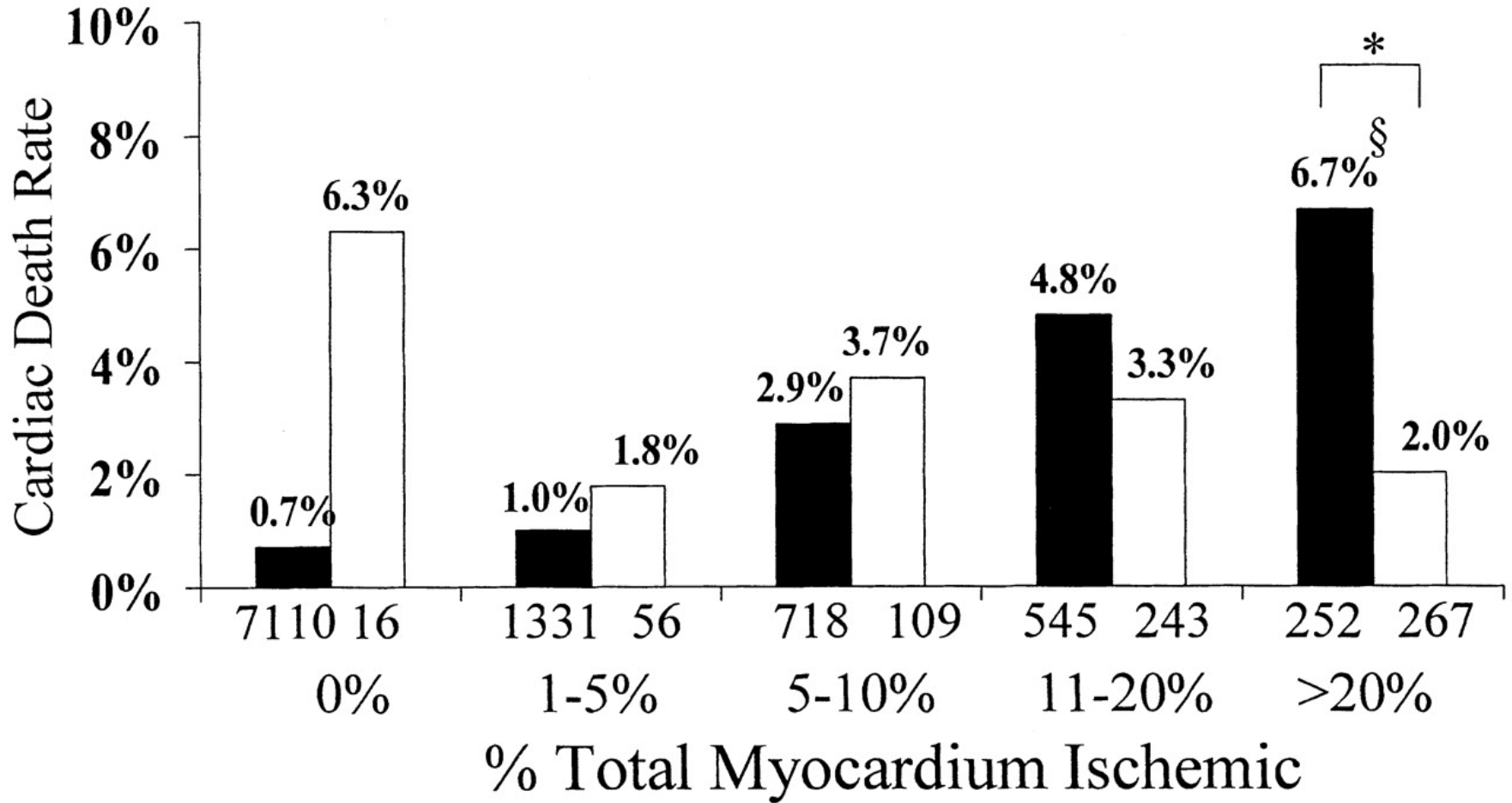


No. at Risk

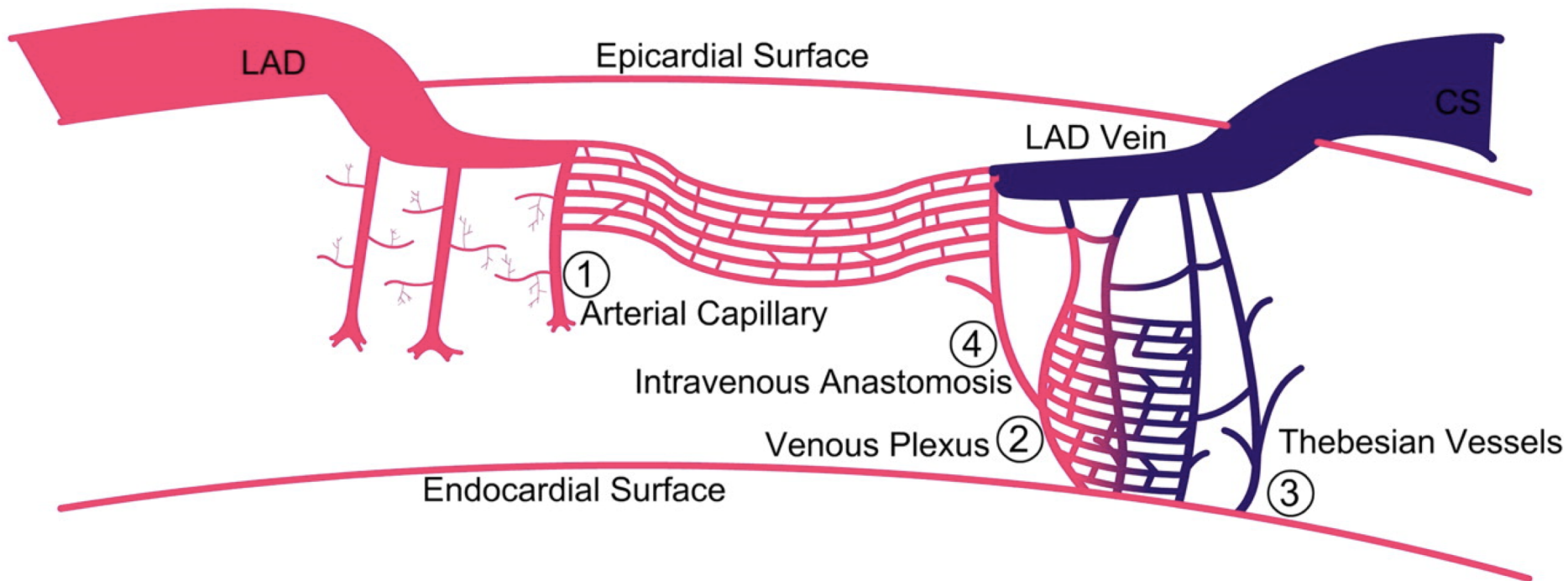
Medical therapy	1138	1019	962	834	638	409	192	120
PCI	1149	1015	954	833	637	418	200	134



■ Medical Rx □ Revasc

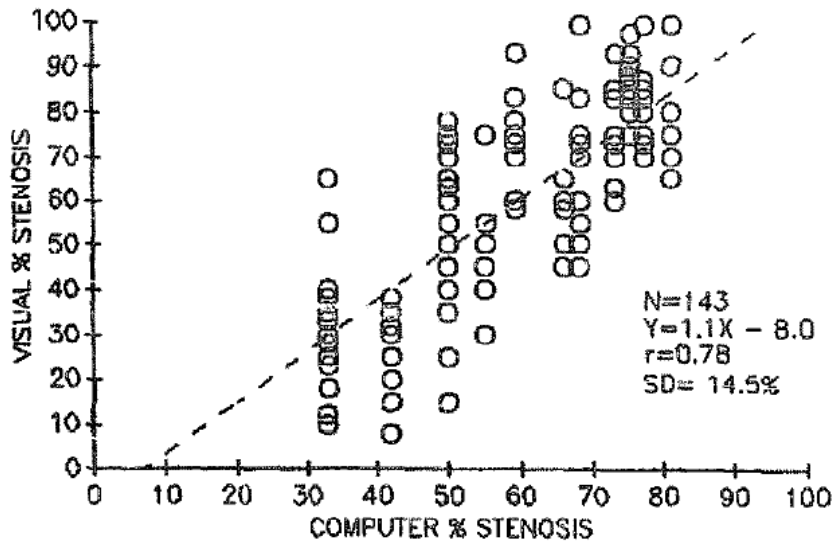


- Ischemie: flow is onvoldoende om aan de vraag van het myocard naar zuurstof te voldoen op dat moment

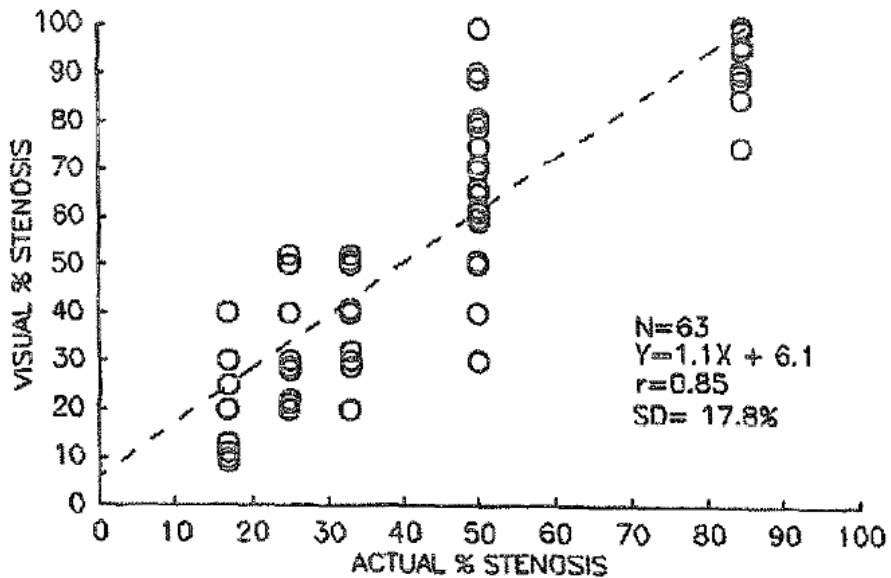




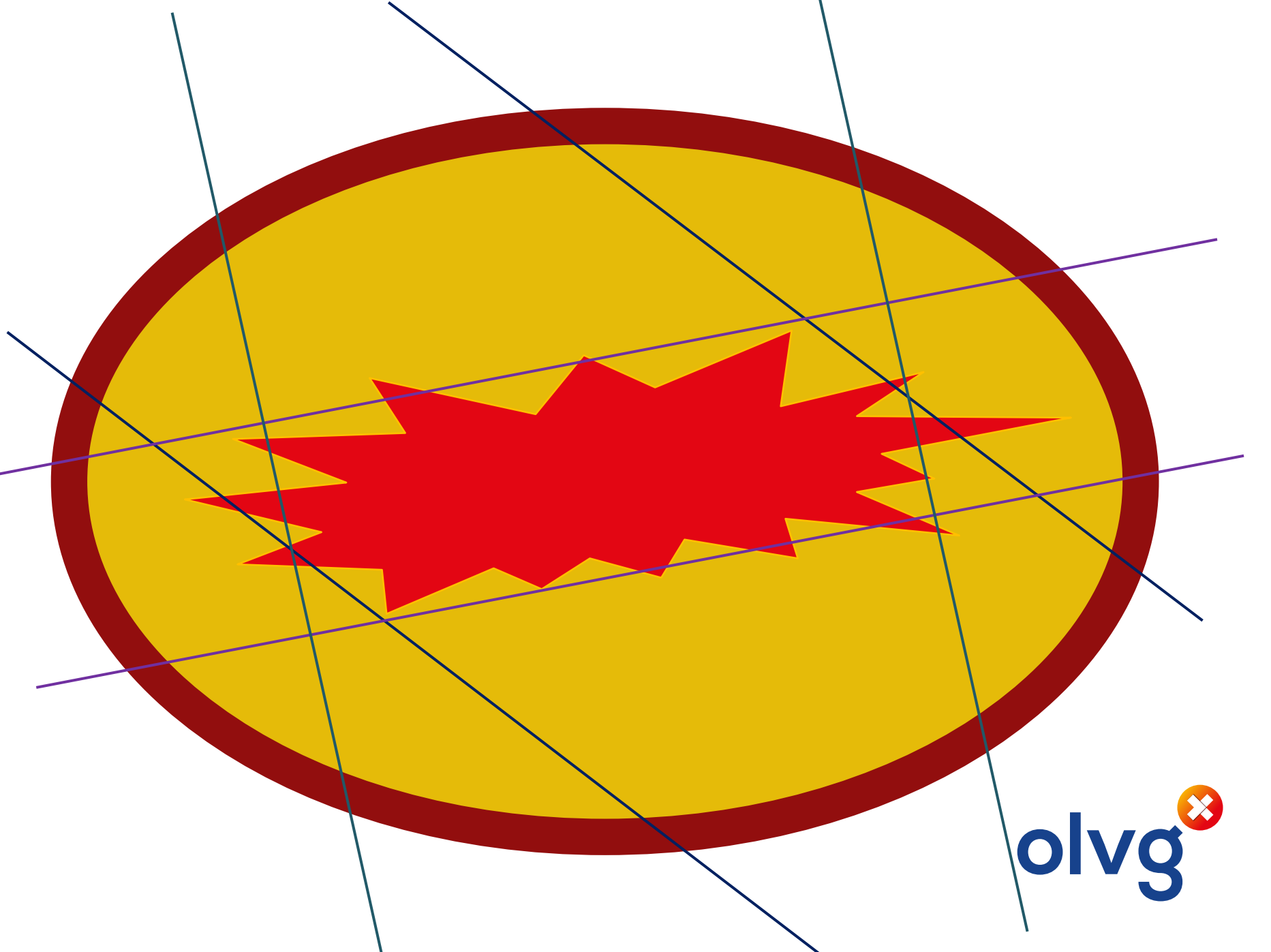
Klinisch coronairangiografie



Computermodel



Beauman JACC 1990



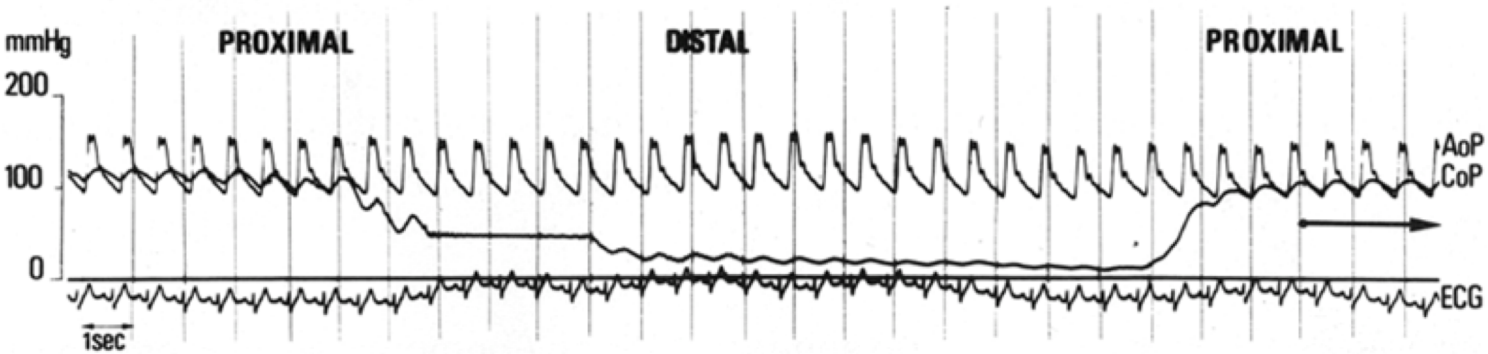
olvg⁺



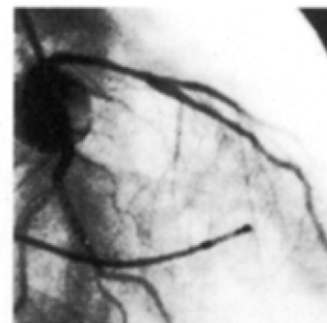
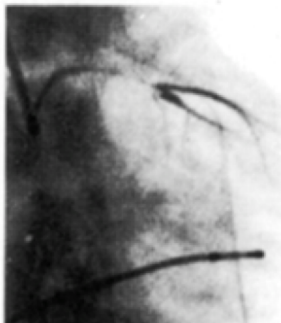
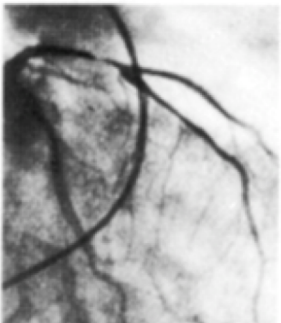
ADVANCING CATHETER CM INJECTION THROUGH STENOSIS

DILATATION OF STENOSIS

DEFLATION OF BALLON AND PULL BACK →



B.A.σ 1939



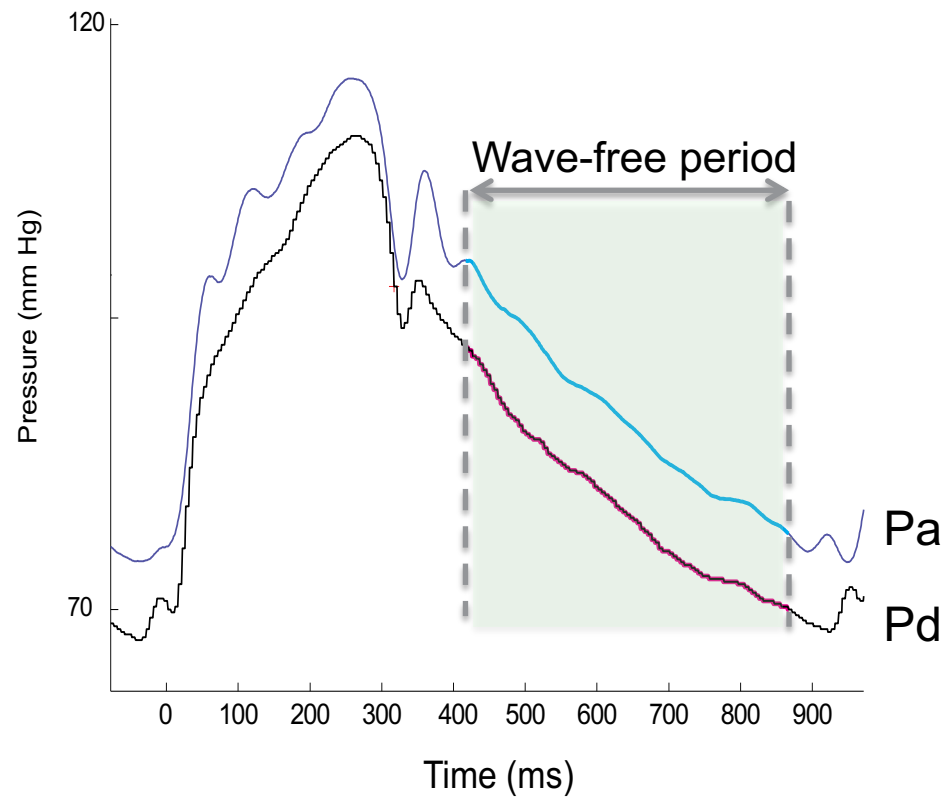
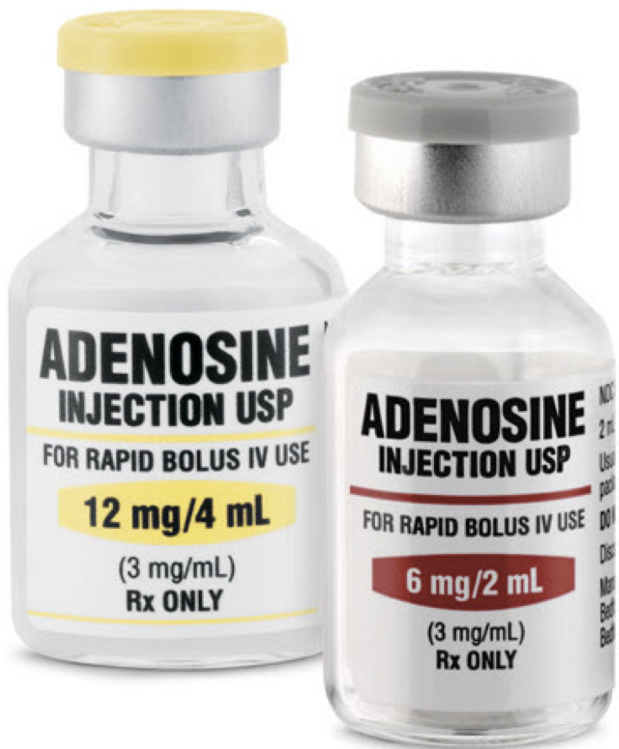
$$P = Q \times R$$

Druk = Flow x Weerstand

$$P_d = Q_d \times R_d$$

$$P_a = Q_a \times R_a$$

Wanneer de **Weerstand (R)** constant is, zijn de veranderingen in **Druk (P)** evenredig met veranderingen in **Flow (Q)**

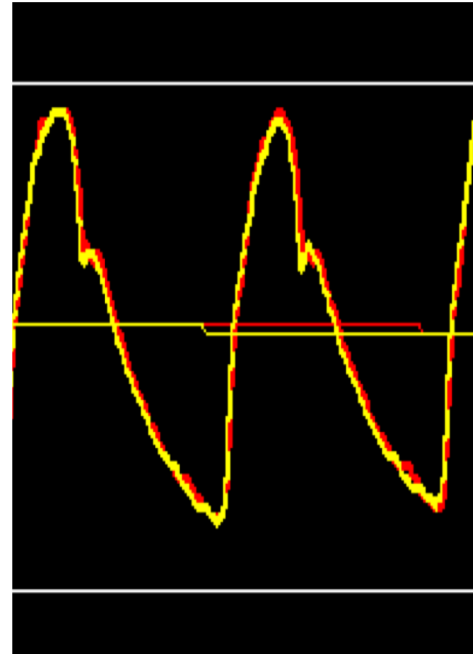
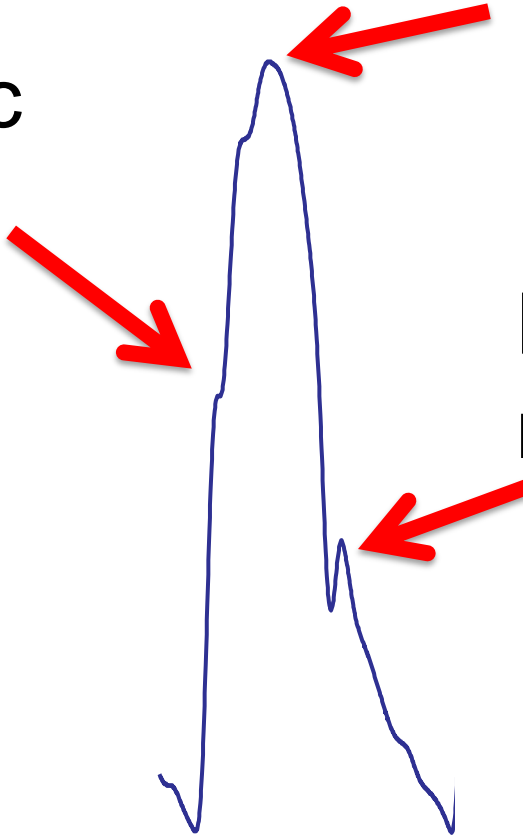


Correcte uitvoering van drukmeting

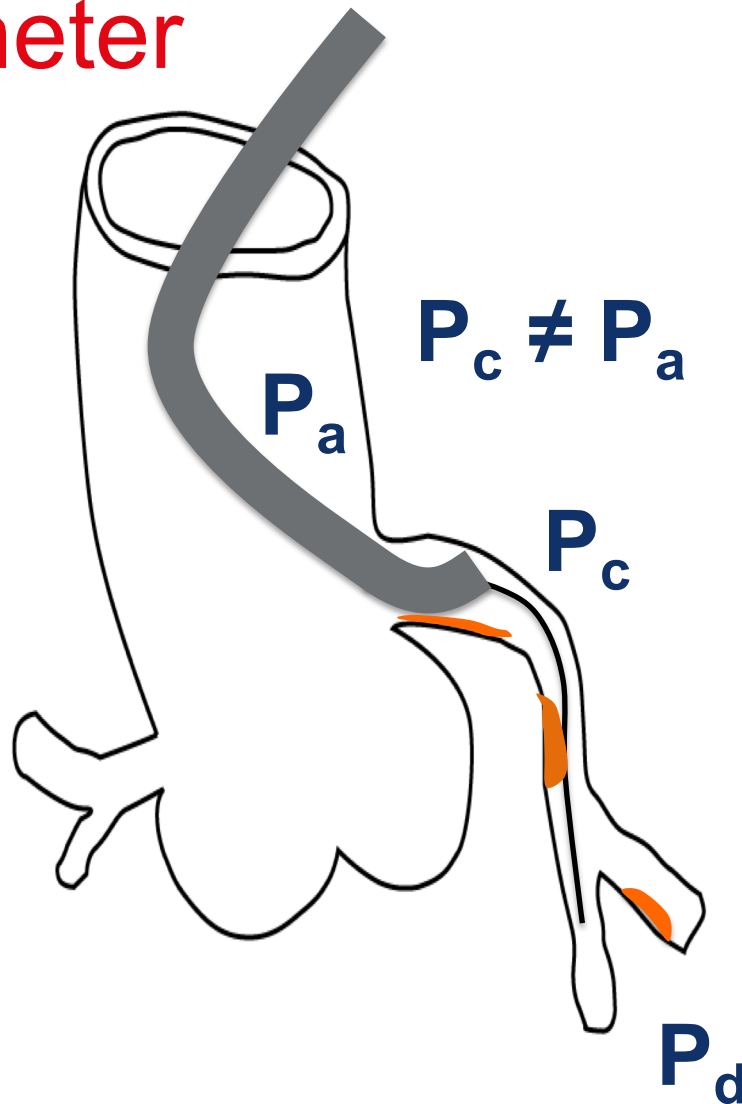
Anachrotic notch

Peak pressure

Diachrotic notch



Let op eventuele wedging van de katheter



$\frac{P_d}{P_a}$ \uparrow FFR of iFR

Ernst van de stenose wordt onderschat

Geef nitroglycerine intracoronair voor alle metingen

- Nitroglycerine minimaal 200 mcg intracoronair
- Geven voor positioneren van draad
- Geven voor normaliseren
- Voorkomt spasme door de draad
- Zorgt voor maximale vasodilatatie van het epicardiale vat en minimaliseert weerstand epicardiale vat

Correct normaliseren

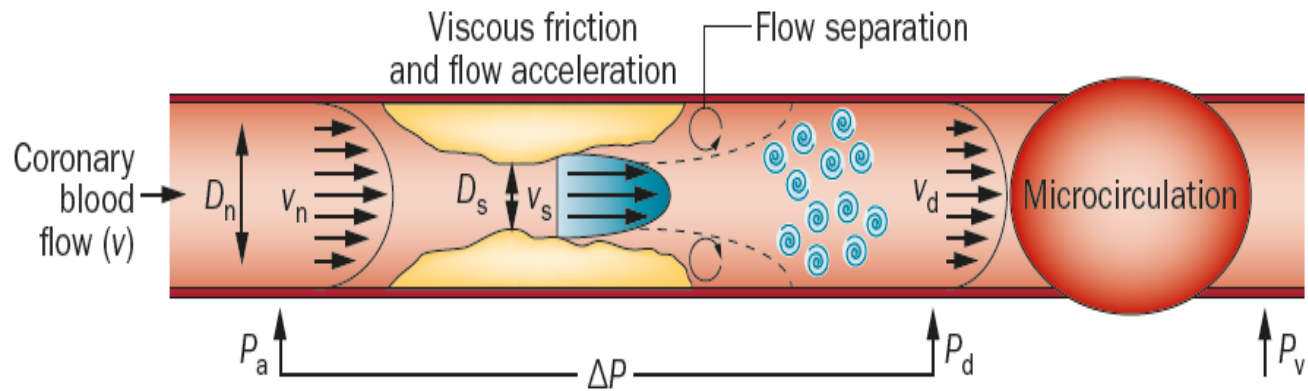


Verwijder introductienaald voor normalisatie
Met naald: $\downarrow\downarrow$ Pa, derhalve \uparrow FFR of iFR

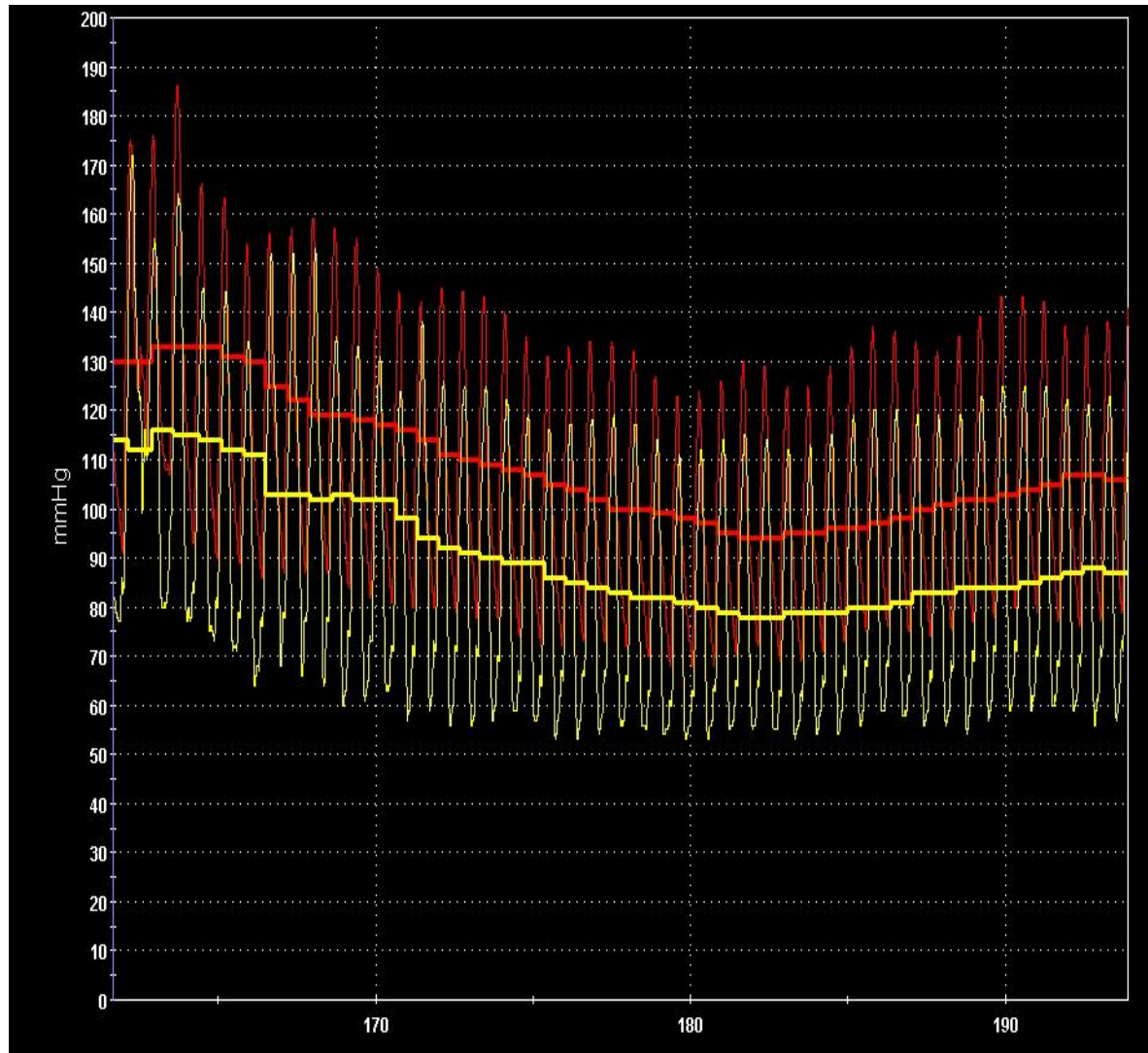


Juiste positionering draad distaal

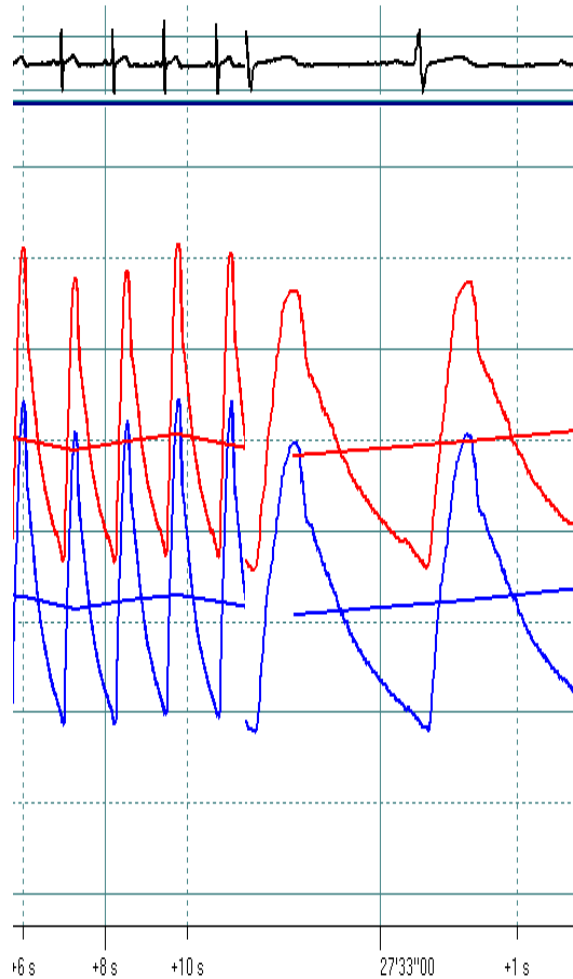
- Sensor distaal van de stenose op een afstand 3x referentiediameter



FFR: meten tijdens de steady state



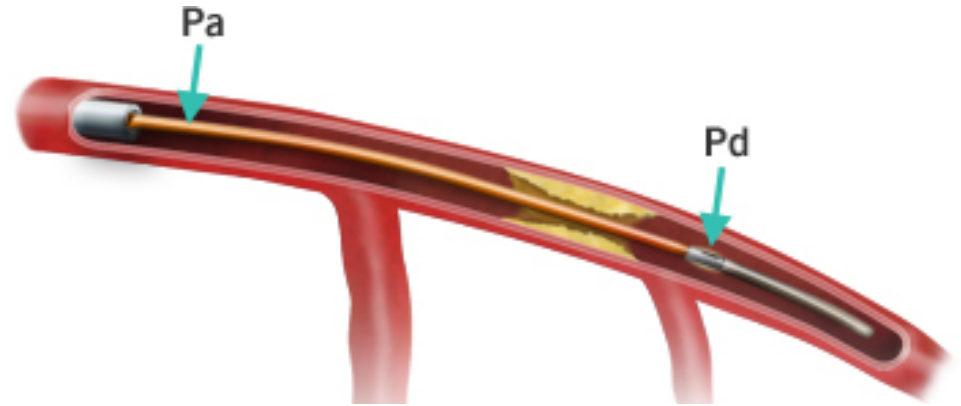
Last but not least: controller of er drift is



FFR

Fractional flow reserve

$$\text{FFR} = \frac{\text{Distal Coronary Pressure (Pd)}}{\text{Proximal Coronary Pressure (Pa)}} \\ \text{(During Maximum Hyperemia)}$$



FFR is defined as the maximal blood flow to the myocardium in the presence of a stenosis in the supplying coronary artery, divided by the theoretical normal maximal flow in the same distribution. This index represents the fraction of the normal maximal myocardial flow that can be achieved despite the coronary stenosis.

First Author, Year (Ref. #)	Number of Patients (Lesions)	Ischemic Test	Best Cutoff Value	Accuracy (%)	Clinical Setting
Intravenous adenosine infusion (140 µg/kg/min)					
Pijls et al., 1995 (18)	60 (60)	X-ECG	0.74	97	SVD
Pijls et al., 1996 (19)	45 (45)	X-ECG, MPS, DSE	0.75	93	SVD
Jimenez-Navarro et al., 2001 (58)	21 (21)	DSE	0.75	90	SVD
Rieber et al., 2004 (59)	48 (48)	MPS, DSE	0.75	76-81	MVD
Erhard et al., 2005 (60)	47 (47)	MPS, DSE	0.75	77	MVD
Hacker et al., 2005 (61)	50 (50)	MPS	0.75	86	SVD
Total or average (as applicable)	271 (271)	NA	0.75	87	NA
Intracoronary adenosine bolus (maximum 40-60 µg)					
Tron et al., 1995 (62)	62 (70)	MPS	0.69	67	1, 2, and 3-VD
Bartunek et al., 1997 (63)	37 (37)	DSE	0.67	90	SVD
Caymaz et al., 2000 (64)	30 (40)	MPS	0.75	95	SVD
Fearon et al., 2000 (65)	10 (10)	MPS	0.75	95	SVD
Chamuleau et al., 2001 (66)	127 (161)	MPS	0.74	77	MVD
Seo et al., 2002 (67)	25 (25)	MPS	0.75	60	Previous MI
Krüger et al., 2005 (68)	42 (42)	MPS	0.75	88	ISR
Samady et al., 2006 (69)	48 (48)	MPS, DSE	0.78	92	Previous MI
van de Hoef et al., 2012 (70)	232 (299)	MPS	0.76	74	MVD
Total or average (as applicable)	613 (732)	NA	0.74	83	NA
Other method of vasodilation					
De Bruyne et al., 1995 (intracoronary papaverine or adenosine) (13)	60 (60)	X-ECG, MPS	0.66	87	SVD
Bartunek et al., 1997 (intracoronary papaverine or adenosine) (63)	75 (75)	DSE	0.75	81	SVD
Abe et al., 2000 (intravenous ATP) (71)	46 (46)	MPS	0.75	91	SVD
De Bruyne et al., 2001 (intravenous or intracoronary adenosine, or intravenous ATP) (72)	57 (57)	MPS	0.78	85	Previous MI
Yanagisawa et al., 2002 (intracoronary papaverine) (39)	165 (194)	MPS	0.75	76	Previous MI
Ziaee et al., 2004 (intravenous or intracoronary adenosine) (73)	55 (55)	MPS, X-ECG, DSE	0.75	88	Ostial
Morishima et al., 2004 (intracoronary papaverine) (74)	20 (20)	MPS	0.75	85	SVD
Kobori et al., 2005 (intracoronary papaverine) (75)	147 (155)	MPS	0.75	70	Restenosis
Ragosta et al., 2007 (intracoronary adenosine, 30-40 µg in the RCA, 80-100 µg in the LMCA) (76)	36 (36)	MPS	0.75	69	MVD
Total or average (as applicable)	661 (698)	NA	0.74	81	NA
Total or average (as applicable) for all studies	1,545 (1,701)	NA	0.74	83	NA

DEFER

n=325, angina pectoris

FFR <0.75 → PCI

FFR >0.75 → PCI of Rx

5y follow-up

FFR <0.75 event free 61%

FFR >0.75 + PCI 73%

FFR >0.75 + Rx 79%

FFR >0.75 jaarlijks risico
op AMI of dood <1%

FAME

n = 509 FFR guided

n = 496 CAG guided

FFR </= 0.80 cut-off

1y follow-up

FFR guided 13%

CAG guided 18%

FAME 2

FFR </= 0.80 cut-off

OMT + PCI of OMT
alleen

vroegtijdig gestopt
vanwege hoger risico

MACE in OMT alleen

groep, echter o.b.v.

revascularisatie

patiënten niet

geblindeerd, helaas

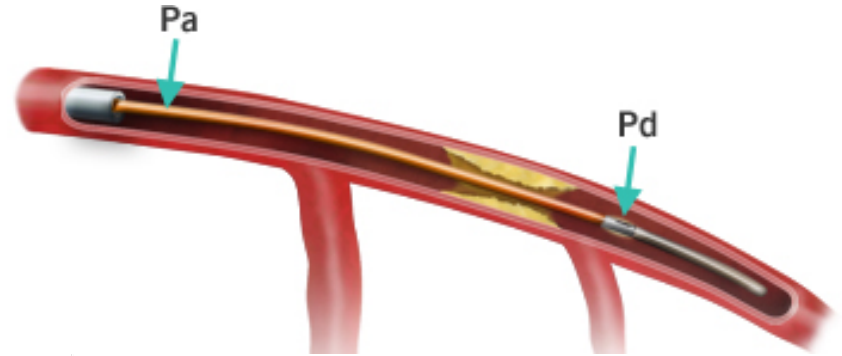
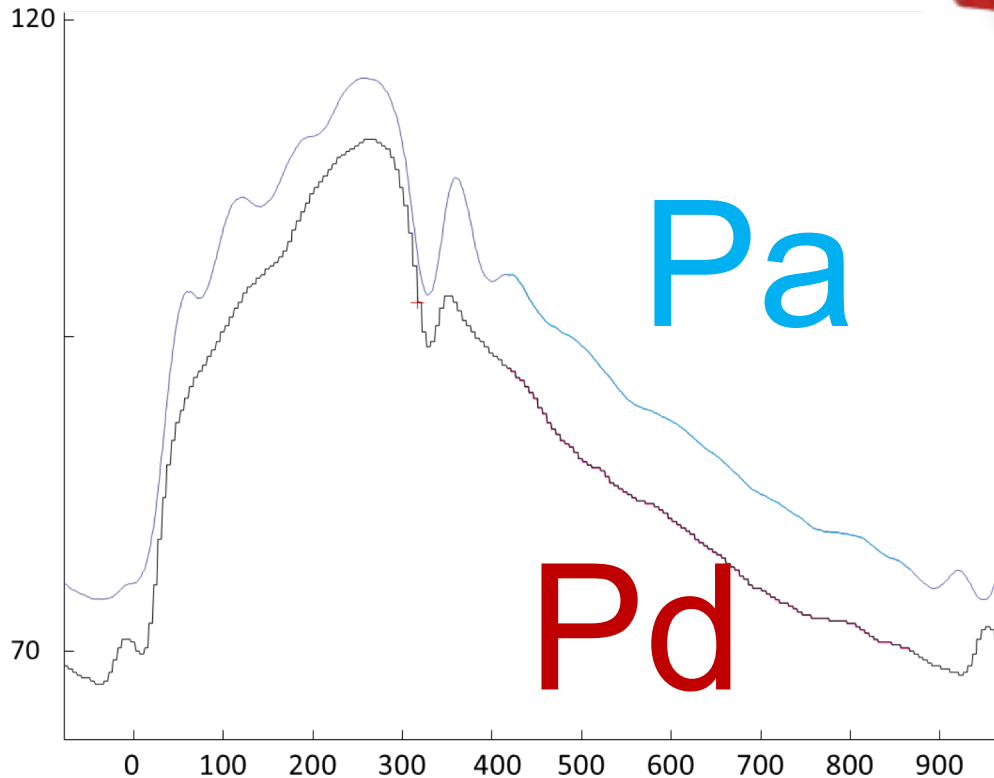
geen uitspraak op effect

AMI of dood

cut-off van 0.75 naar 0.80
vanwege hogere
nauwkeurigheid: 90% in
plaats van 80%

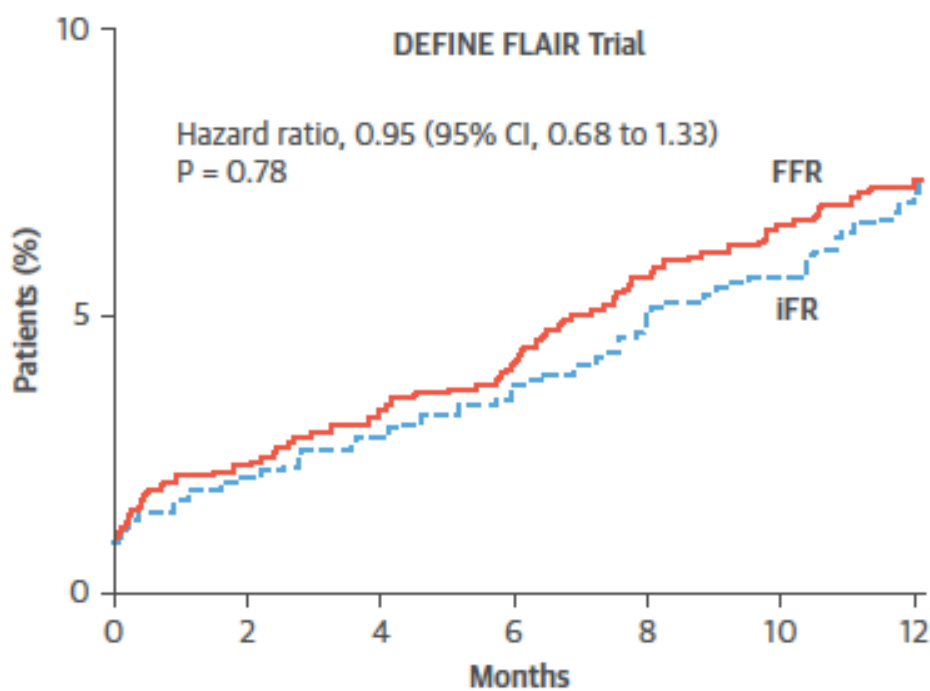
iFR

Instantaneous wave-free ratio

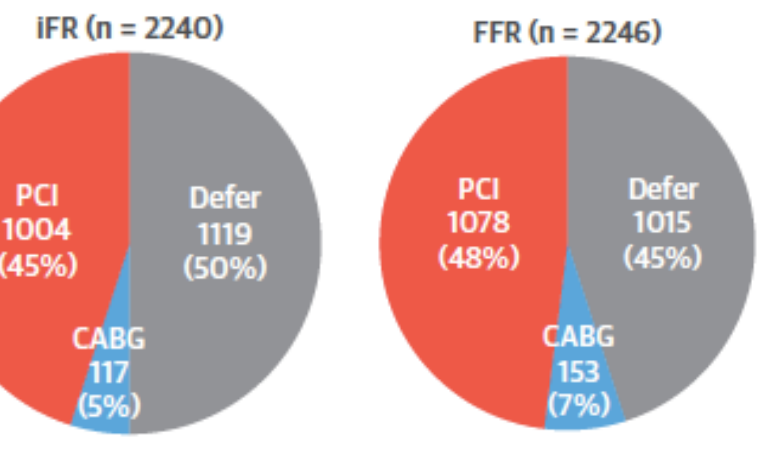
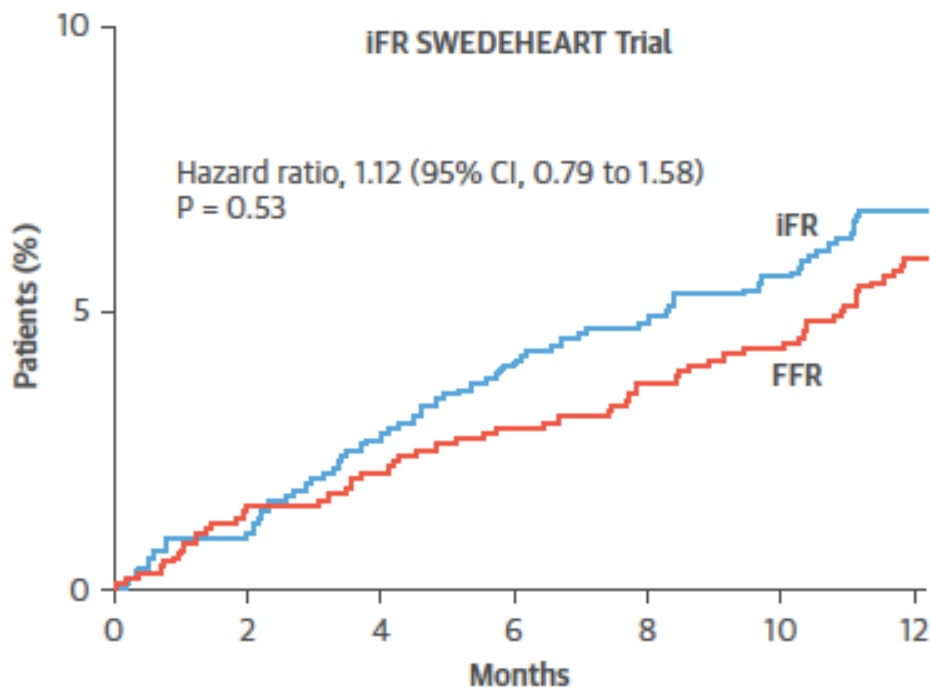


$$iFR = \frac{Pd}{Pa}$$

during the wave-free period

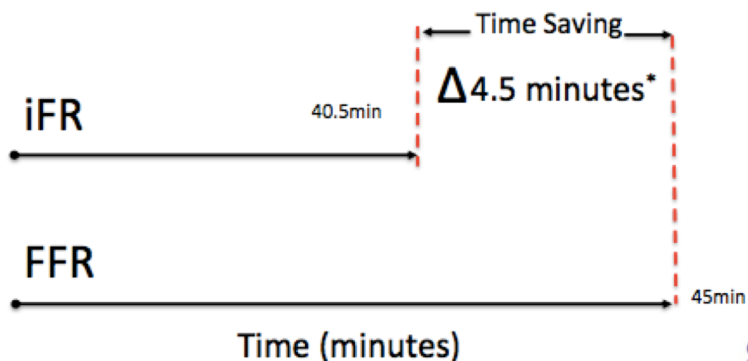


DEFINE FLAIR
 noninferiority iFR t.o.v. FFR
 n= 2491
 cut-off iFR \leq 0.89
 MACE 1y iFR 6.8%, FFR 7.0%



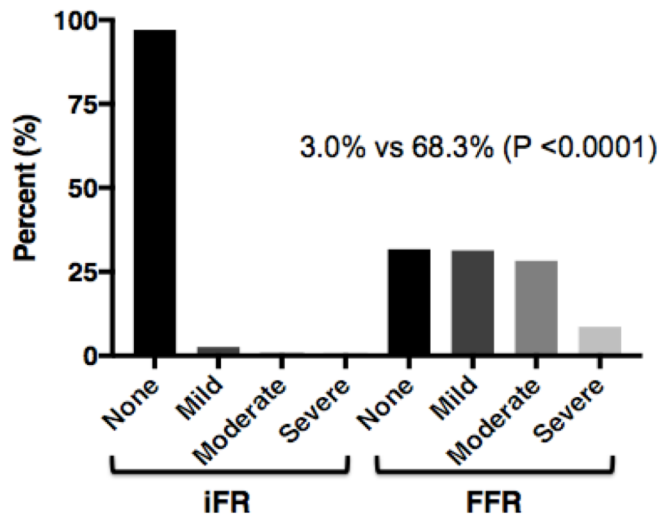
IFR SWEDEHEART
 noninferiority iFR t.o.v. FFR
 n= 2037
 cut-off iFR \leq 0.89
 MACE 1y iFR 6.7%, FFR 6.1%

DEFINE-FLAIR iFR guided revascularization strategy reduces procedure time

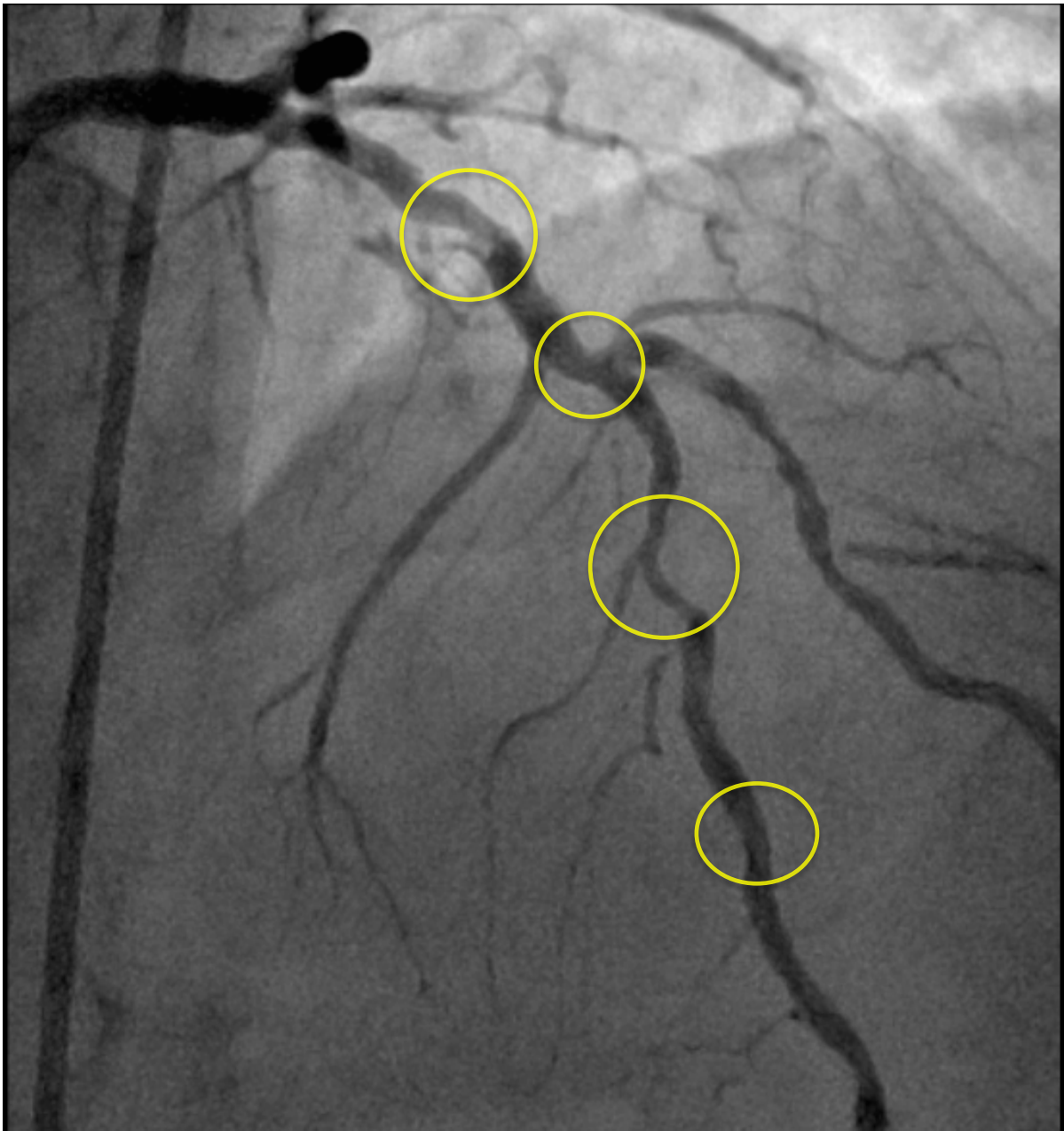


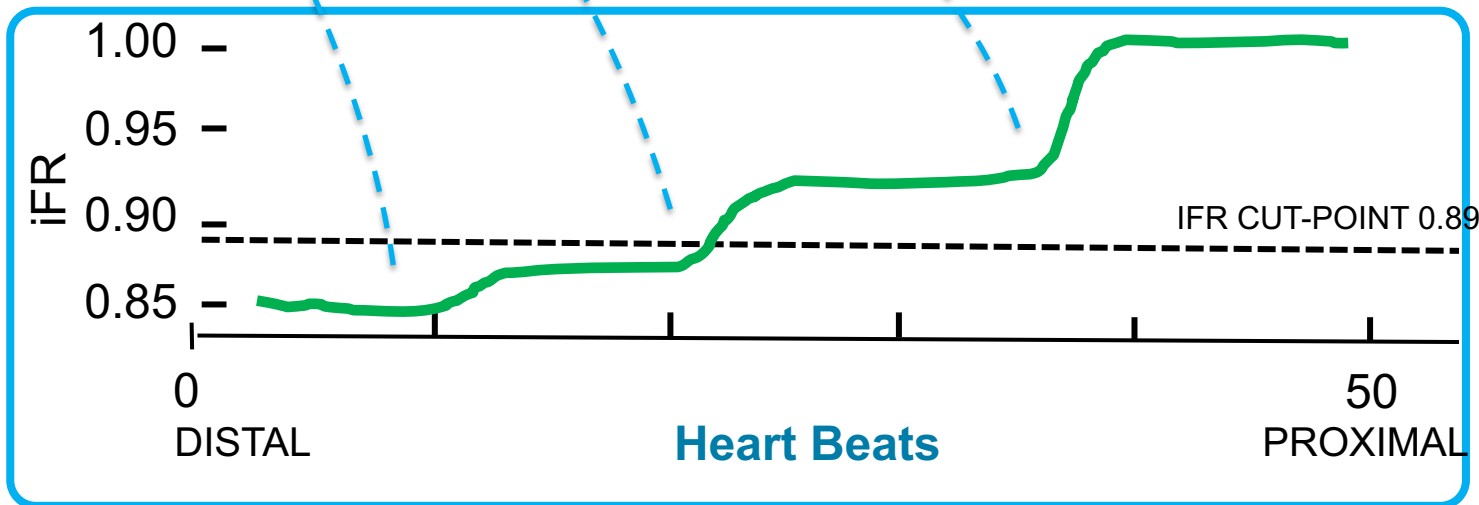
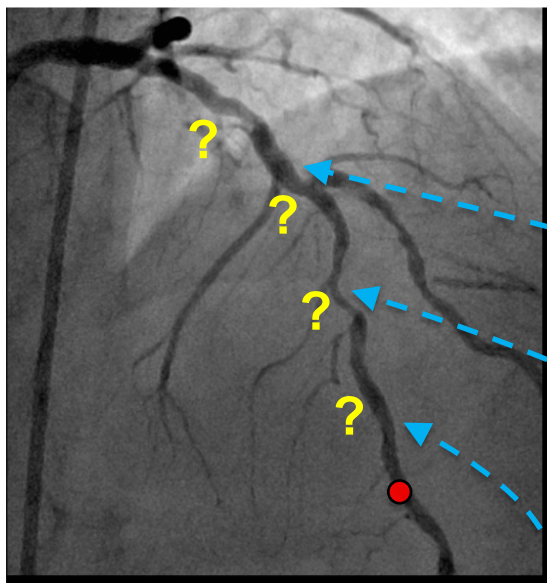
* Threshold for significance

iFR-SWEDEHEART Chest discomfort



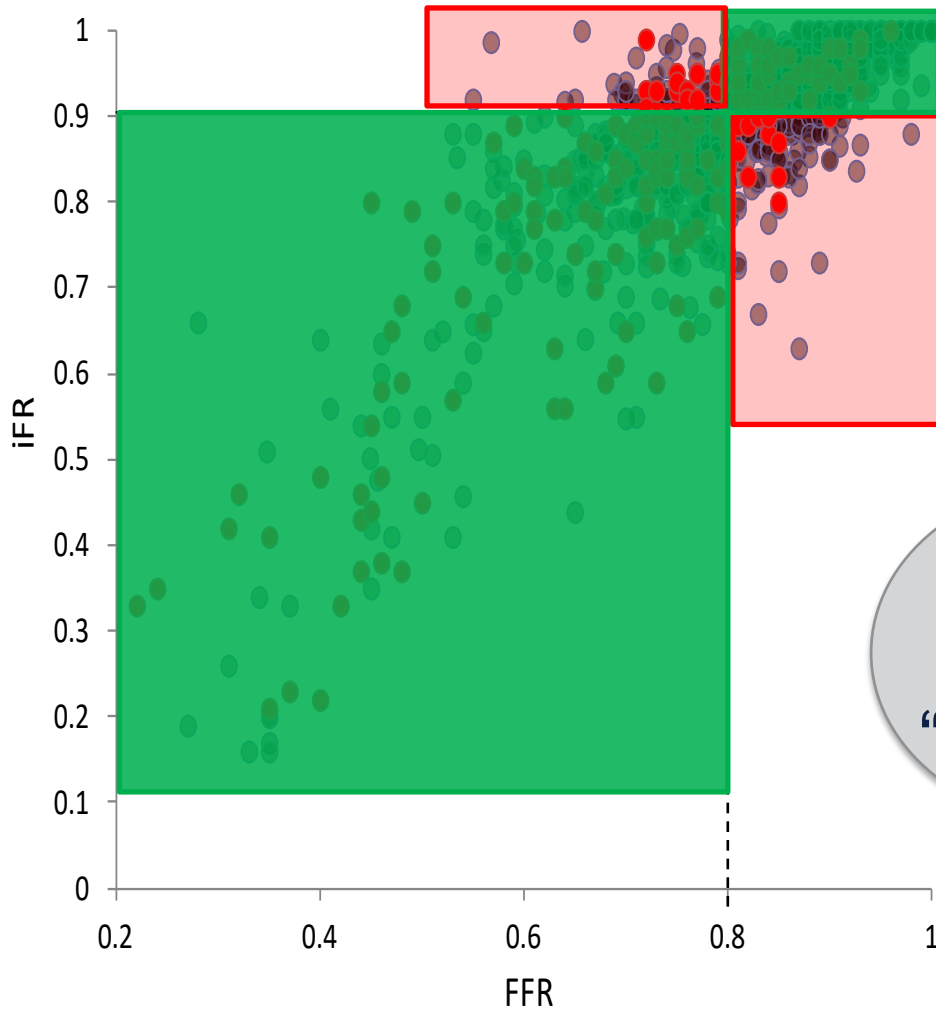
Significantly more chest discomfort in the FFR-group





Vershil tussen FFR en iFR

N>5000 stenoses
RESOLVE study
US Registry Internal data



✓ 80-90%

✗ 10-20%

...which one is "correct"?

Conclusie

- Met FFR en iFR meten we druk en dat zegt iets over de bloedstroom.
- Schatten van ernst stenose met het oog bij angiografie is onbetrouwbaar.
- FFR en iFR meten niet precies hetzelfde.
- Op basis van FFR én iFR betrouwbaar beslissing te nemen over wel/niet dotteren.
- Bij twijfel over ernst stenose: doe een FFR of iFR.
- Verschil tussen FFR en iFR mogelijk te verklaren door (problemen in de) microvasculatuur.

Dank voor jullie aandacht

