Les approximations de la FFR

Patrick Dupouy

PCVI Antony-Melun

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Les approximations techniques de la mesure de FFR

- Dose d'adénosine
- Stabilité de la ligne iso et du signal
- Sonde coro ou sonde ATL (4F)
- Sonde dans l'ostium ou dégagée
- Hémodynamique de base

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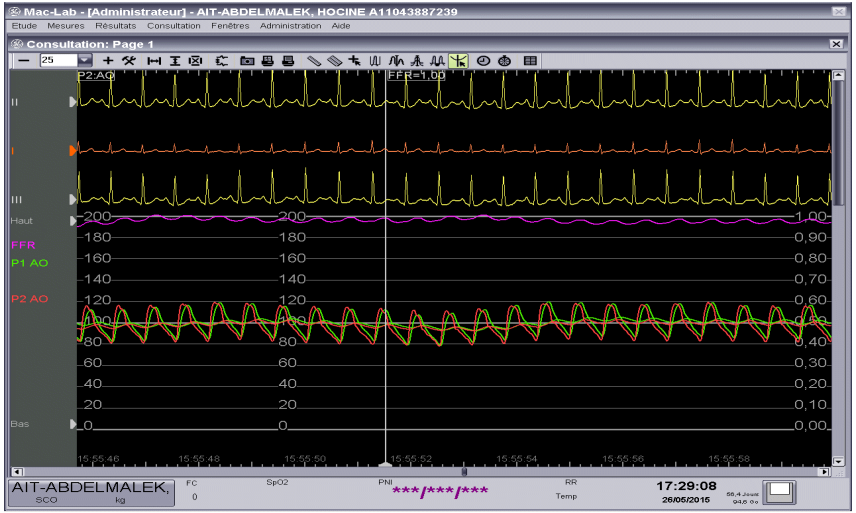
Stabilité du signal



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Variations hémodynamiques

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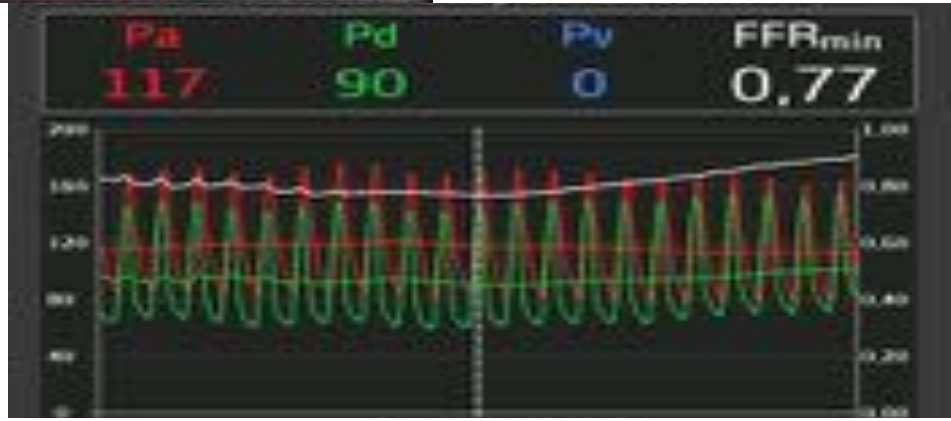
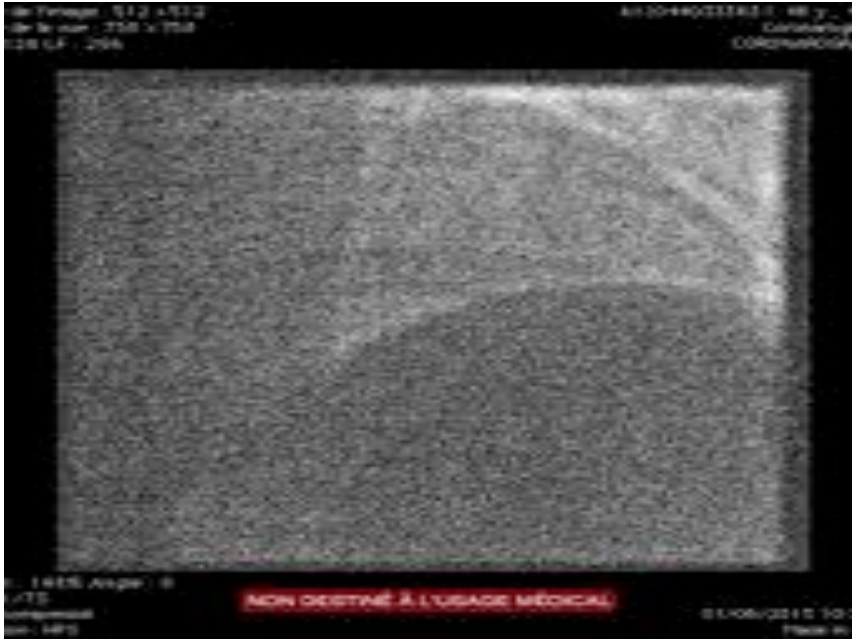


Vasodilatation épicardique



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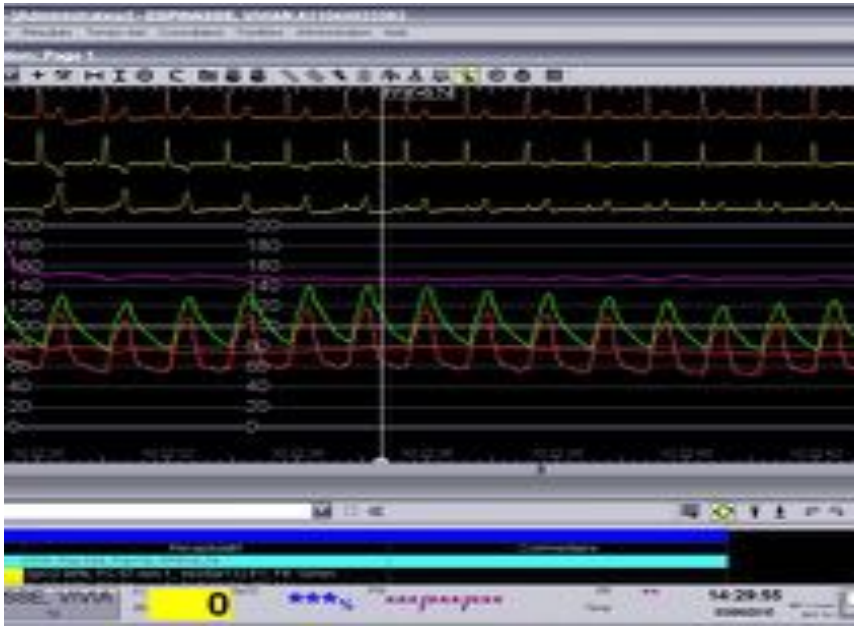
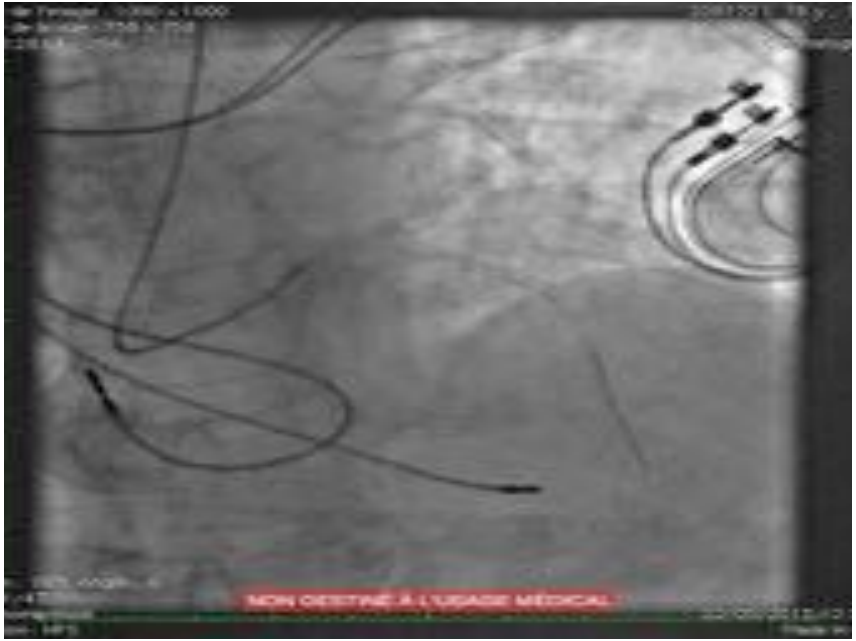
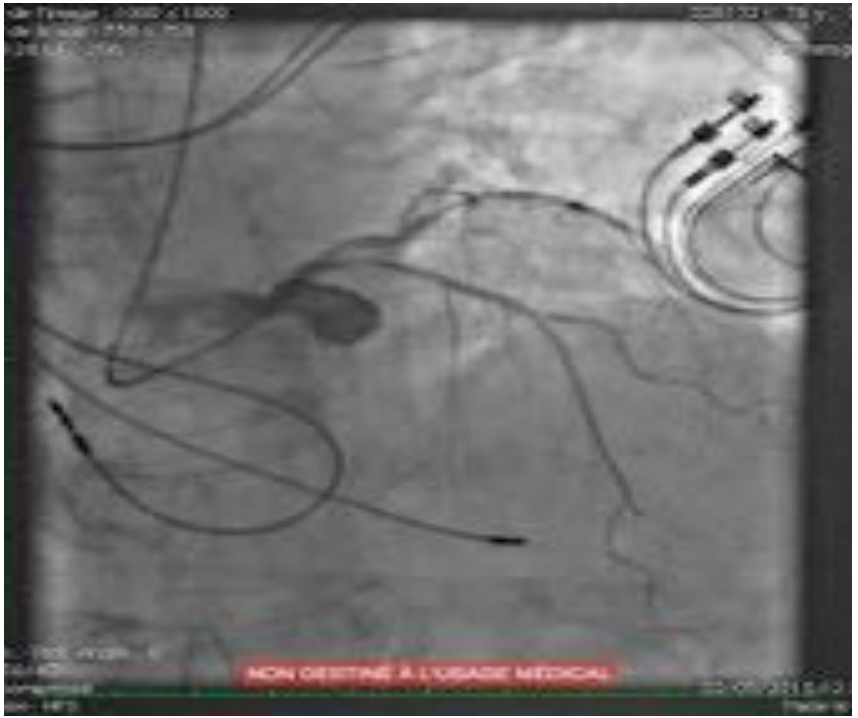
PRE RISORDAN FFR 0,60

POST RISORDAN FFR 0,74



Se dégager de l’ostium





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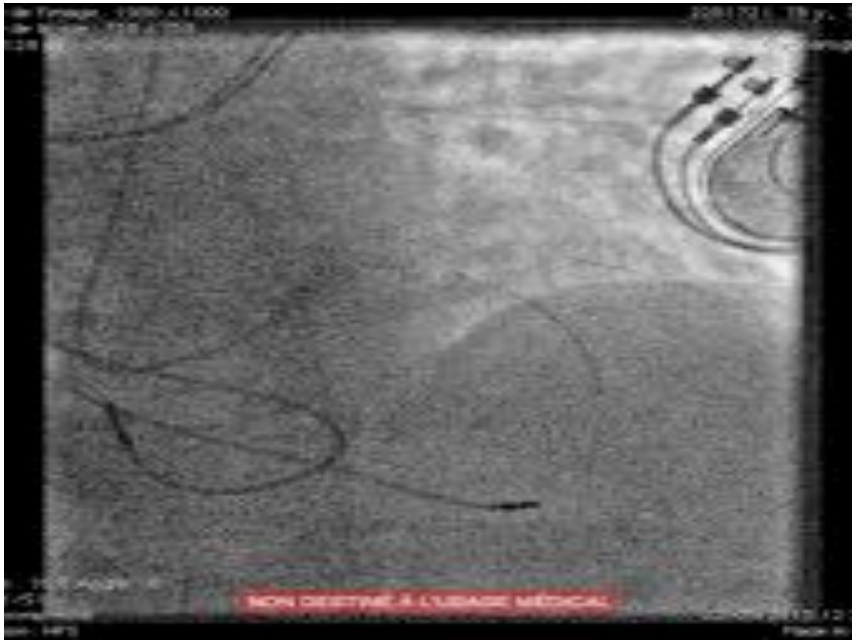

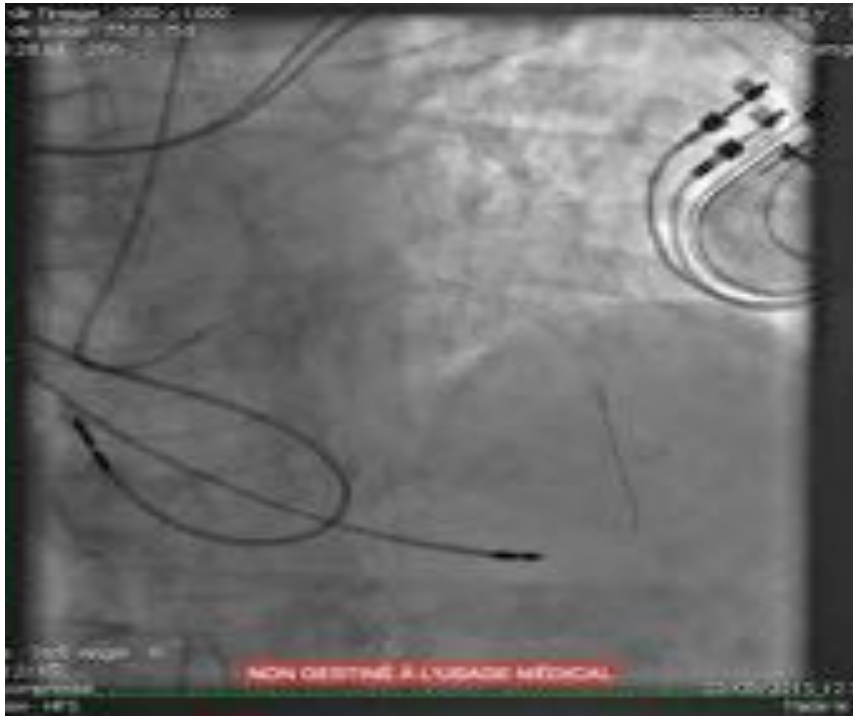

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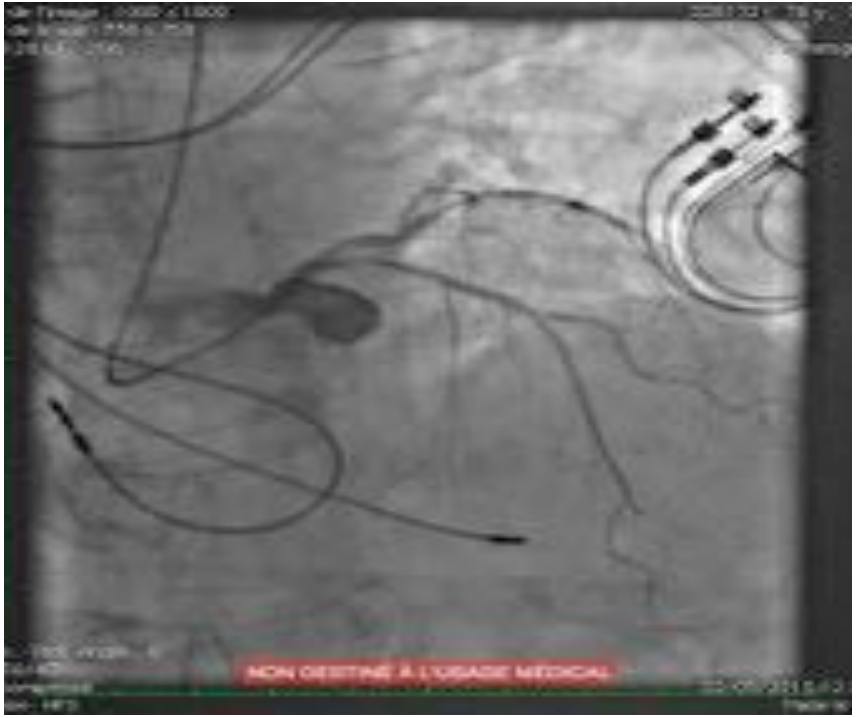

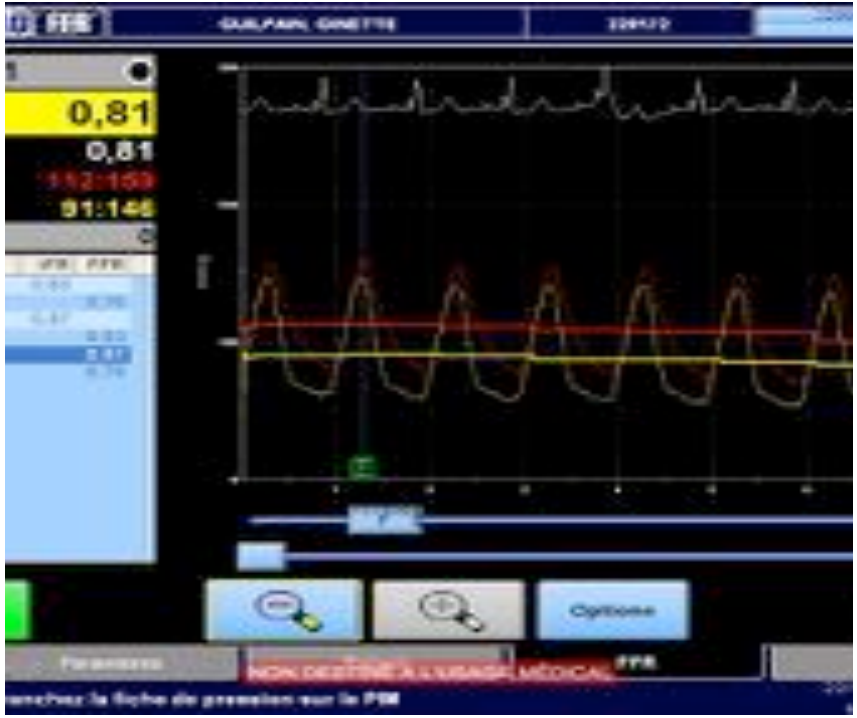

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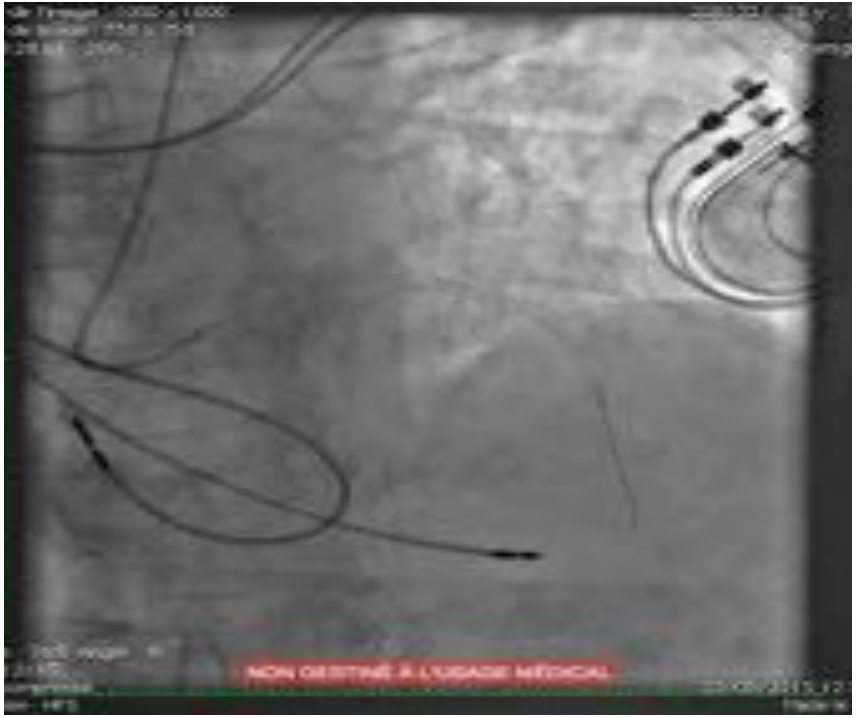
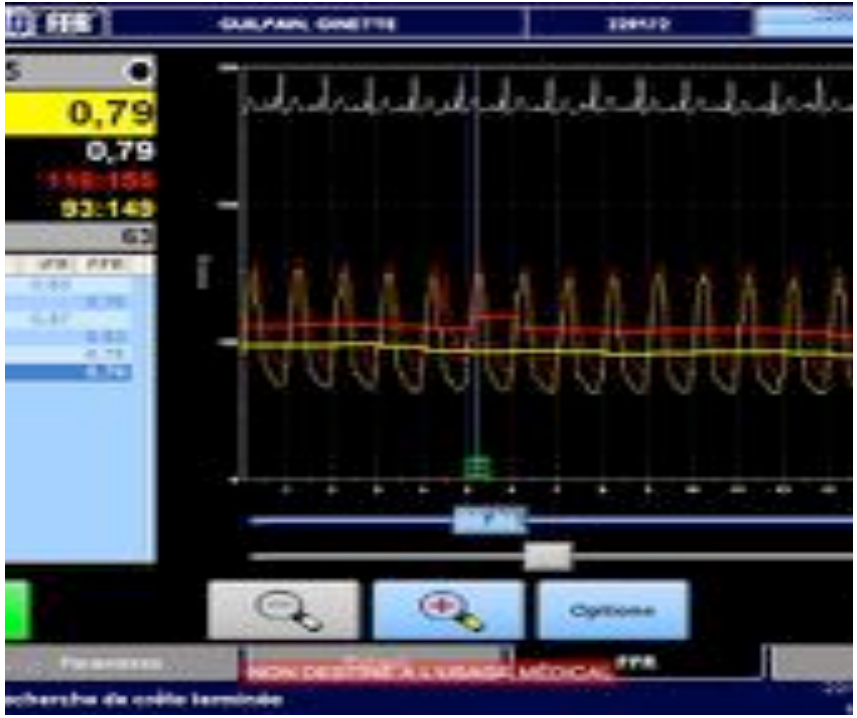
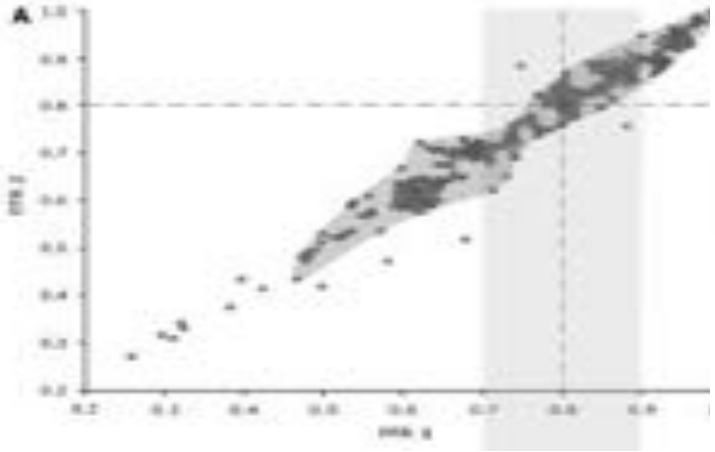
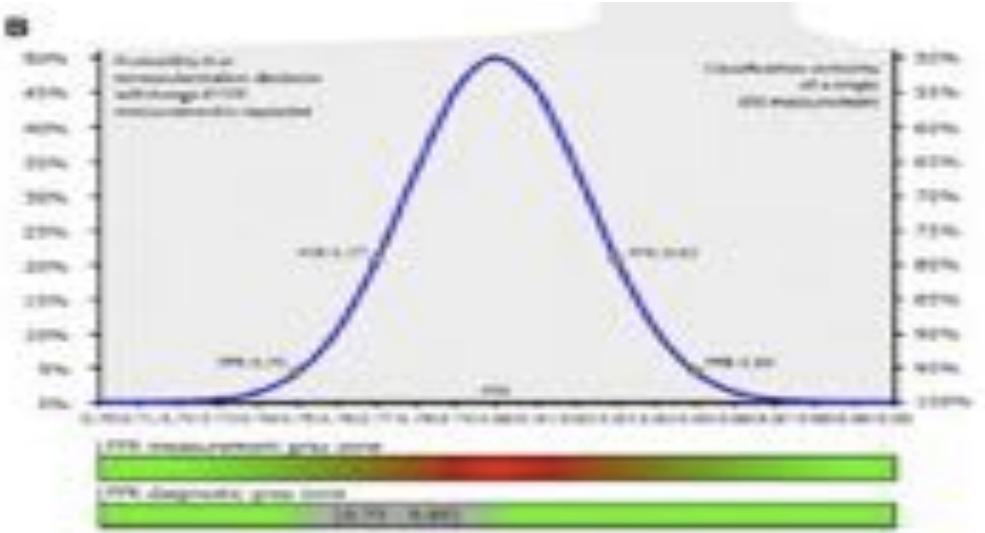




Une FFR peu en cacher une autre ..





Petracco et col, J Am Coll Cardiol Intv 2013;6:222–5

Des Alternatives à l'adénosine ?

- Gradient de repos
- FFR contraste
- iFR
- FFR Adénosine
- FFR Adénosine + contraste

- Quel intérêt ?

- Gain de temps
- Moins d'injection
- Moins de toxicité ?

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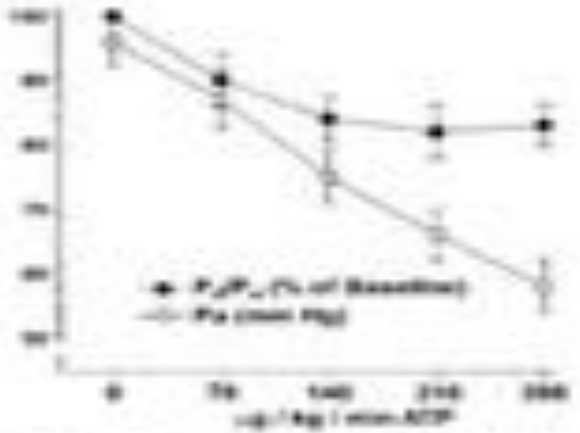
TABLE 2. Mean P_d/P_a Ratio, Time to Peak Action, Duration of the Plateau Phase, and Electrocardiographic Changes Induced by the Different Vasodilatory Stimuli in Group 1 Patients

	P_d/P_a	Time to Peak Action, s	Duration of the Plateau Phase, s	Pain Score, 0–10
Papa IC 20 mg	0.91±0.20	23±5	33±7	0
Ado IC 20 mg	0.82±0.20	15±2	7±3	0
Ado IC 40 mg	0.82±0.19	15±2	5±1	0
ATP IC 20 mg	0.82±0.20	14±3	4±1	0
ATP IC 40 mg	0.80±0.19	14±3	5±1	0
CM IC 6 mL	0.88±0.21	10±3	2±1	0
Ado fem 140 μg·kg^{-1}·min^{-1}	0.81±0.19	80±3	NA	3.3±3.4
Ado fem 180 μg·kg^{-1}·min^{-1}	0.87±0.18	NA	NA	6.7±2.7
ATP fem 140 μg·kg^{-1}·min^{-1}	0.81±0.19	76±29	NA	4.8±3.5
ATP fem 180 μg·kg^{-1}·min^{-1}	0.81±0.17	NA	NA	4.8±3.3
Ado peri 140 μg·kg^{-1}·min^{-1}	0.81±0.19	112±48	NA	4.3±2.7
Ado peri 180 μg·kg^{-1}·min^{-1}	0.80±0.17	NA	NA	6.0±3.46
ATP peri 140 μg·kg^{-1}·min^{-1}	0.81±0.17	104±36	NA	4.3±3.4
ATP peri 180 μg·kg^{-1}·min^{-1}	0.82±0.20	NA	NA	3.8±2.7
Papa IC 20 mg	0.91±0.18	21±5	21±6	0

Values are mean±SD. Papa indicates papaverine; Ado, adenosine; CM, contrast media; IC, intracoronary; fem, femoral vein; and peri, peripheral vein.



4. Plots of the mean values (±SEM) of P_d and of P_d/P_a as a function of the dosage of intravenous infusion of ATP in 12 patients (stenotic artery). Above a dosage of 140 μg·kg^{-1}·min^{-1}, no further decline in P_d/P_a was observed despite a continued decline in mean P_d.

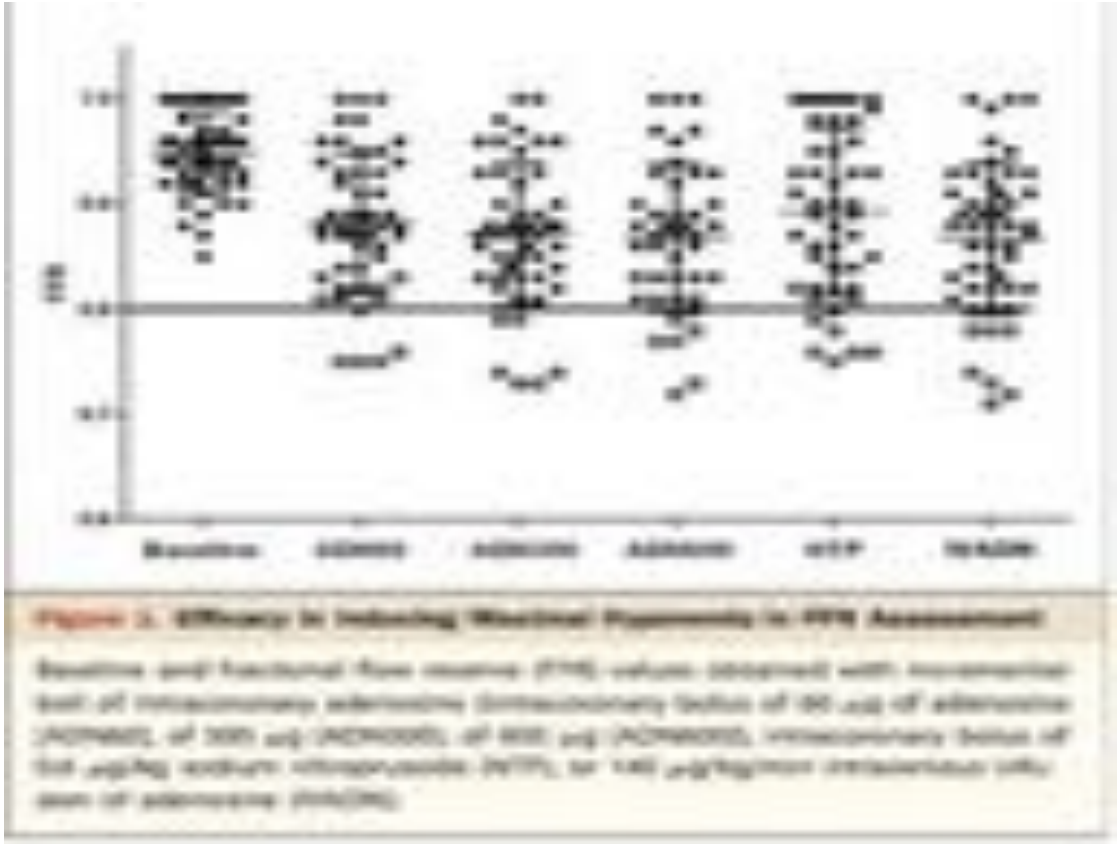
Bernard De Bruyne, Circulation. 2003;107:1877-1883

Effets de l’adénosine

Table 2. Results: Effect of Different Doses of IC or IV Adenosine and IC Sodium Nitroprusside on Profile, Symptoms, Atrioventricular Block, and FFR

	n	HR (beats/min)	SBP (mm Hg)	DBP (mm Hg)	MBP (mm Hg)	Symptoms	AVB	FFR
Baseline	50	70 ± 8 71 (64–75)	144 ± 20 146 (130–160)	79 ± 9 80 (74–82)	101 ± 11 100 (93–107)	0 (0%)	0 (0)	0.98 ± 0.04 0.95 (0.92–0.98)
ADN60	50	68 ± 12 68 (63–75)	142 ± 22* 140 (130–159)	75 ± 10† 75 (70–80)	97 ± 12† 96 (90–103)	1 (2%)†	6 (16%)	0.88 ± 0.07† 0.86 (0.83–0.93)
ADN300	48	64 ± 12 68 (57–74)	144 ± 21* 142 (135–160)	74 ± 9† 75 (70–80)	97 ± 10† 97 (91–103)	4 (8.3%)†	13 (27%)	0.87 ± 0.07† 0.87 (0.83–0.93)
ADN600	43	62 ± 12 64 (50–73)	145 ± 25* 144 (130–156)	76 ± 9† 75 (70–80)	96 ± 19† 97 (91–102)	5 (9.3%)†	10 (23%)	0.87 ± 0.07† 0.87 (0.81–0.92)
NTP	48	74 ± 11 75 (69–82)	123 ± 19† 120 (110–138)	67 ± 8† 66 (60–72)	84 ± 10† 87 (80–93)	4 (8.4%)†	0 (0%)	0.89 ± 0.07† 0.90 (0.82–0.96)
NADN	50	73 ± 12 76 (66–80)	137 ± 23† 130 (120–159)	79 ± 12† 75 (70–80)	96 ± 14† 91 (87–107)	20 (40%)†	1 (2%)	0.87 ± 0.07† 0.86 (0.82–0.91)

Elisabeth M. Baile , CHEST 1999; 116:1039–1045



Antonio Maria Leone ; J Am Coll Cardiol Intv 2012;5:402– 8

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FFR = Pm Co / Pm Ao

EN HYPERHEMIE

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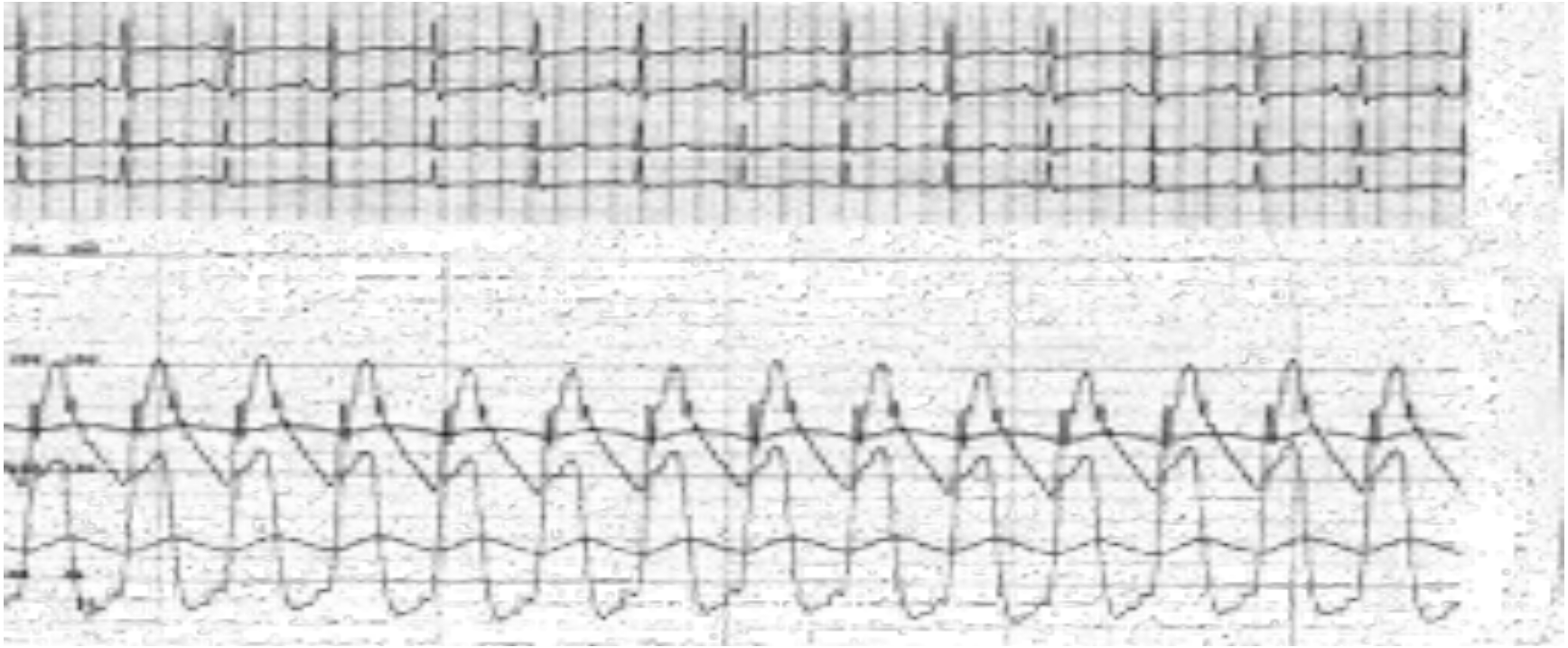
Gradient de Repos



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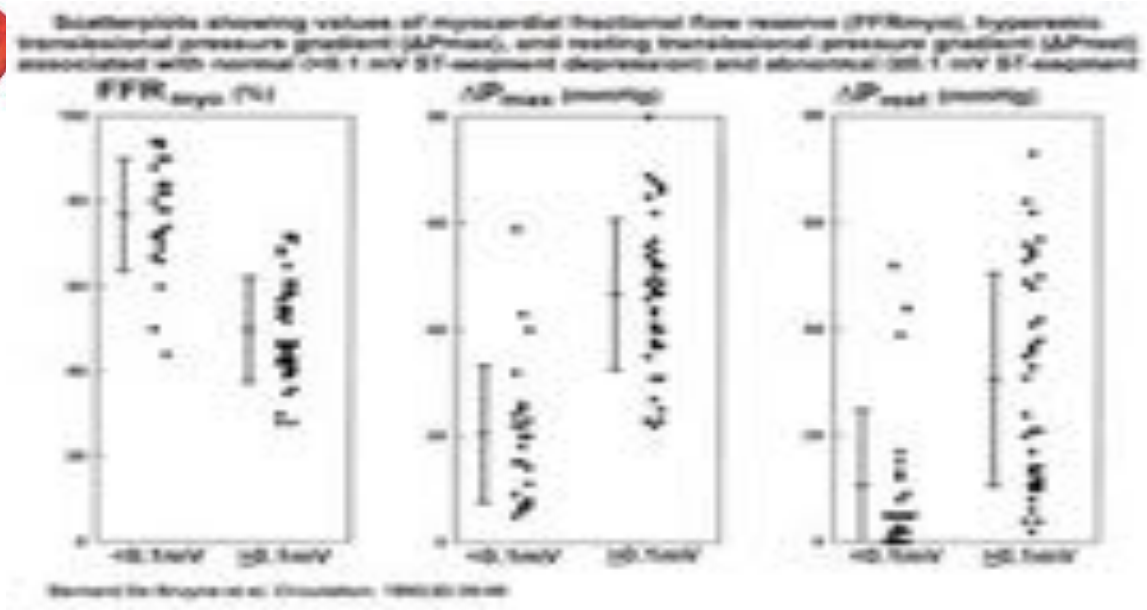
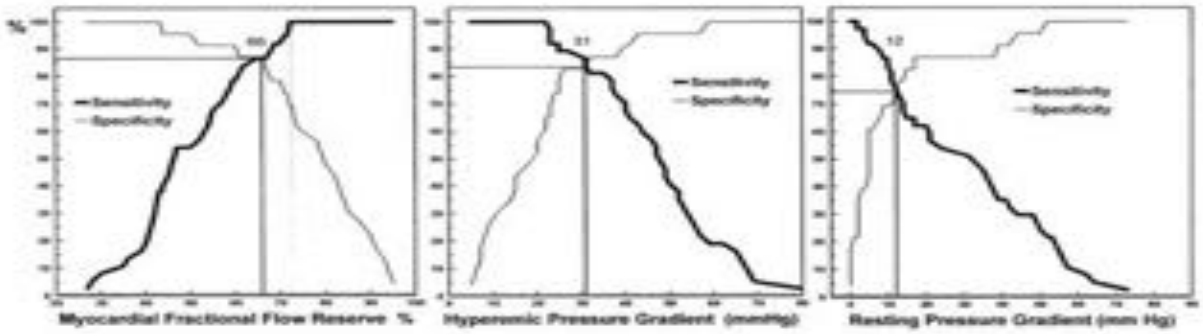
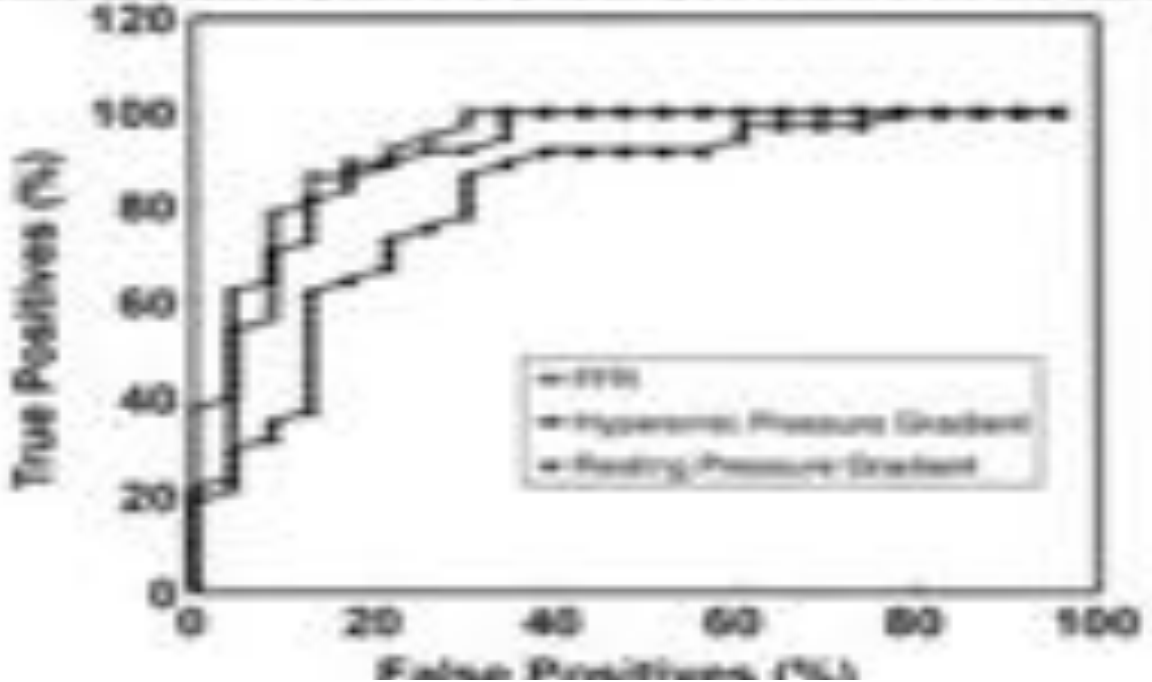




transtesticular pressure gradient for predicting the results of the exercise ECG.



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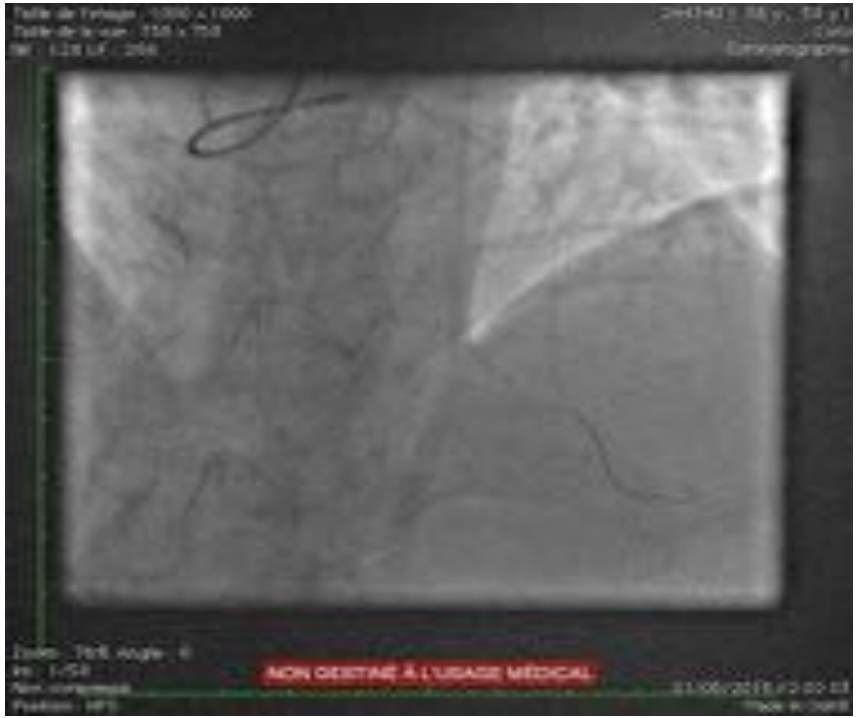

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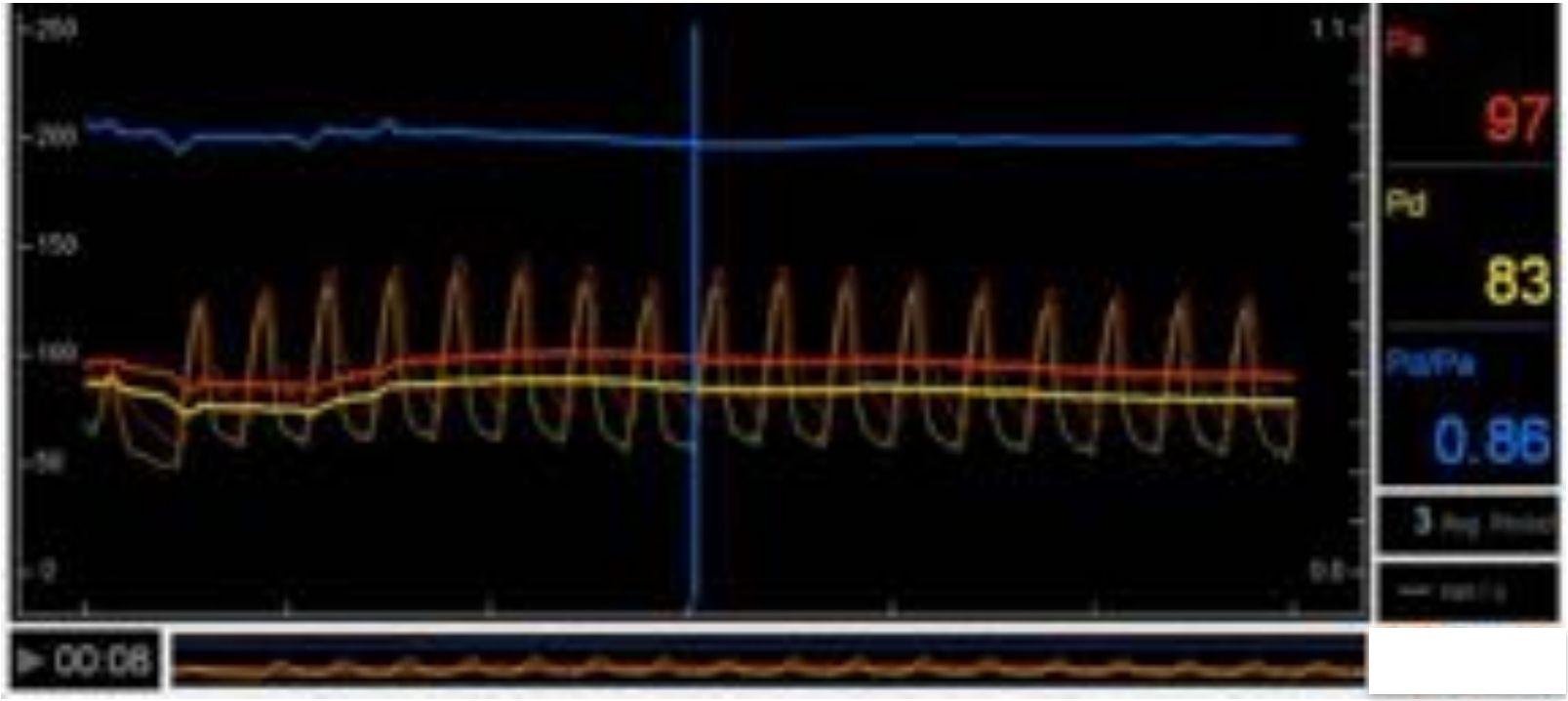
Gradient de base



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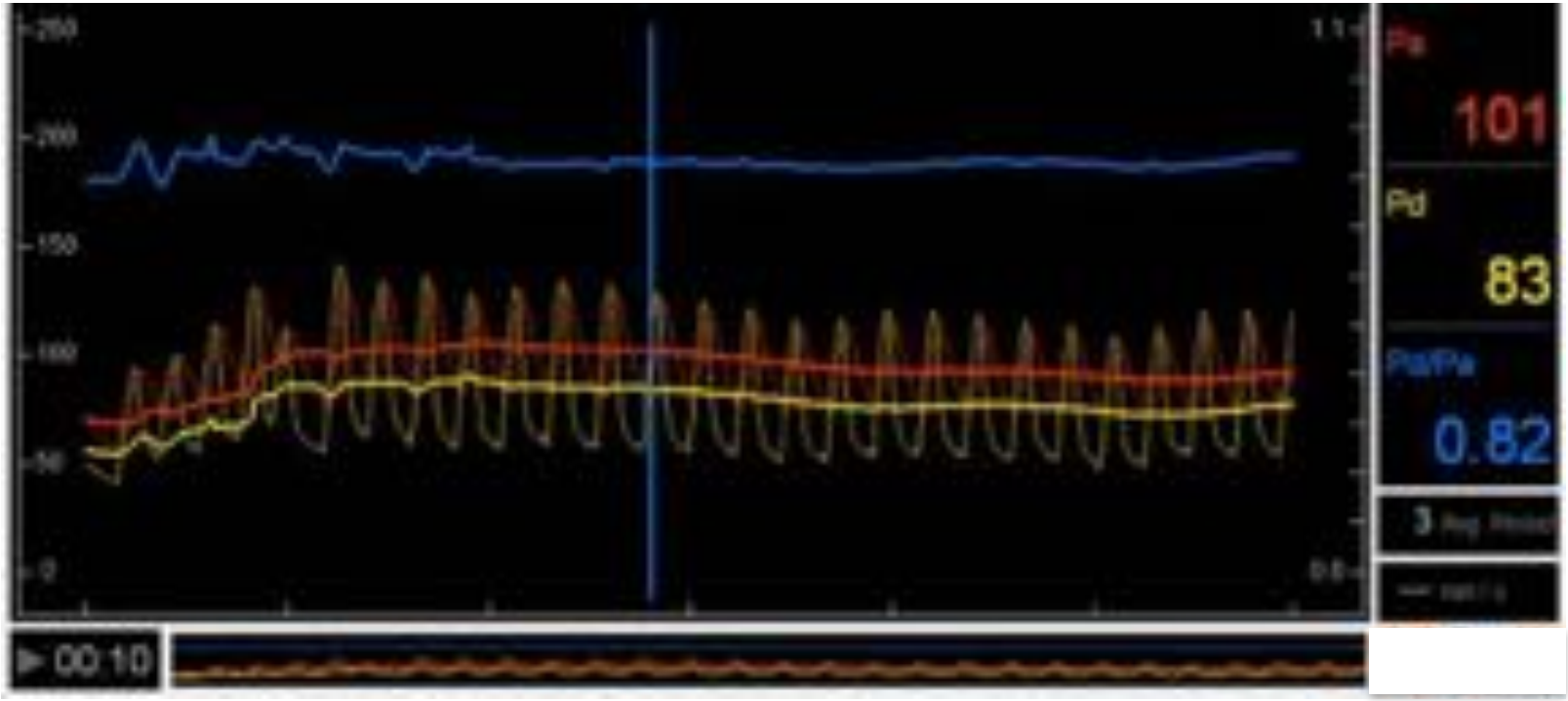
Gradient contraste



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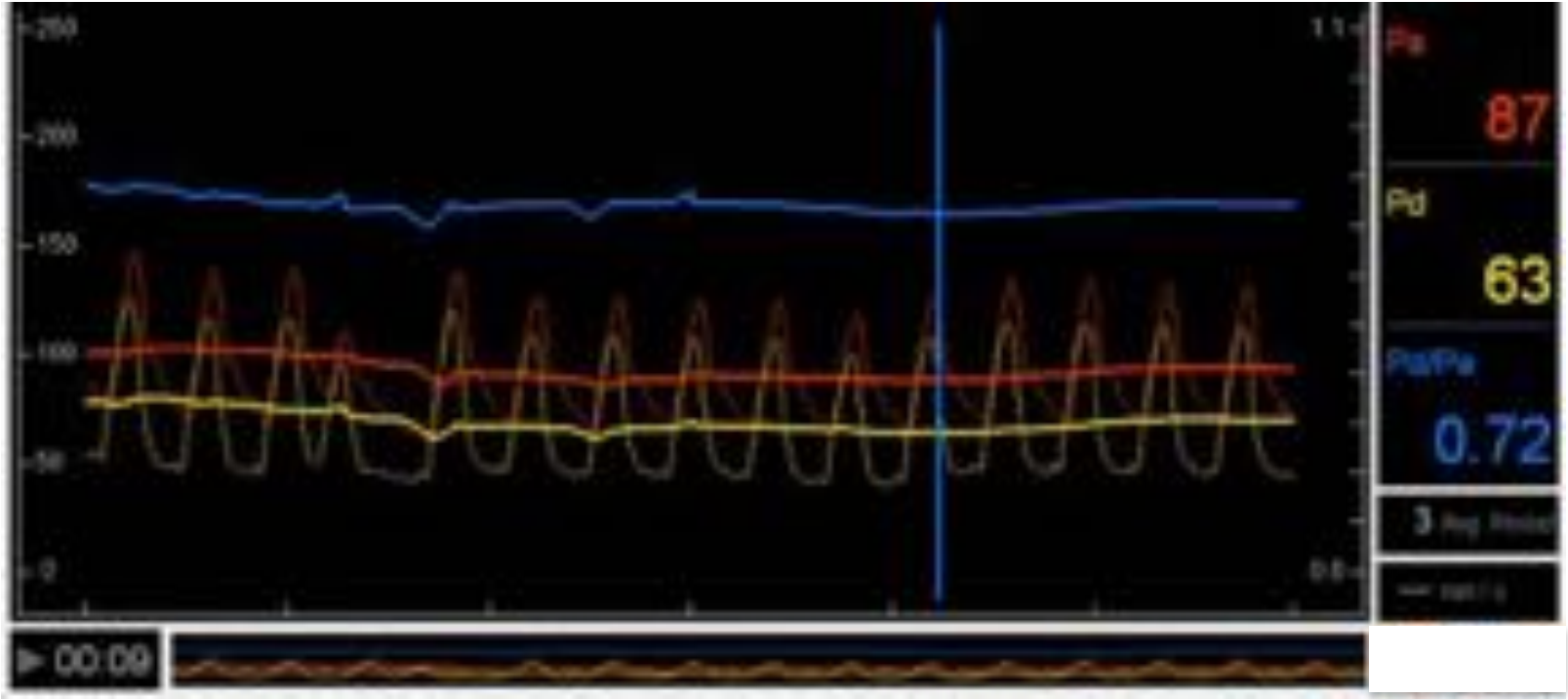
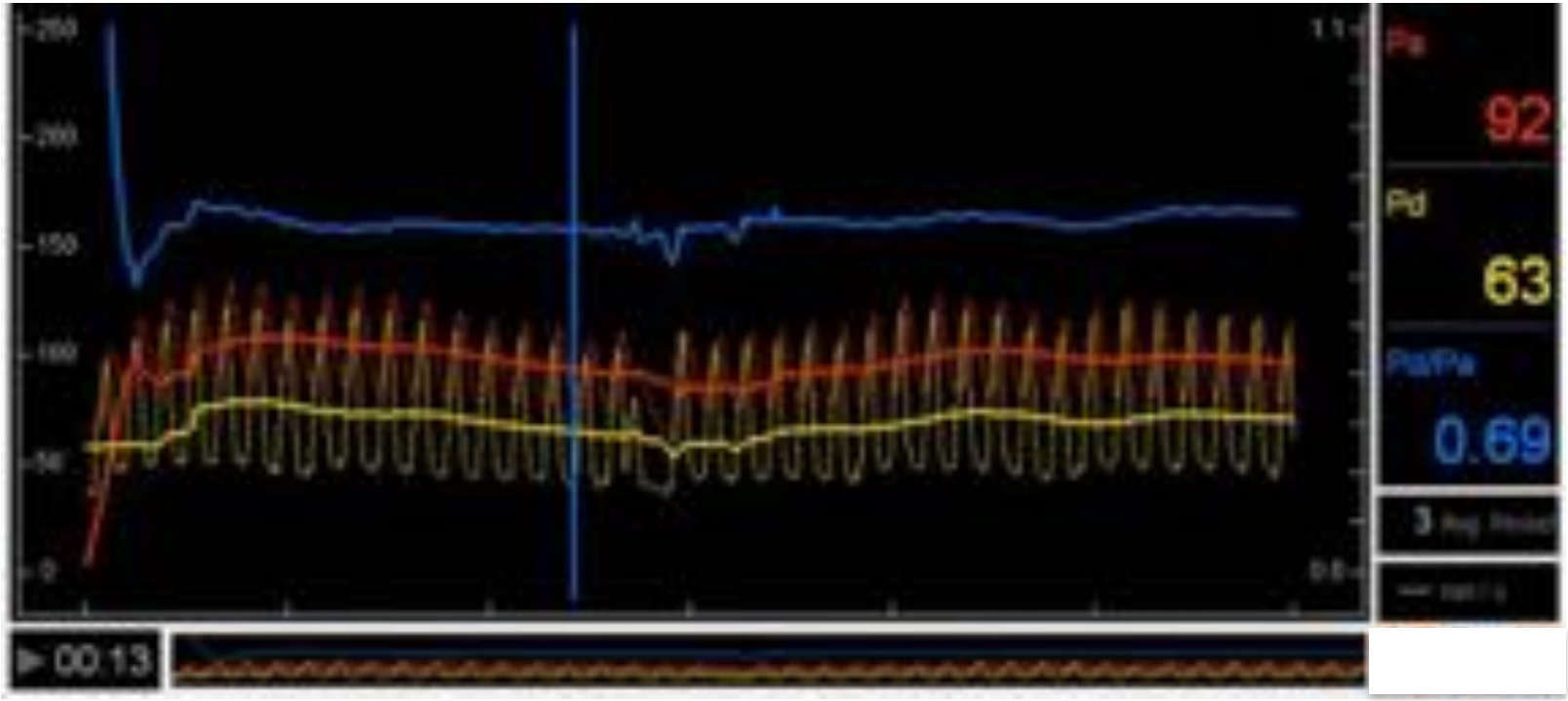
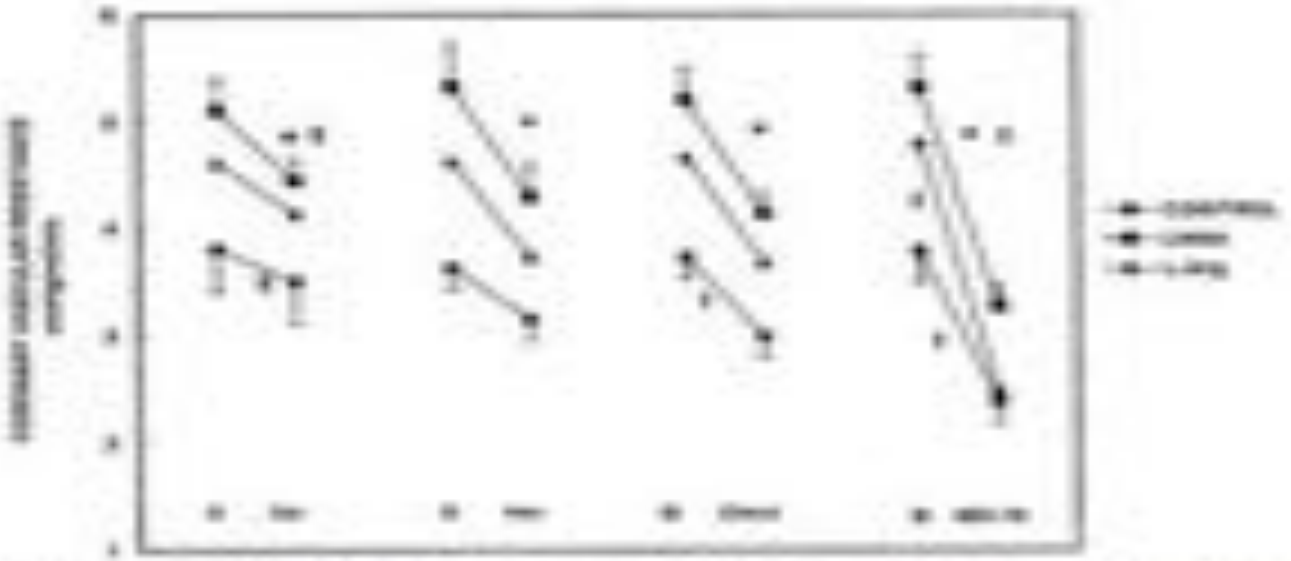
Gradient Adenosine 140ug bolus



Adenosine + contraste

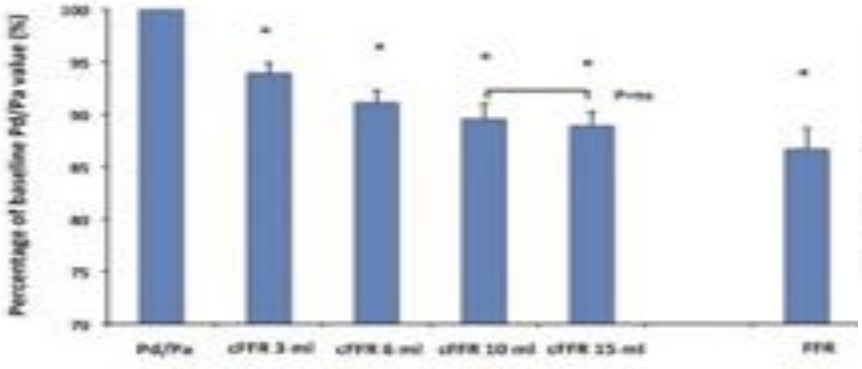


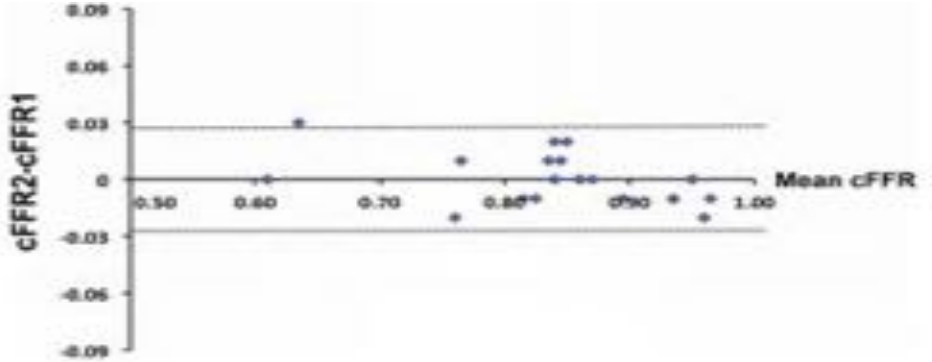
Contraste et Résistances myocardiques



Elisabeth M. Baile , CHEST 1999; 116:1039–1045

cFFR n=138





Vincent Spagnoli , Canadian Journal of Cardiology 32 (2016) 739e746

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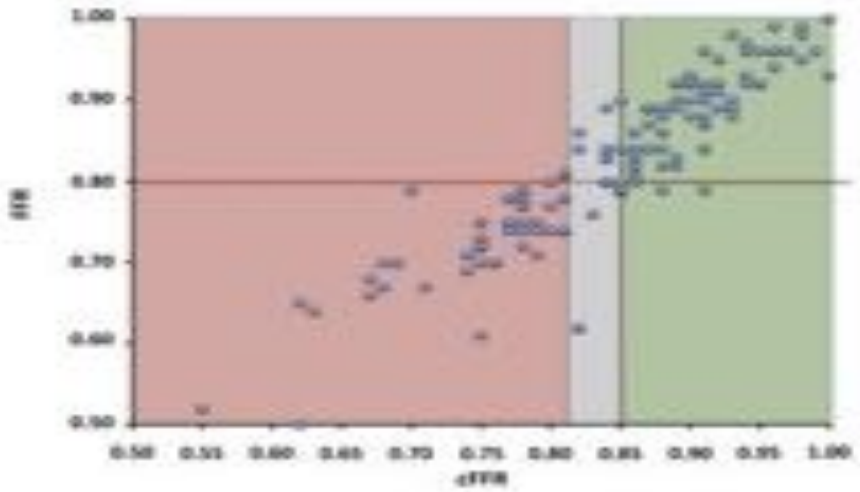


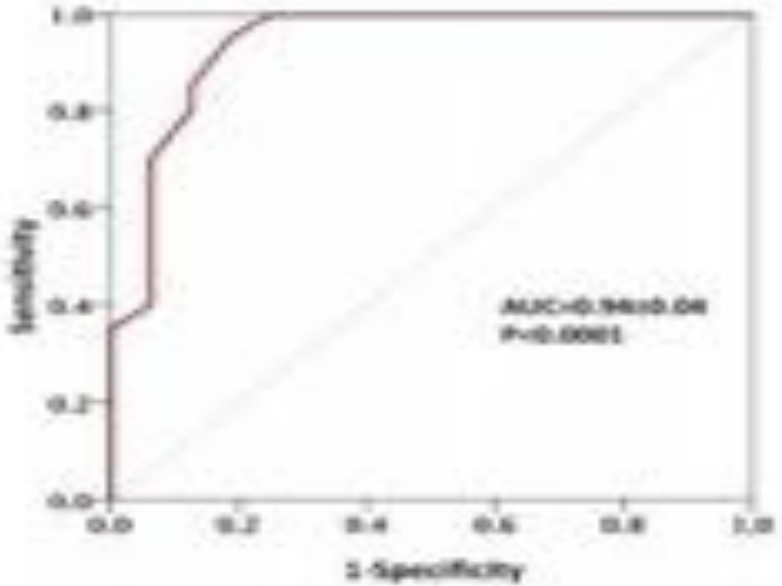
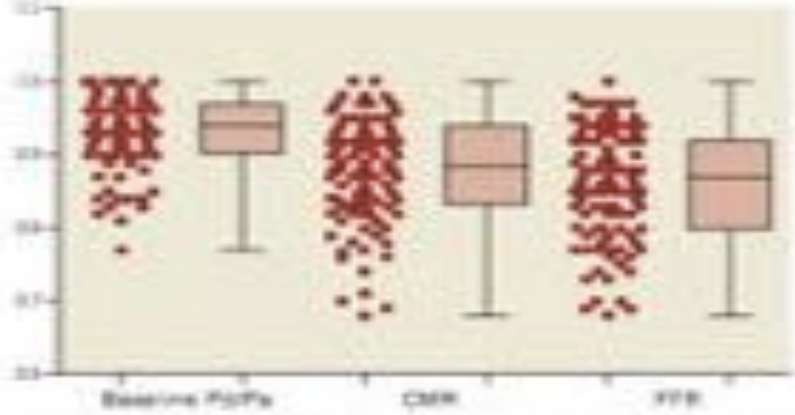
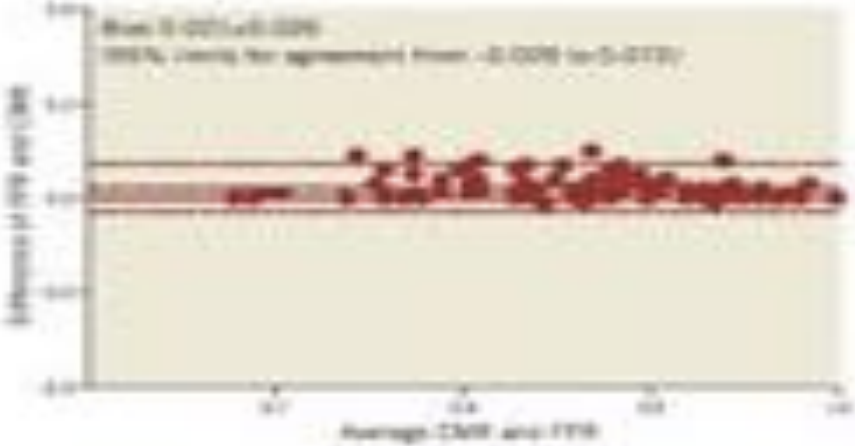


Figure 3. A receiver-operating characteristic curve was calculated using the threshold cutoff for contrast-enhanced fractional flow reserve (cFFR) of 0.80 in the exploration cohort. The receiver-operating characteristic was found to have an area under the curve (AUC) of 0.94 ± 0.04, which suggests the high accuracy rate of contrast-enhanced FFR in predicting FFR.

Vincent Spagnoli , Canadian Journal of Cardiology 32 (2016) 739e746

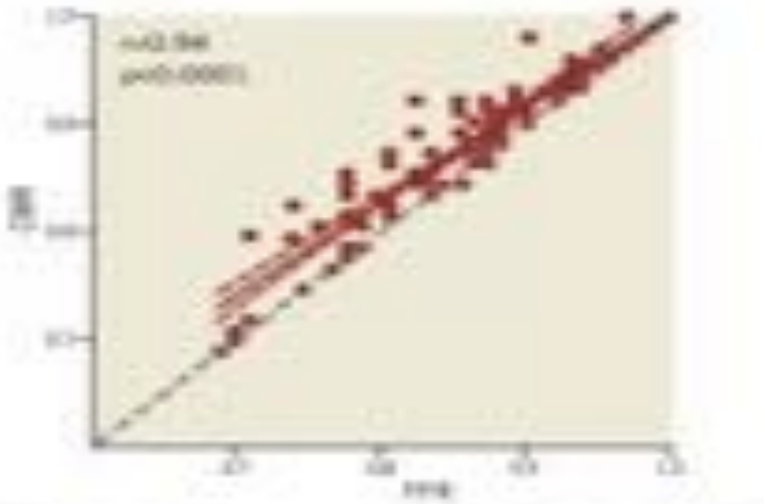
RINASCI Study n =104





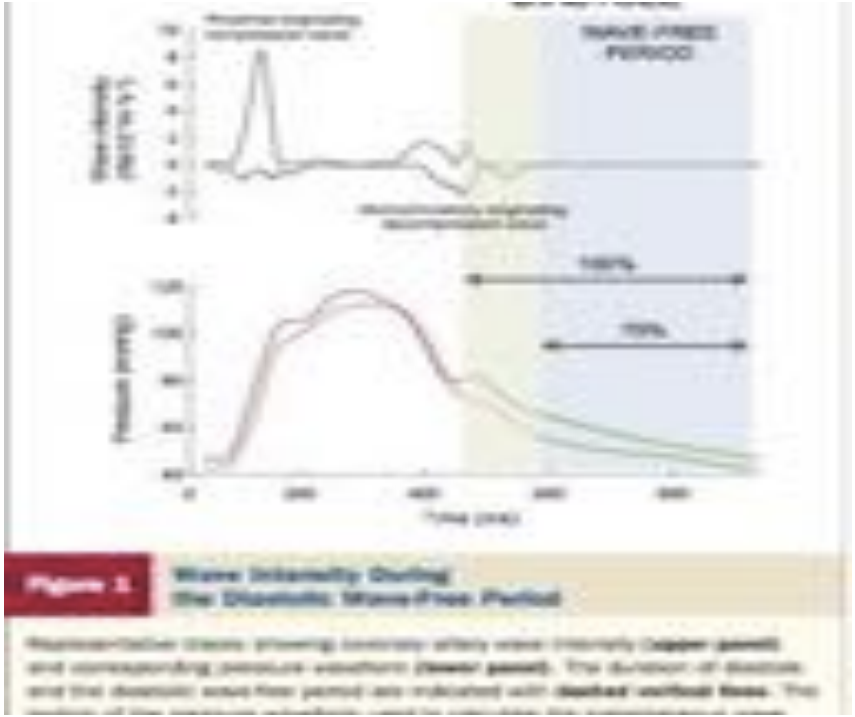
Antonio Maria Leone, EuroIntervention 2015;11:421-427

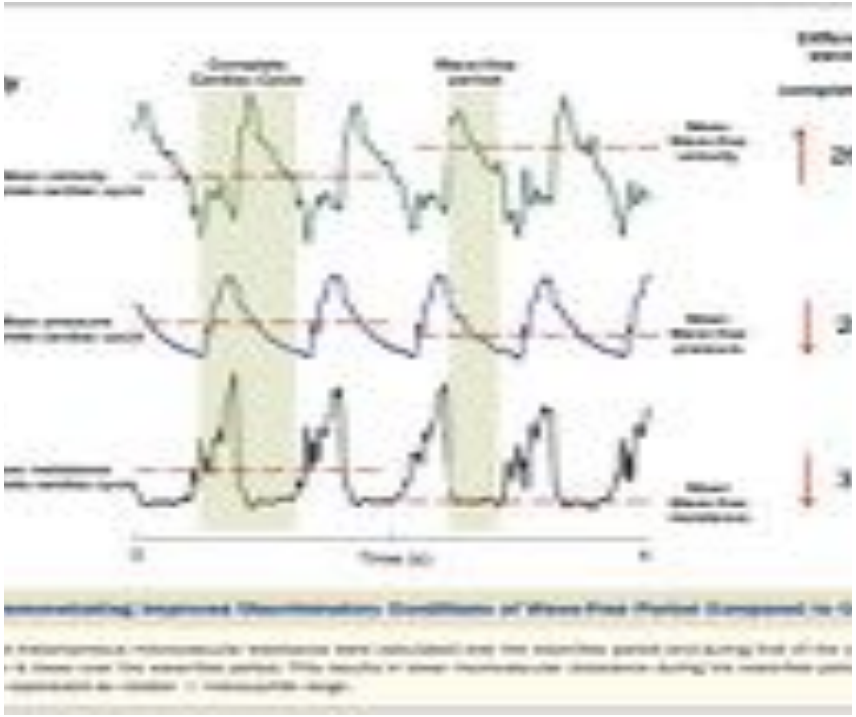
RINASCI Study n =104



Antonio Maria Leone, EuroIntervention 2015;11:421-427

iFR





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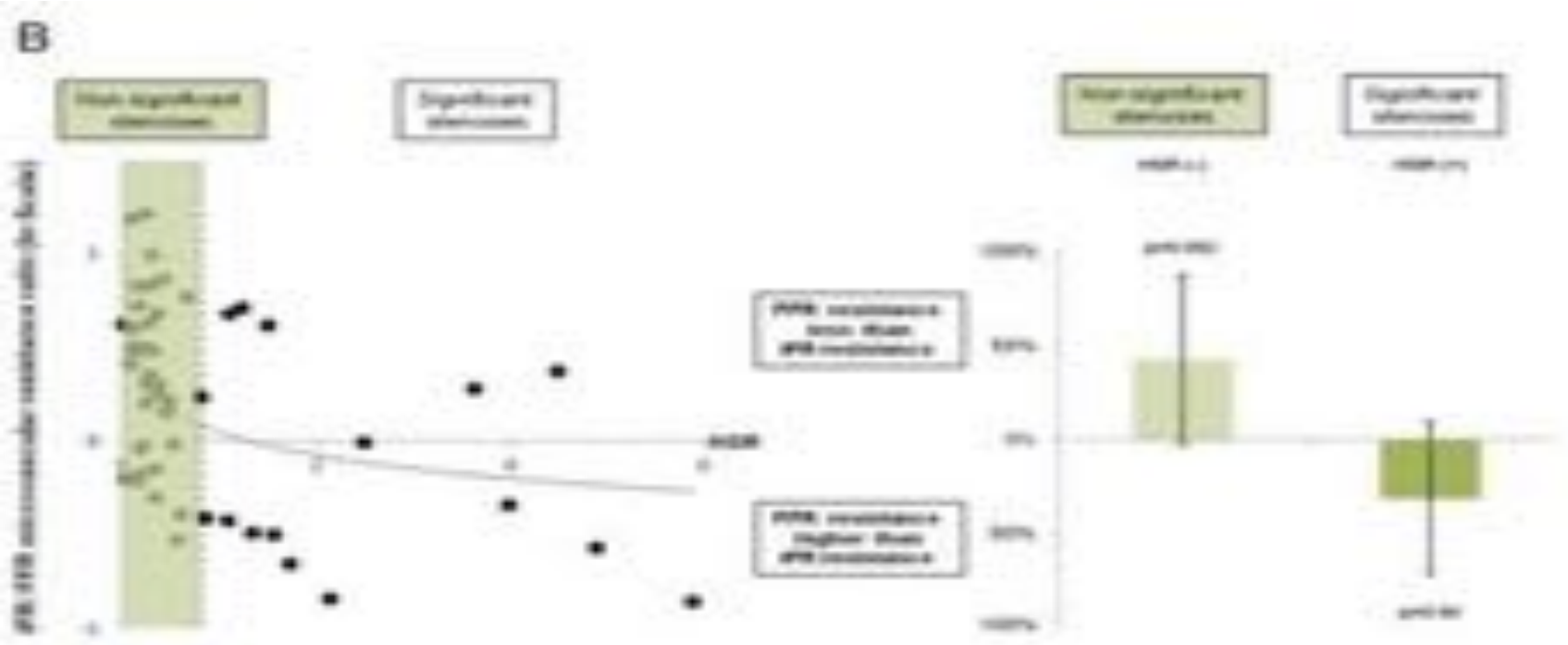
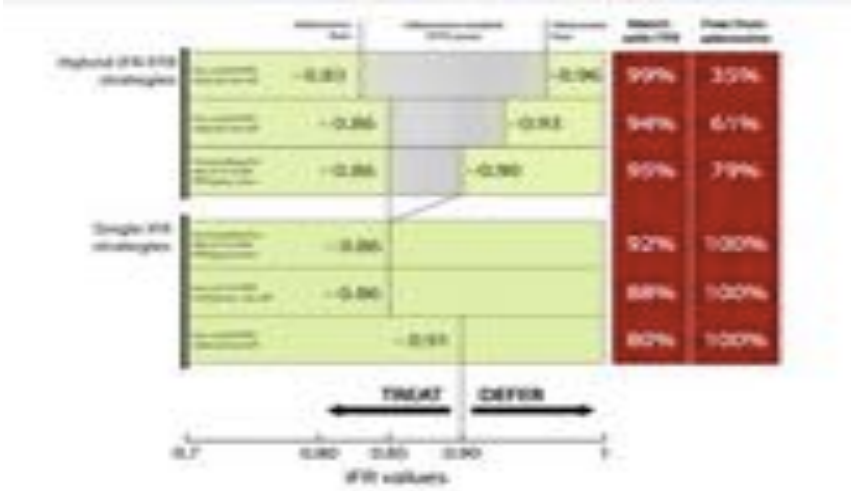
iFR



Advise Study

Classification agreement between iFR and FFR

	FFR 0.8	FFR 0.75	FFR grey zone*
iFR cut-off	0.9	0.85	0.85
ROC AUC	0.87	0.90	0.93
Classification match	80%	88%	92%
Sensitivity	81%	75%	82%
Specificity	79%	91%	96%
PPV	71%	70%	86%
NPV	87%	93%	95%



Petraco , Am Heart J 2014;168:739-48

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iFR

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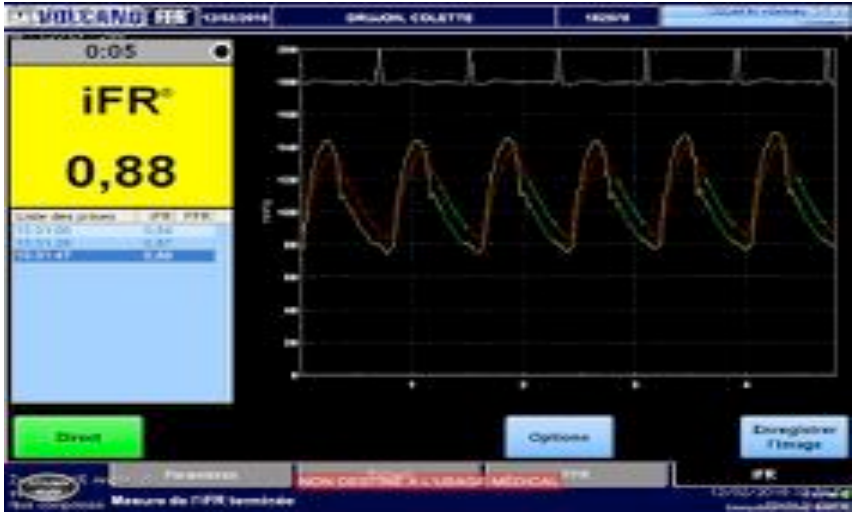
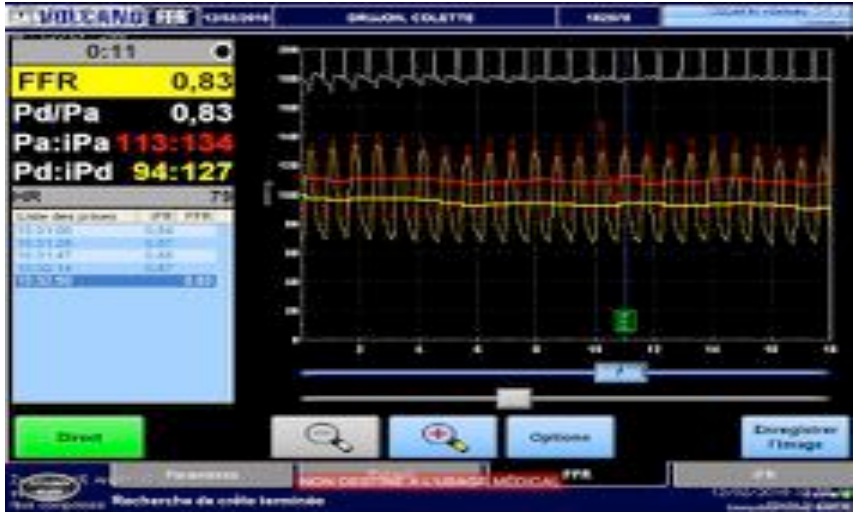
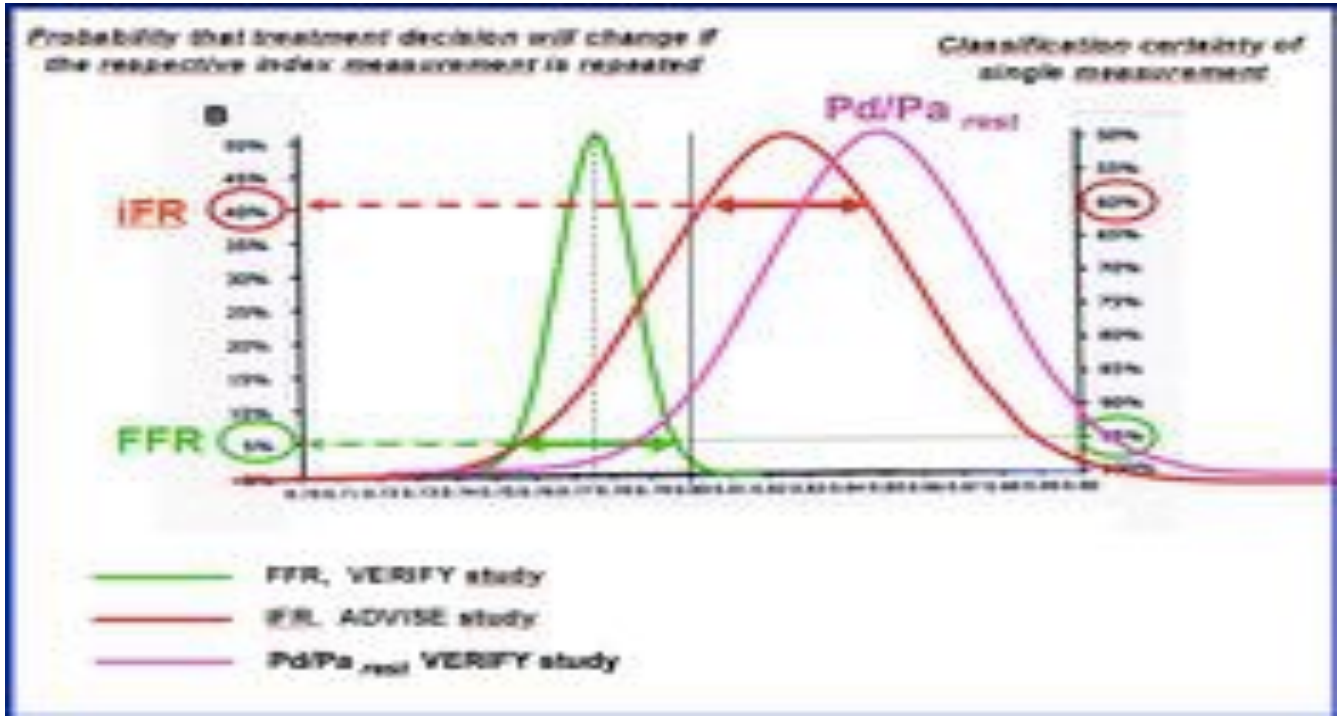
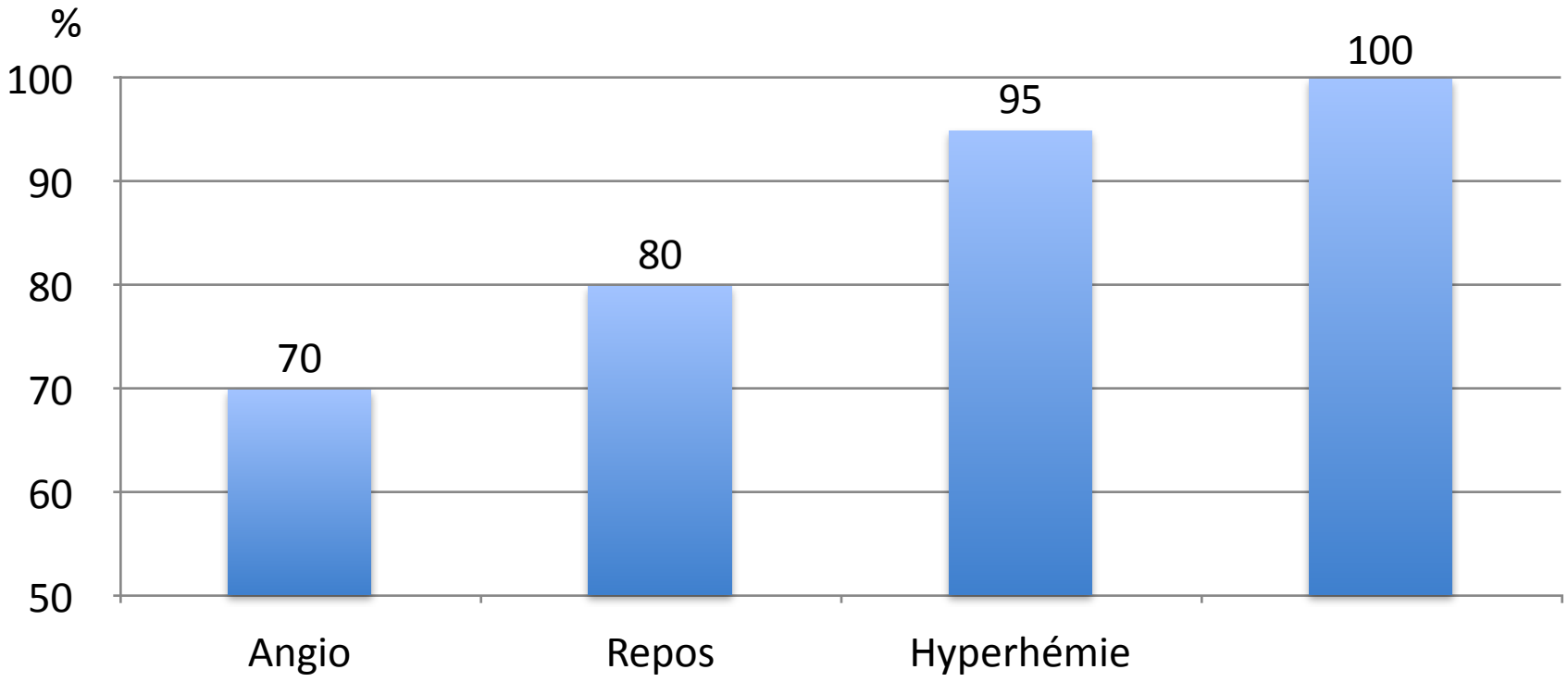





Probability that treatment decision will change if the respective index measurement is repeated
Classification certainty of single measurement
Pd/Pa rest
iFR
FFR
FFR, VERIFY study
iFR, ADVISE study
Pd/Pa rest VERIFY study

Précision diagnostique lésion ischémique



Conclusions

- L’utilisation du guide pression sans stimulus adjuvant est possible
- Quelque soit la technique utilisée, un valeur < 0,80 signe la fonctionnalité de la sténose
- Quelle valeur seuil retenir pour
  - Rapport Pd/Pa de repos – aucune étude
  - Contraste 0,83 zone grise : 0,84-0,88 ?
  - iFr 0,9 zone grise : 0,86-0,93
- Manque études de validation
- Define-Flair IFR SwedHeart Studies

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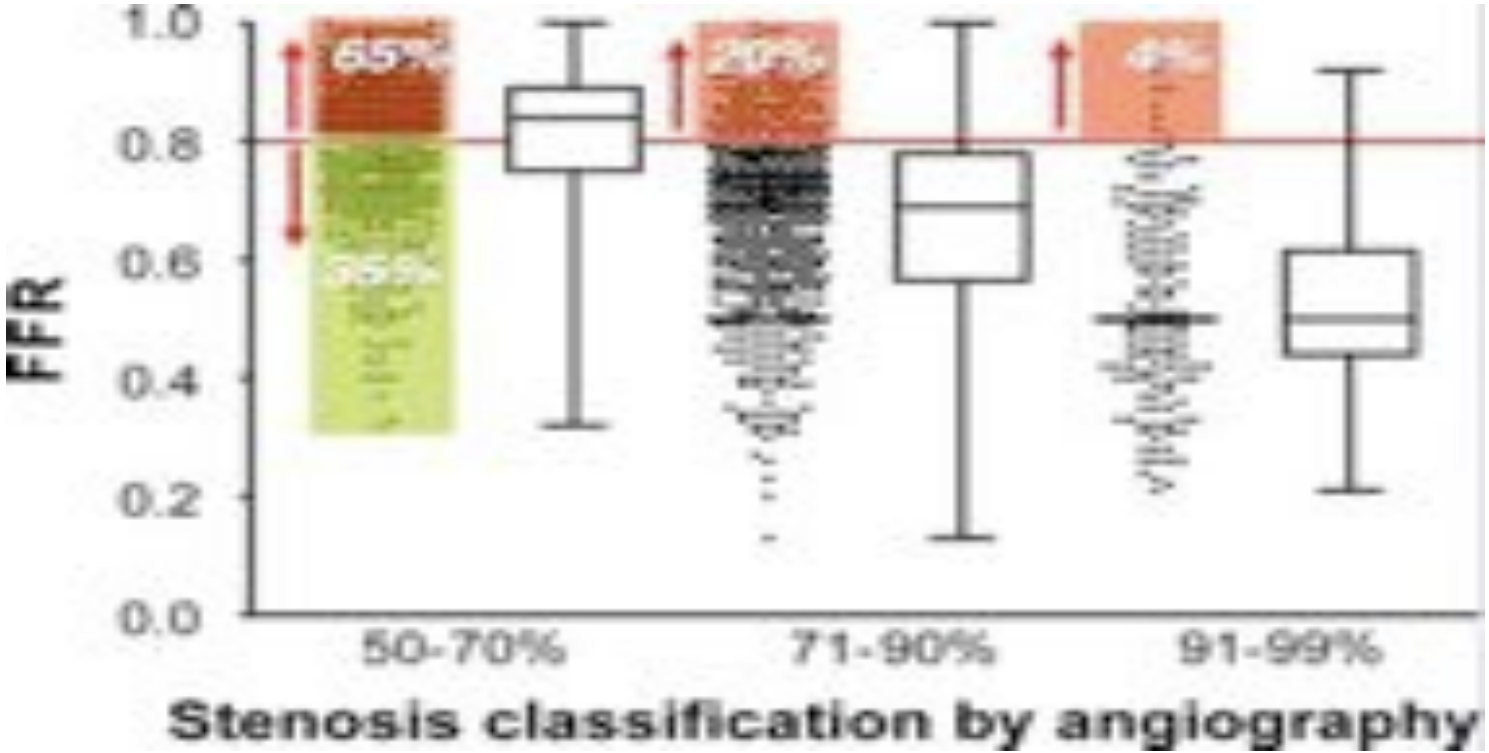
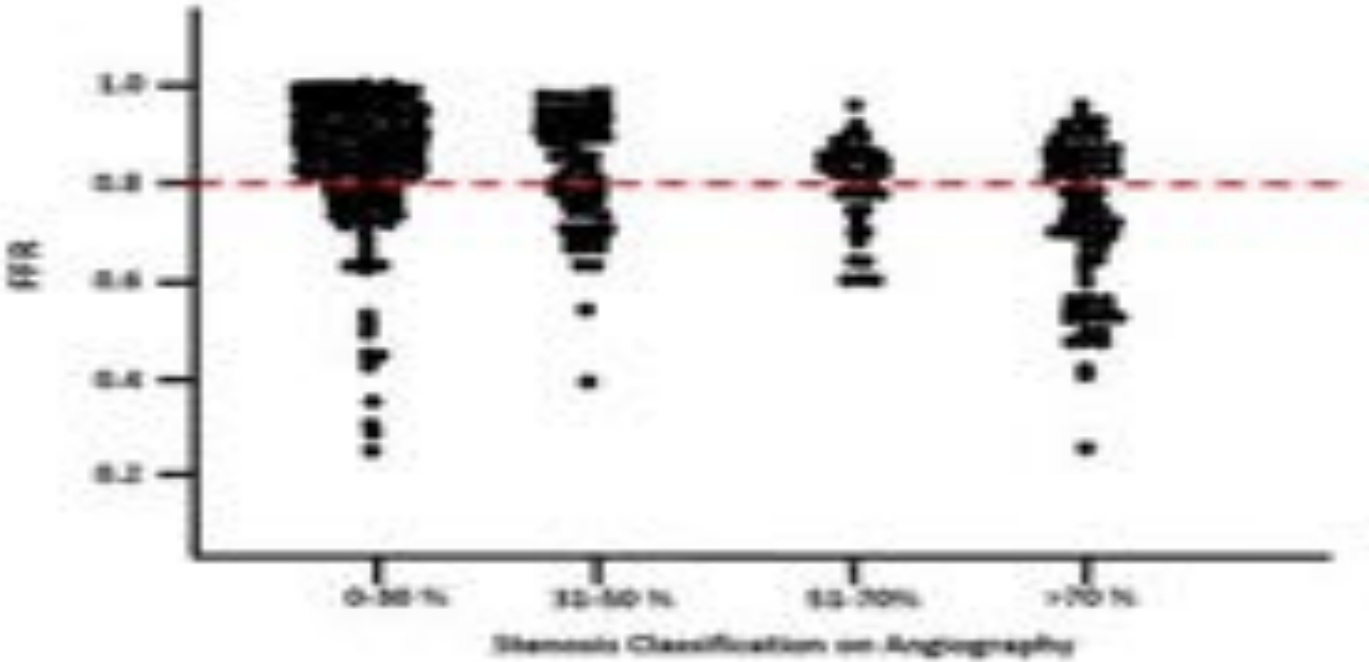
INFLUENCE DE LA FFR SUR L'ACTIVITE ANGIOPLASTIE

FFR vs Angiographie



Tonino, TCT 2009



RIPCORD STUDY, Circulation 2014

R3F registry

The FFR real life in France

- French prospective and multicentric Registry
- Inclusions 2008-2010
- 1101 Patients
- Hop, 6 month and 1 year foll
- Electronic CRF

Circulation

American Heart Association.

Outcome Impact of Coronary Revascularization Strategy Reclassification With Fractional Flow Reserve at Time of Diagnostic Angiography: Insights From a Large French Multicenter Fractional Flow Reserve Registry

Eric Van Belle, Gilles Rioufol, Christophe Pouillot, Thomas Cuisset, Karim Bougrini, Emmanuel Teiger, Stéphane Champagne, Loic Belle, Didier Barreau, Michel Hanssen, Cyril Bernard, Raphael Dumpluis, Jean Dallongeville, Yassine El Hafa, Georgios Sideris, Christophe Bertelle, Nicolas Lhoest, Pierre Barnay, Laurent Leborgne and Patrick Dupouy

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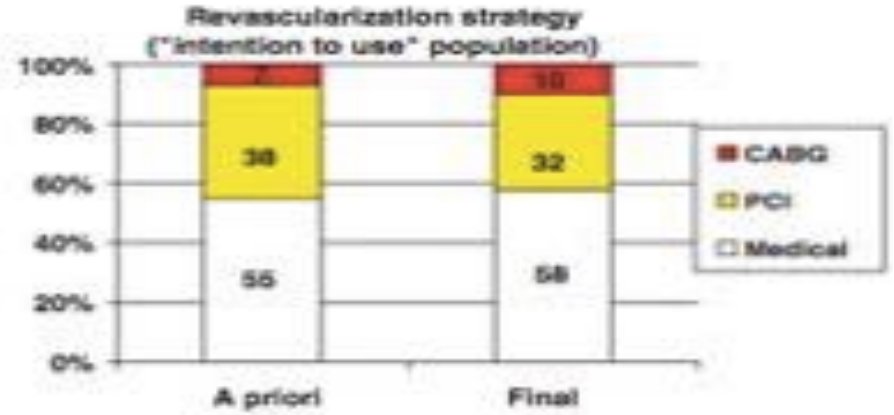
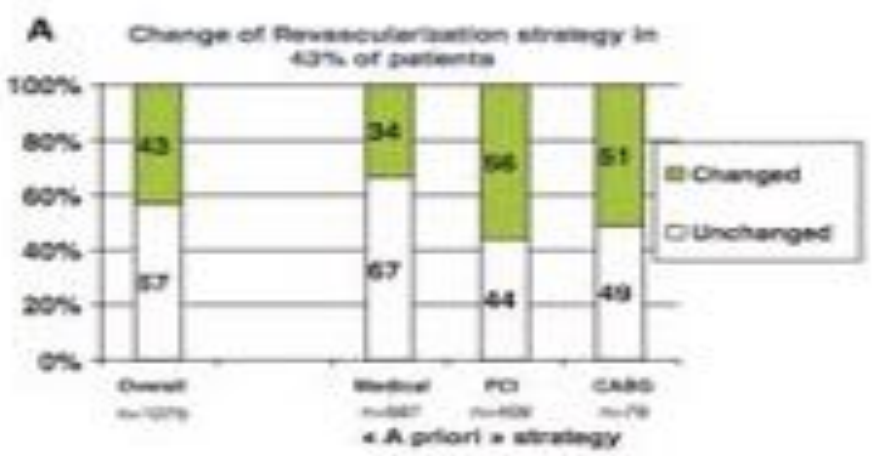
VanBelle, Dupouy et col Circulation. 2014;129:173-185

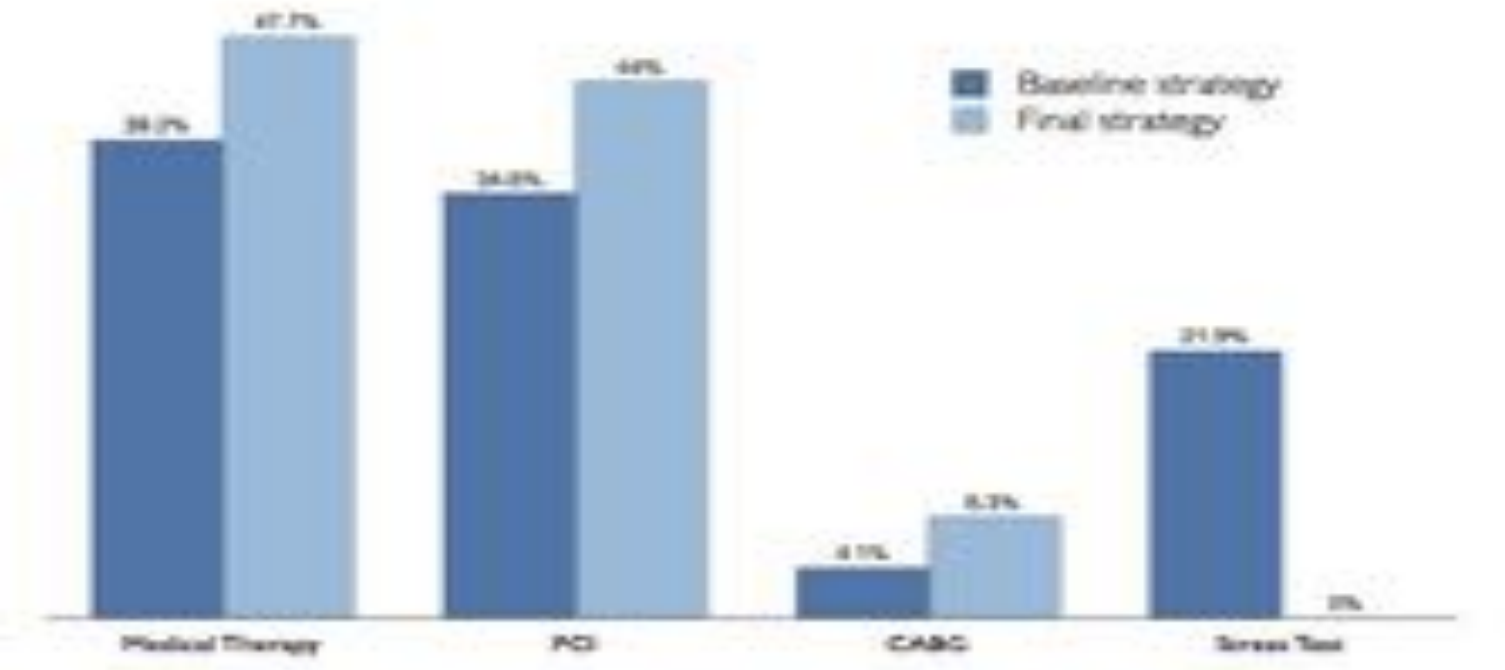




-6% angioplastie

VanBelle, Dupouy et col Circulation. 2014;129:173-185

Post-It study



Baptista et al, Circ Intervent in press

Routine FFR

		FFR PLAN 2				Total
		Medical	PCI	CABG	Further info	
PLAN 1	Medical	63	6	3	0	72
ANGIO	PCI	24	64	2	0	90
	CABG	1	3	19	0	23
	Further info	1	7	6	1	15
Total		89	80	30	1	200

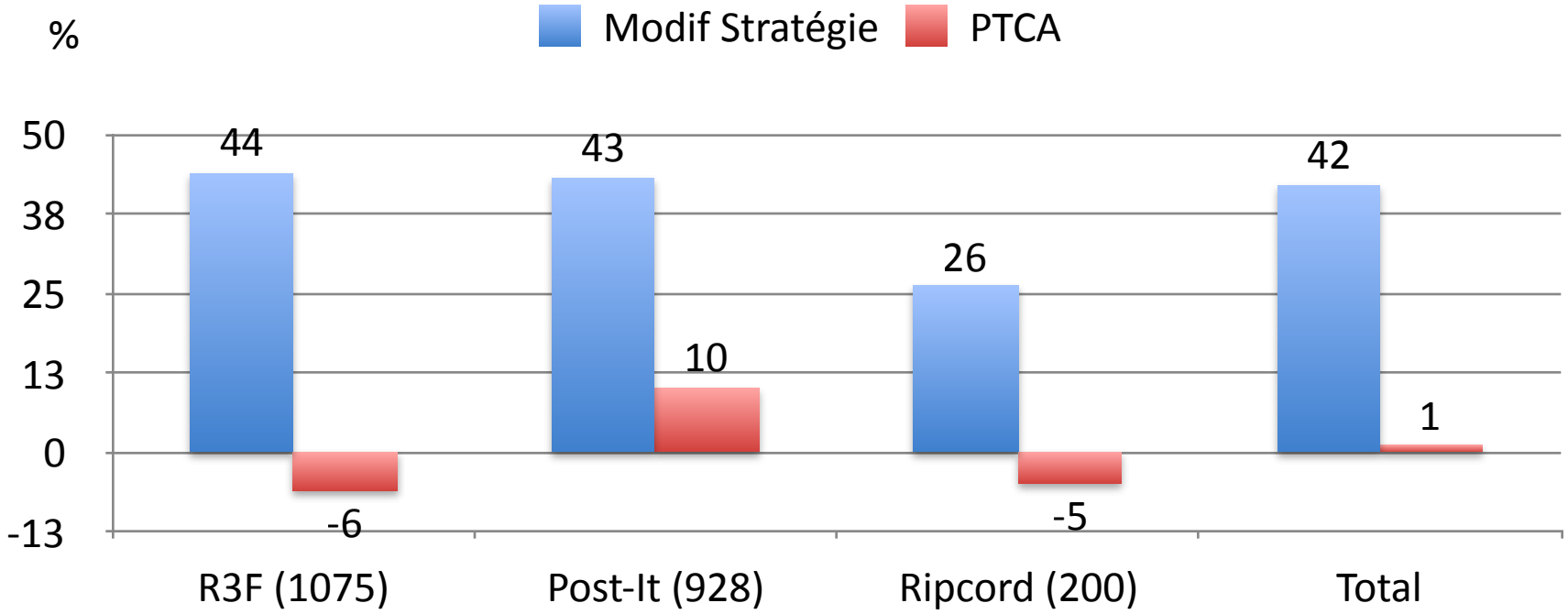
Fishers exact test p<0.0001

Summary

- Agreement about category of management in 147 out of 200 (74%)
  - ie after FFR management change in 26% of cases

-10% ANGIOPLASTIES

RIPCORD STUDY, Circulation 2014


%
Modif Stratégie
PTCA
50
38
25
13
0
-13
44
-6
43
10
26
-5
42
1
R3F (1075)
Post-It (928)
Ripcord (200)
Total

Conclusions

- L’utilisation de la FFR a peu d’impact sur le tau de revascularisation par angioplastie

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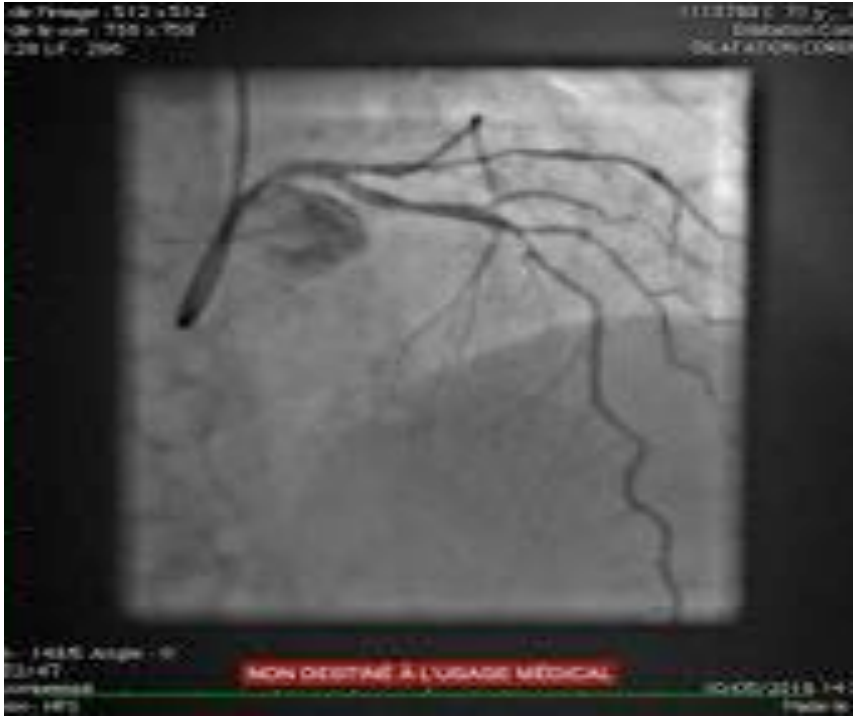
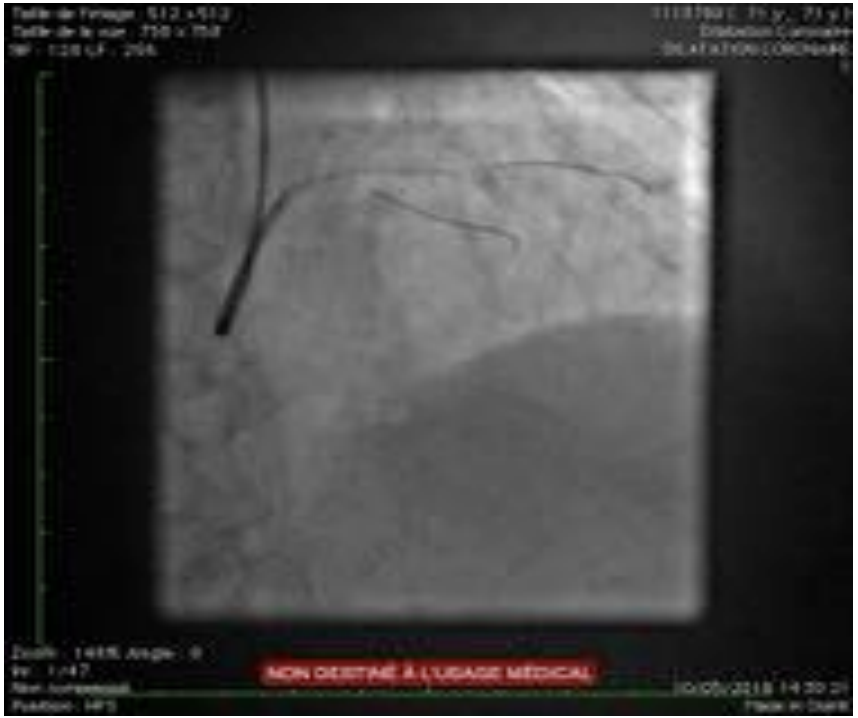
La FFR dans les lésions de bifurcation





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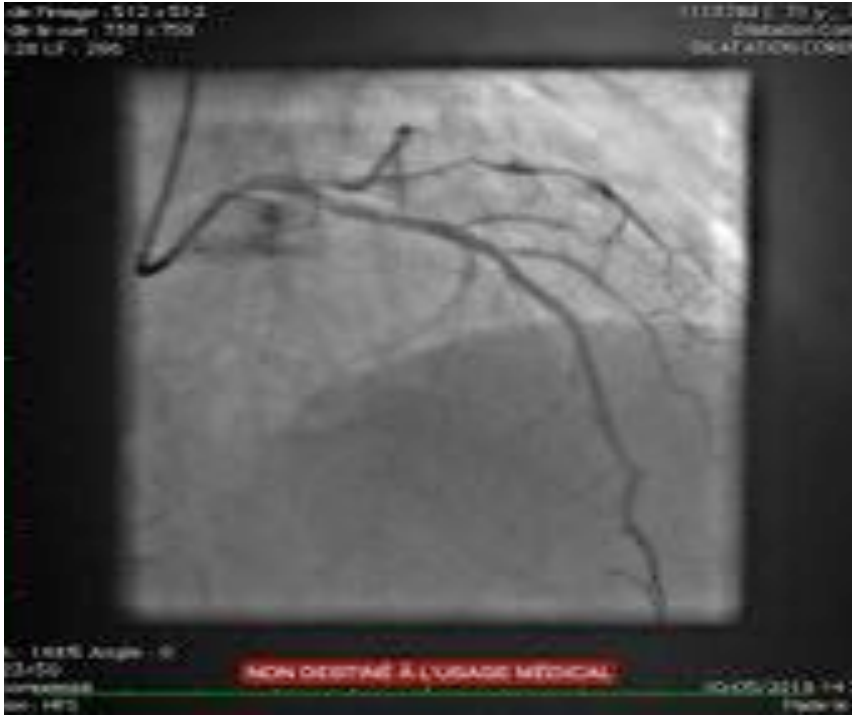

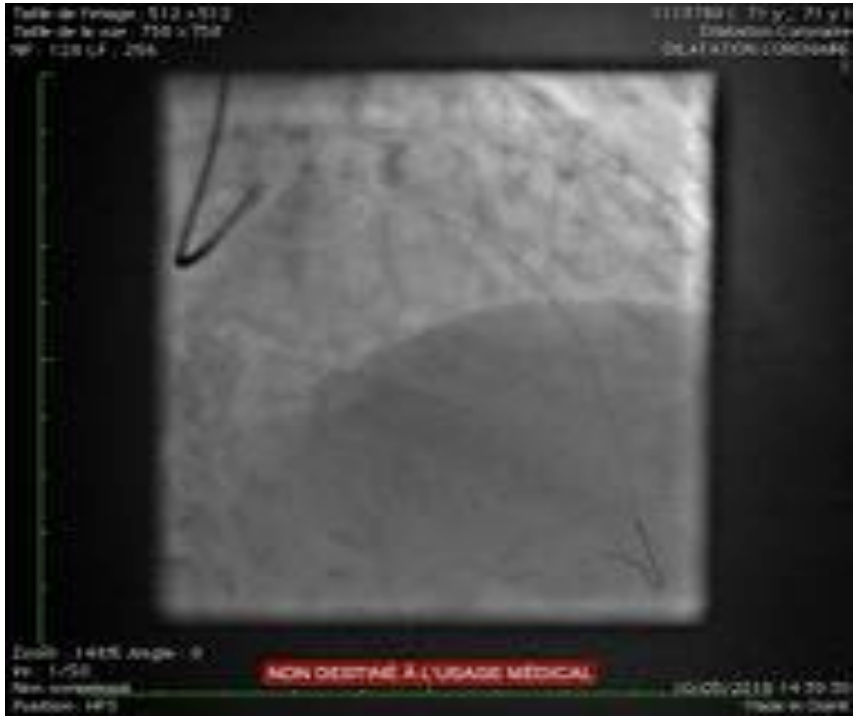

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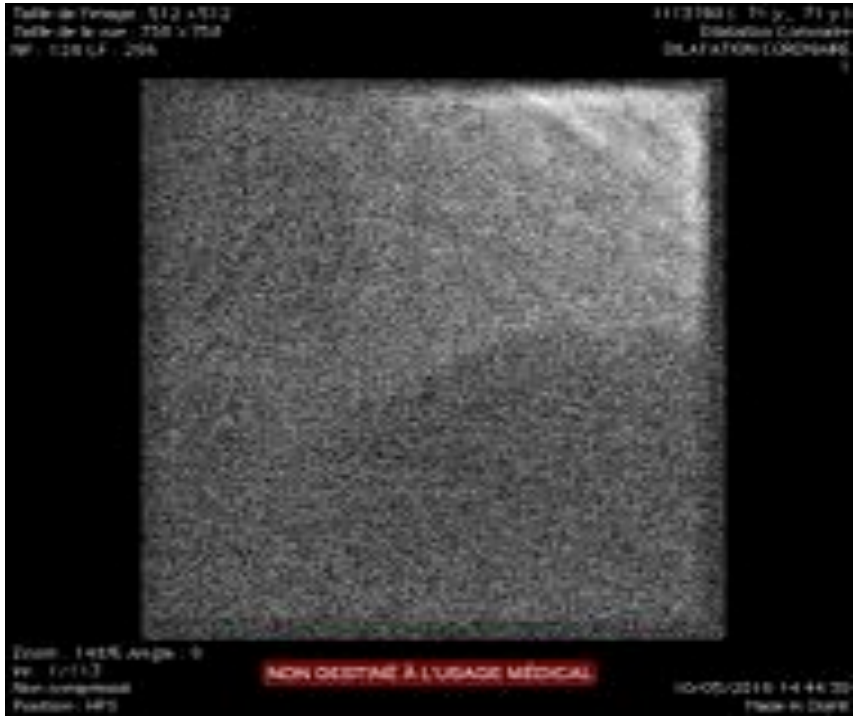
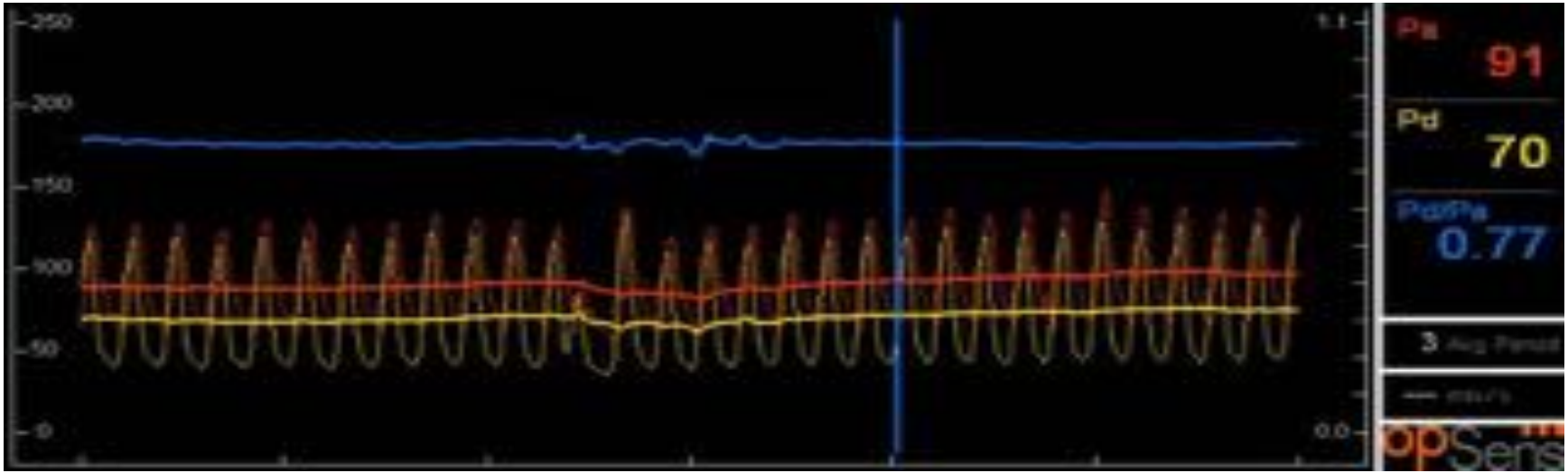


FFR Diag aprés stent IVA



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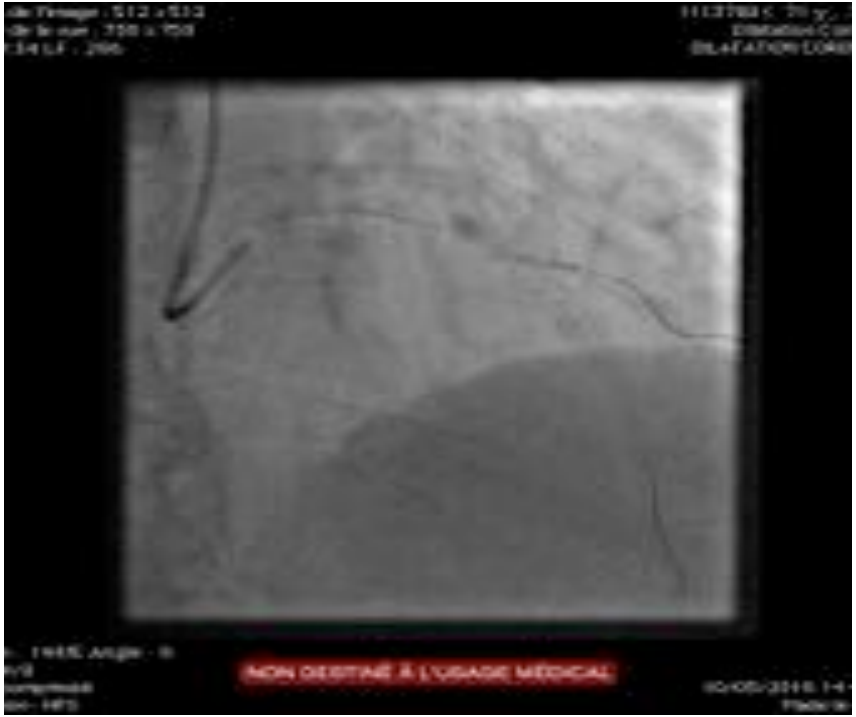
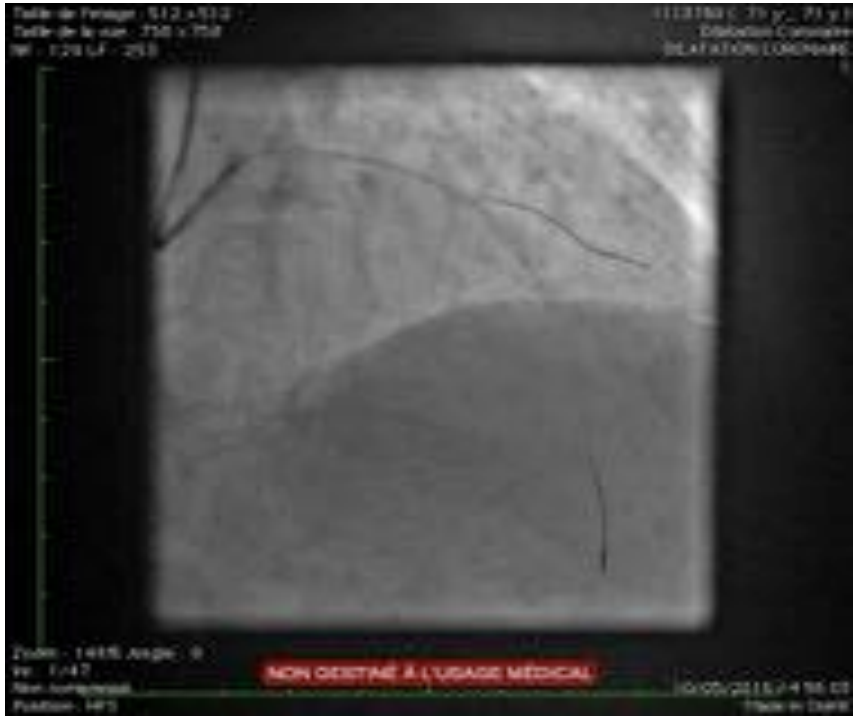
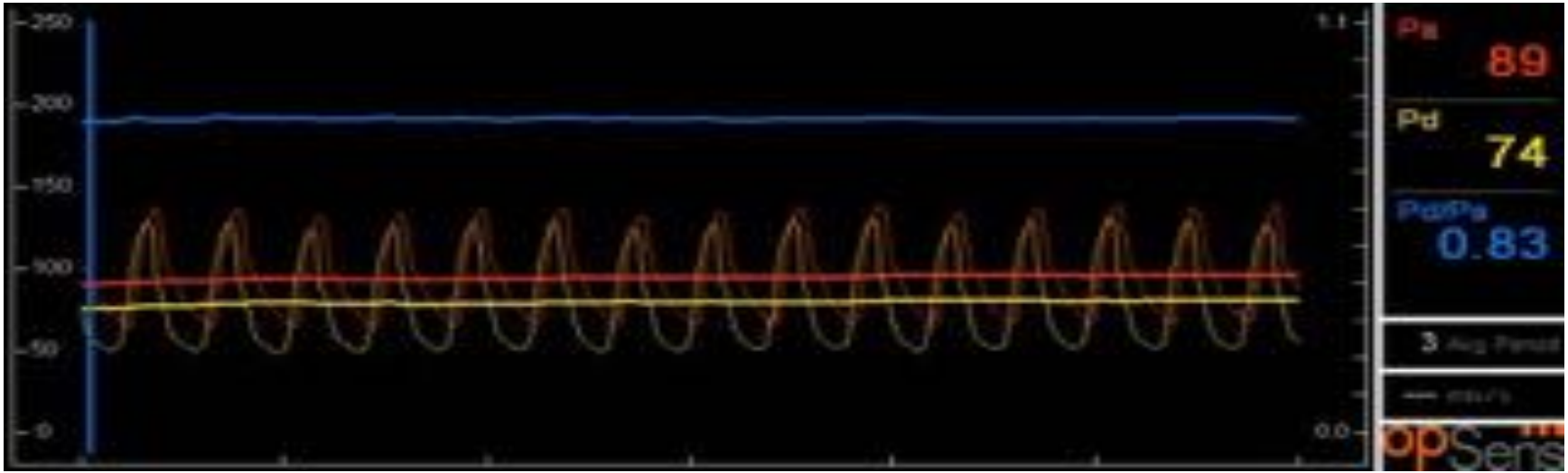




FFR après KB Diag

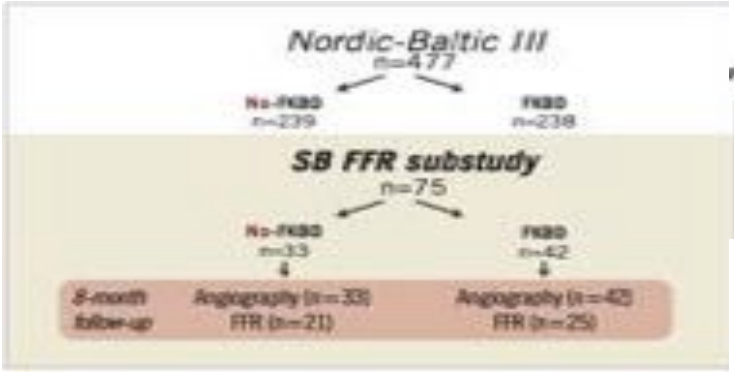


FFR dans les bifurcations

Table 1. FFR during bifurcation intervention.

	FFR is useful	FFR is generally not recommended
Pre-intervention	To assess the functional significance of MB To assess the functional significance of pure SB stenosis	Small SB To determine functional significance of SB when there is a significant MB stenosis SB FFR to predict the functional significance of jailed SB
Post MB stenting	To assess the functional significance of jailed SB and to predict the outcomes	Small SB Long diffuse, highly angulated or calcified SB SB slow flow
Post SB angioplasty	To assess SB procedural success and to predict the outcomes after KBI	SB slow flow SB severe dissection
Post SB stenting	To evaluate residual ischaemia	To predict procedural outcomes of complex two stenting

FFR: fractional flow reserve; KBI: kissing balloon inflation; MB: main branch; SB: side branch



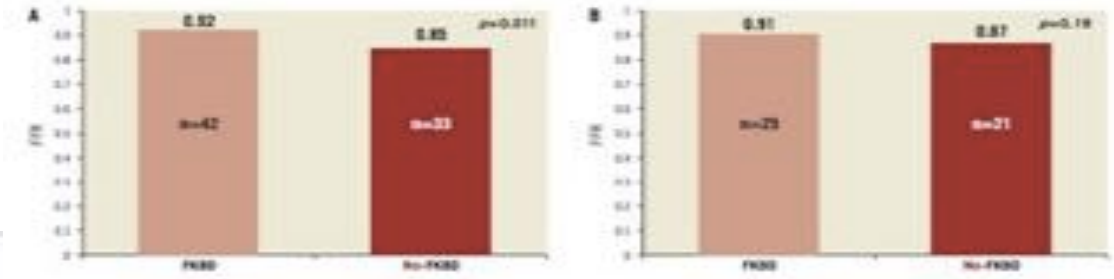
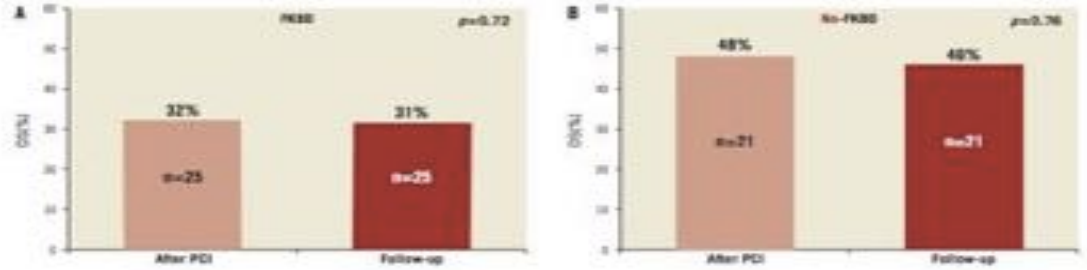
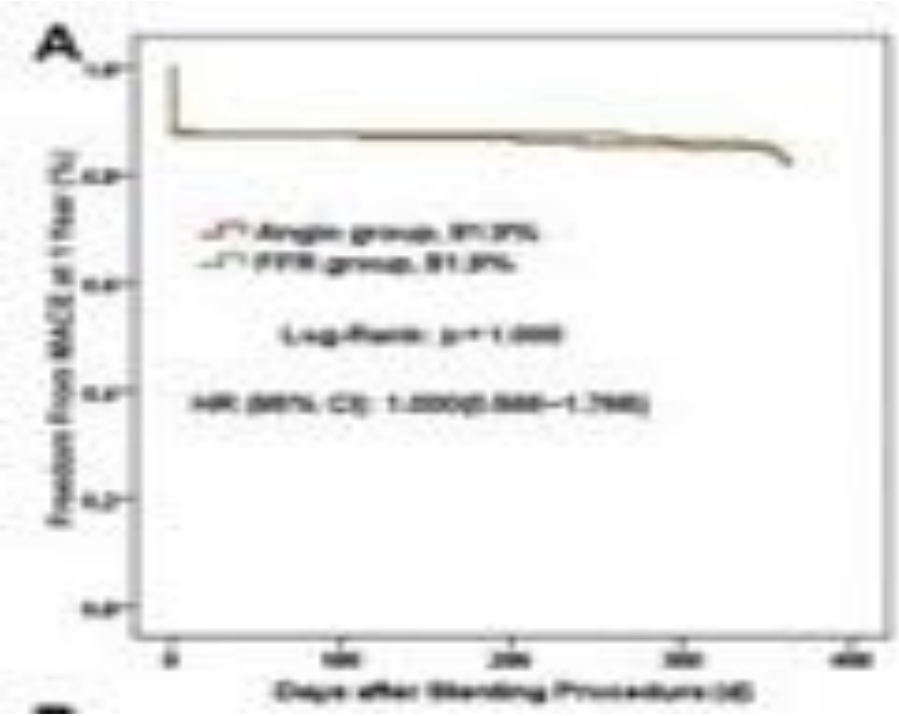


Figure 4. *A) Mean FFR in SB after PCI. B) Mean FFR in SB at 8-month follow-up.*

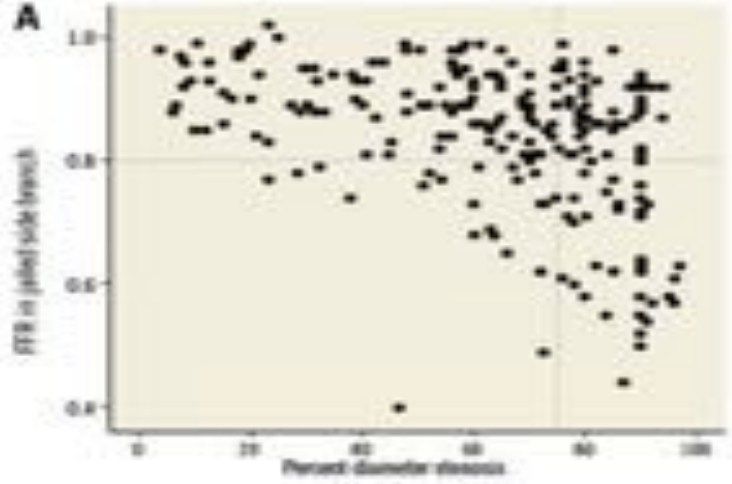


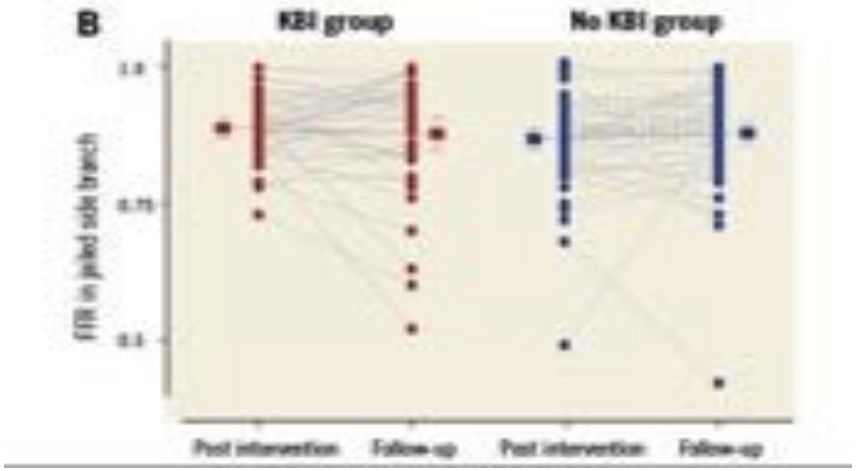
Indulis Kumsars ; EuroIntervention 2012;7:1155-1161

DKCRUSCH-IV Study



Shao-Liang Chen , J Am Coll Cardiol Intv 2015;8:536–46





Joo Myung Lee ; EuroIntervention 2015;11

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Serial FFR measurement in jailed side branch		
Koo BK et al 2008	100 patients with provisional strategy. Repeated SB FFR at 6-month follow-up (n=65).	1. At 6-month follow-up, there were no changes in FFR in lesions with (0.86±0.06 to 0.84±0.01, p=0.4) and without SB balloon angioplasty (0.87±0.06 to 0.89±0.07, p=0.1). 2. Binary restenosis rate was 48%; however, functional restenosis (FFR <0.75) rate was 8% (5/65). There were no changes in SB FFR during the 6-month follow-up period (0.92 to 0.91, p=0.80 in KBI group and 0.87 to 0.87, p=0.91 in no KBI group).
Nordic-Baltic Bifurcation II 2011	75 patients with provisional strategy. Repeated SB FFR at 6-month follow-up (n=46)	There were no changes in SB FFR during the 6-month follow-up period (0.92 to 0.91, p=0.80 in final KBI group and 0.87 to 0.87, p=0.91 in no final KBI group)
FFR-guided PCI vs. Angio-guided PCI for jailed side branch		
Koo BK et al 2008	110 patients with provisional strategy. SB intervention when FFR <0.75. Control group: 110 patients without FFR measurements.	1. The FFR-guided group showed significantly less frequent SB intervention (30% in FFR-guided vs. 45% in angiography-guided group, p=0.03). 2. There was no difference in 9-month TVR (4.6% vs. 3.7%, p=0.7).
DKCRUSH-VI 2014	320 patients with Medina 1,1,1 or 0,1,1 bifurcation lesions. Randomly assigned to FFR-guided (FFR <0.80) or angiography-guided SB treatment.	1. Treatment of SB was less in FFR-guided group than in angiography-guided group (SB stenting: 23.9% vs. 38.1%, p=<0.01). 2. MACE (cardiac death, MI, TVR) rate at 1 year was comparable (18.1% vs. 18.1%, p=1.00). Restenosis at distal MB was more frequent in angiography-guided group than in FFR-guided group (9.2% vs. 1.2%, p=0.01).

Conclusion

- Quelques avantages .. À la marge :
- Il est difficile de montrer un bénéfice clinique à l'utilisation de la FFR dans les bifs
- Souvent, petit territoire (sauf TC)
- Avantage au niveau de la simplification de la procédure en limitant le nombre de kissing

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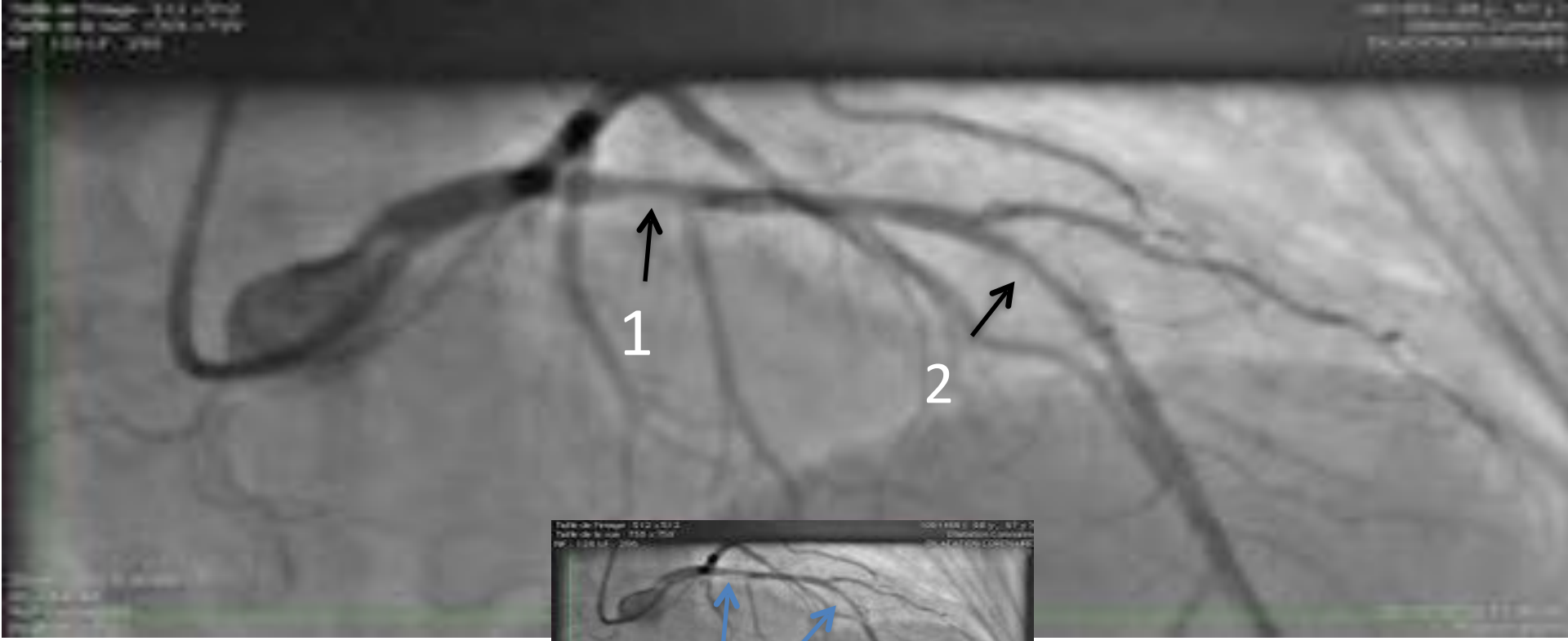
LÉSIONS MULTIPLES


1
2


1
2
NON DESTINÉ À L'USAGE MÉDICAL

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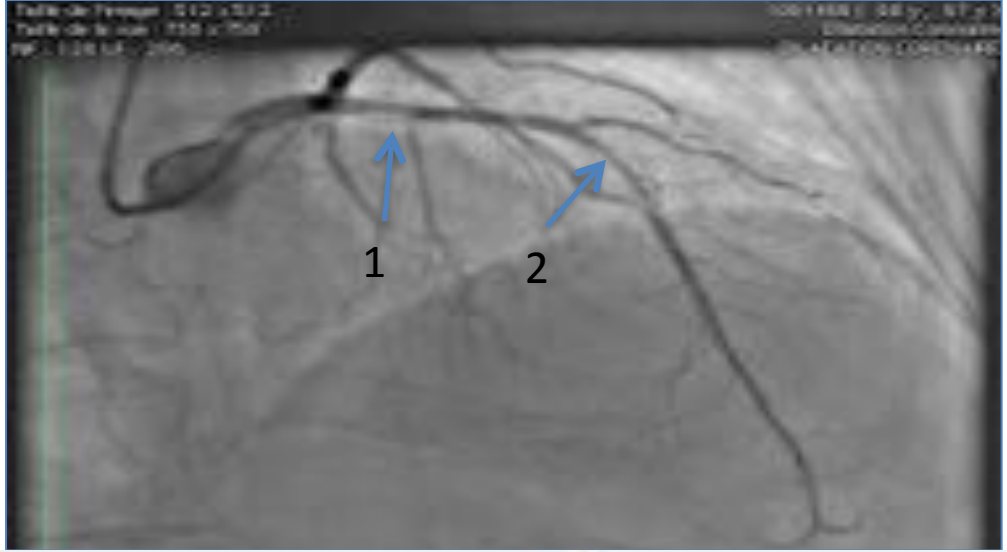

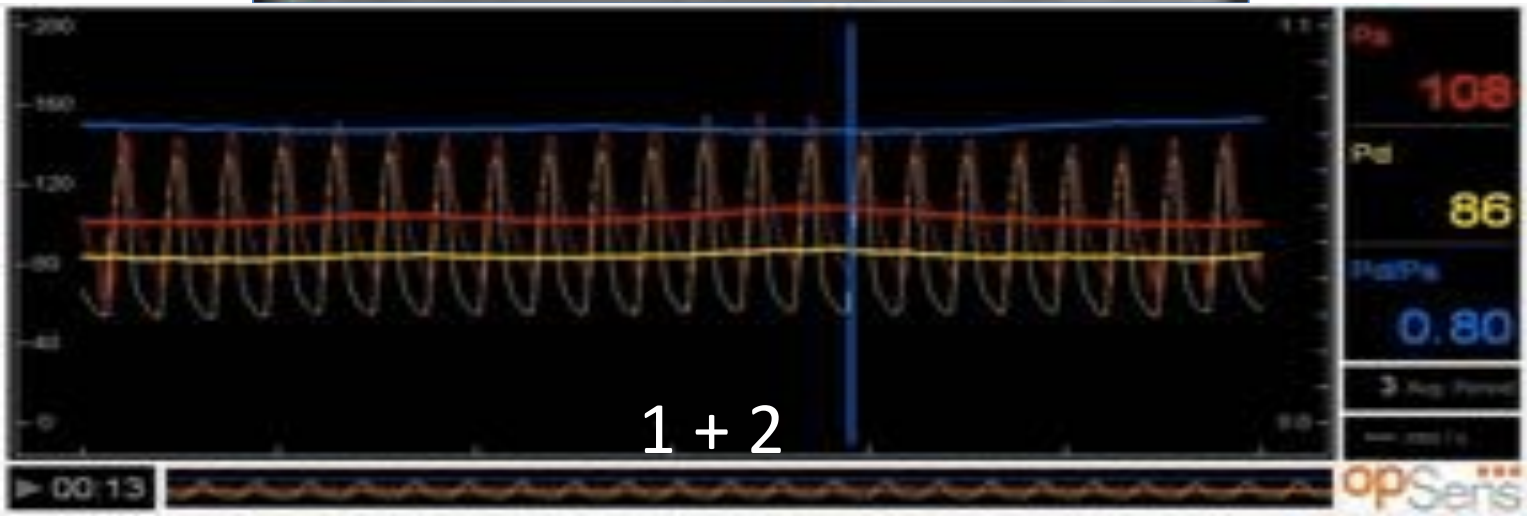

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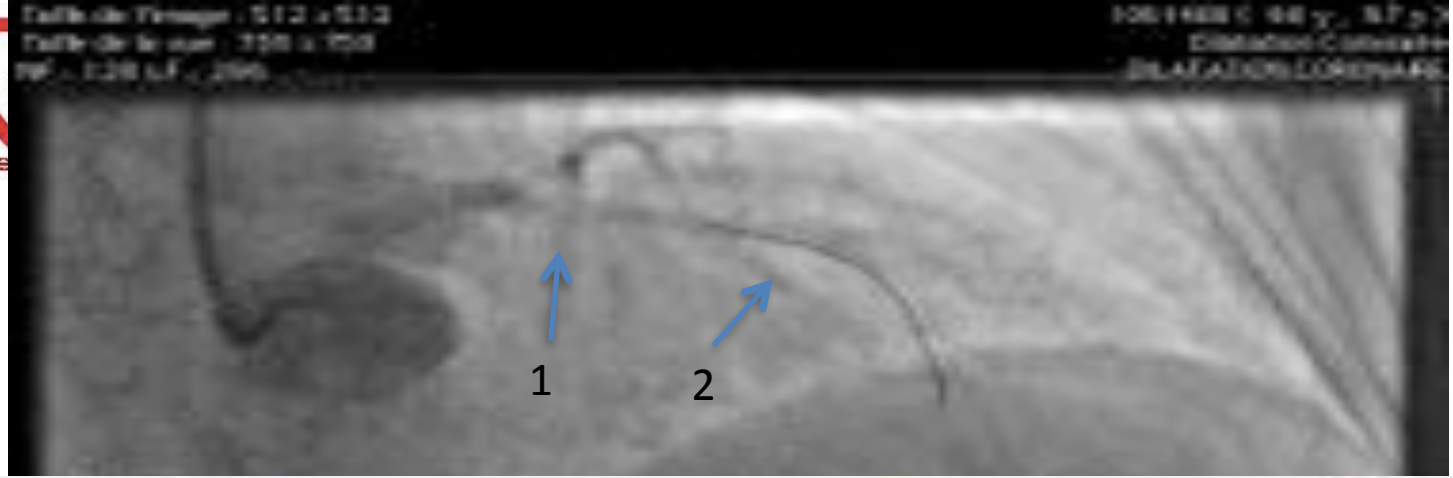

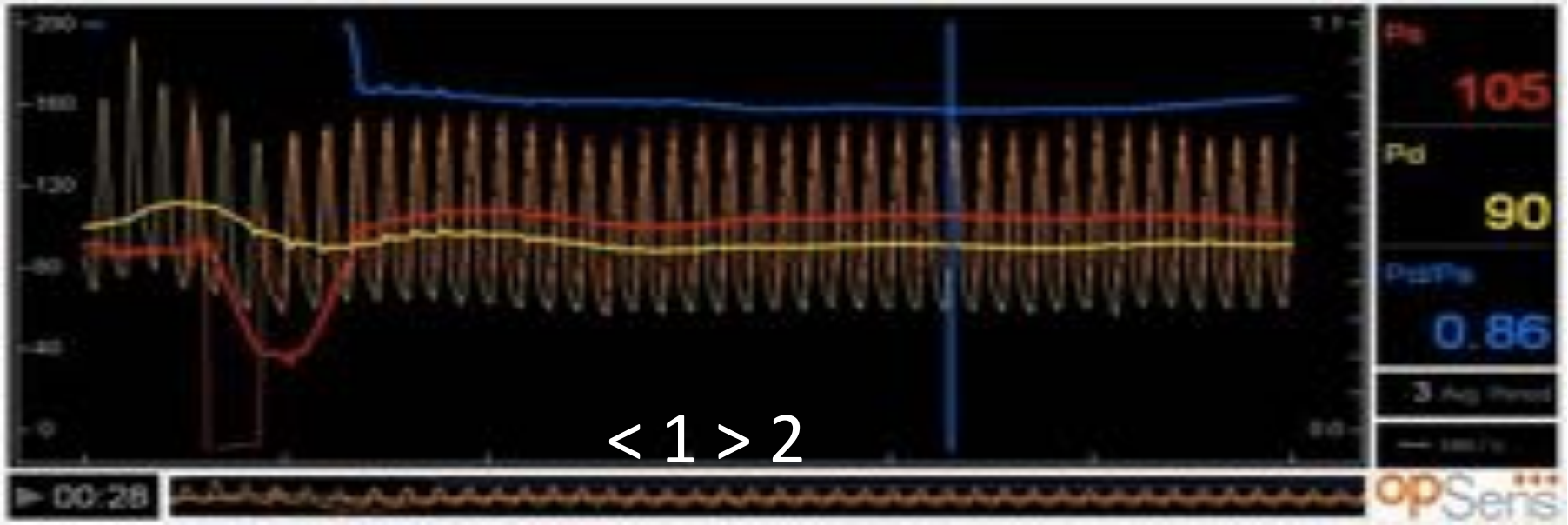

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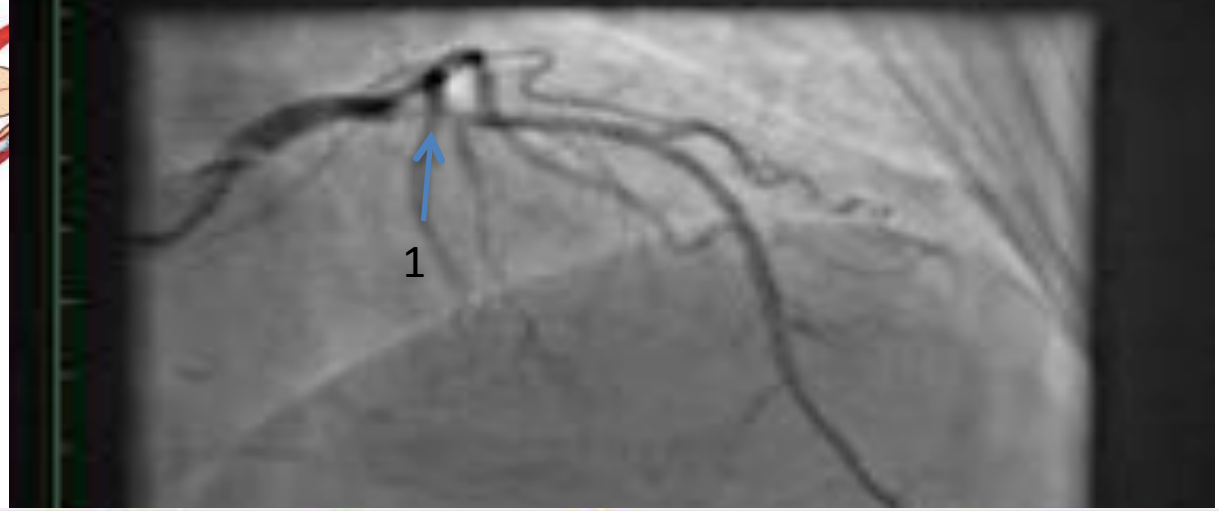

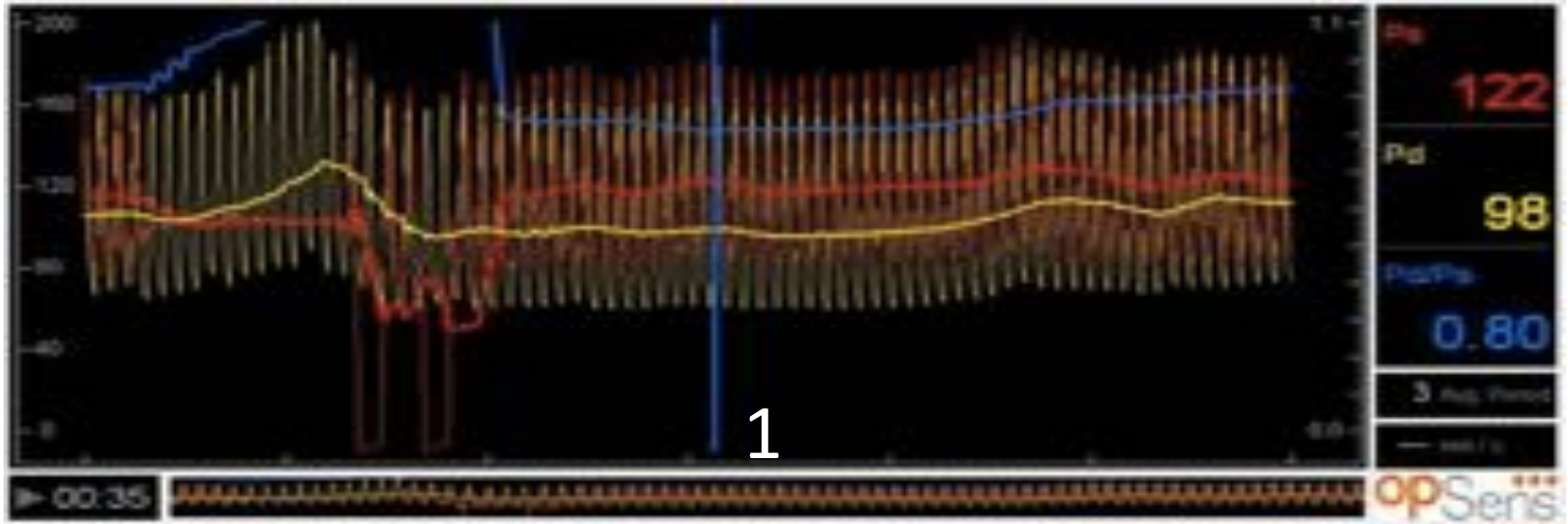

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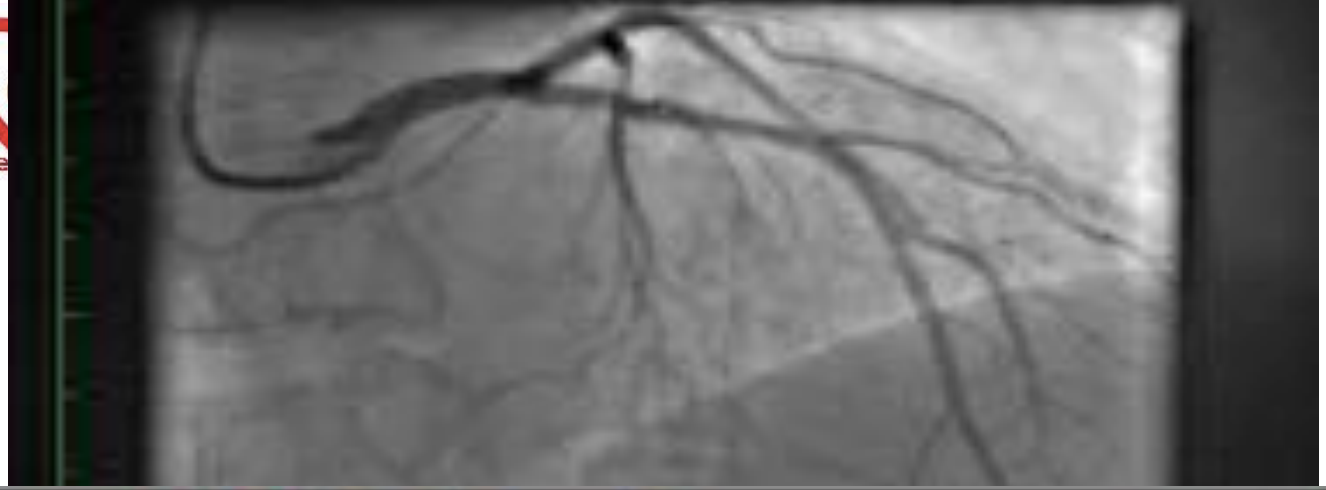

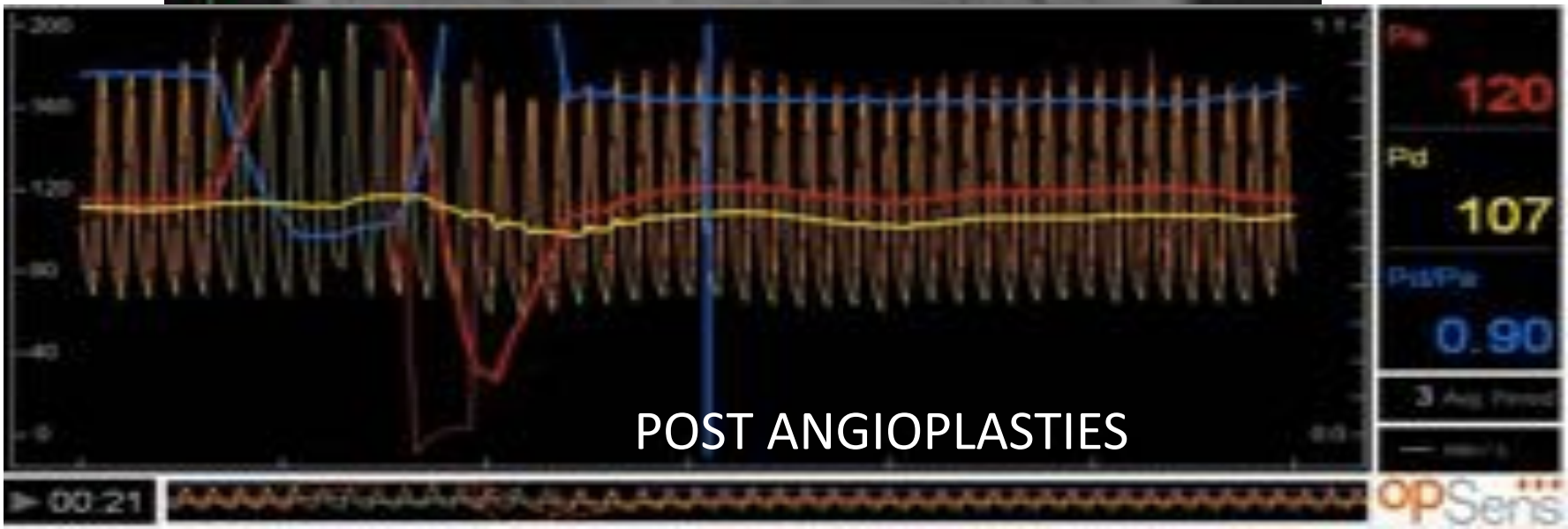

POST ANGIOPLASTIES

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IMPORTANCE DU TERRITOIRE DEPENDANT DE LA LESION

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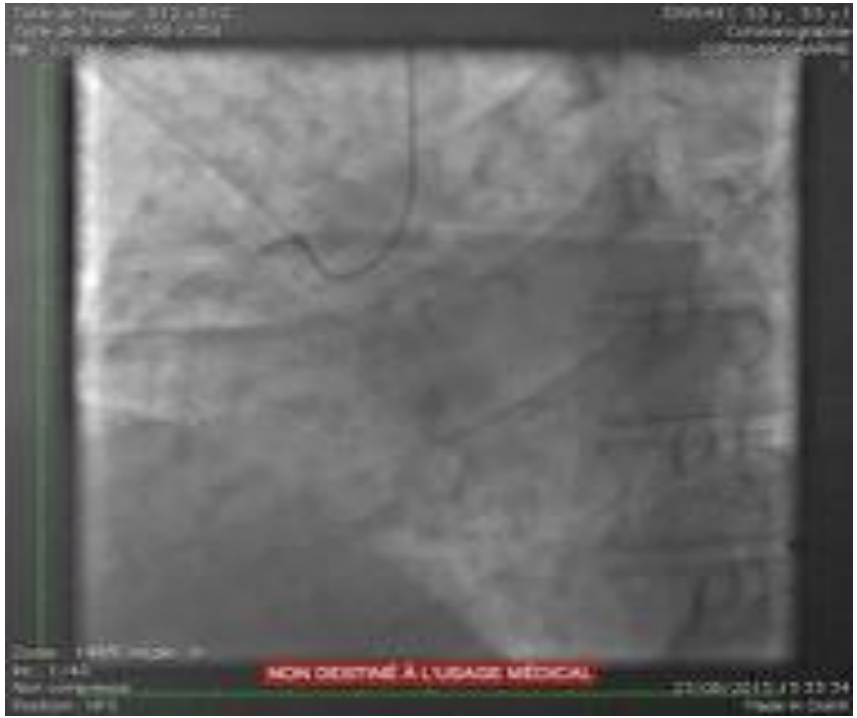

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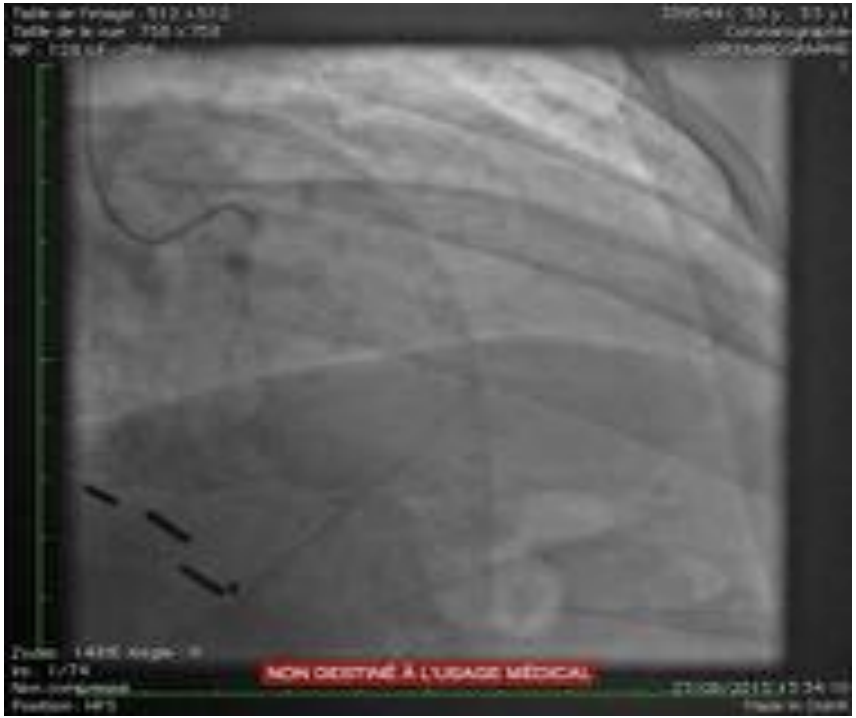

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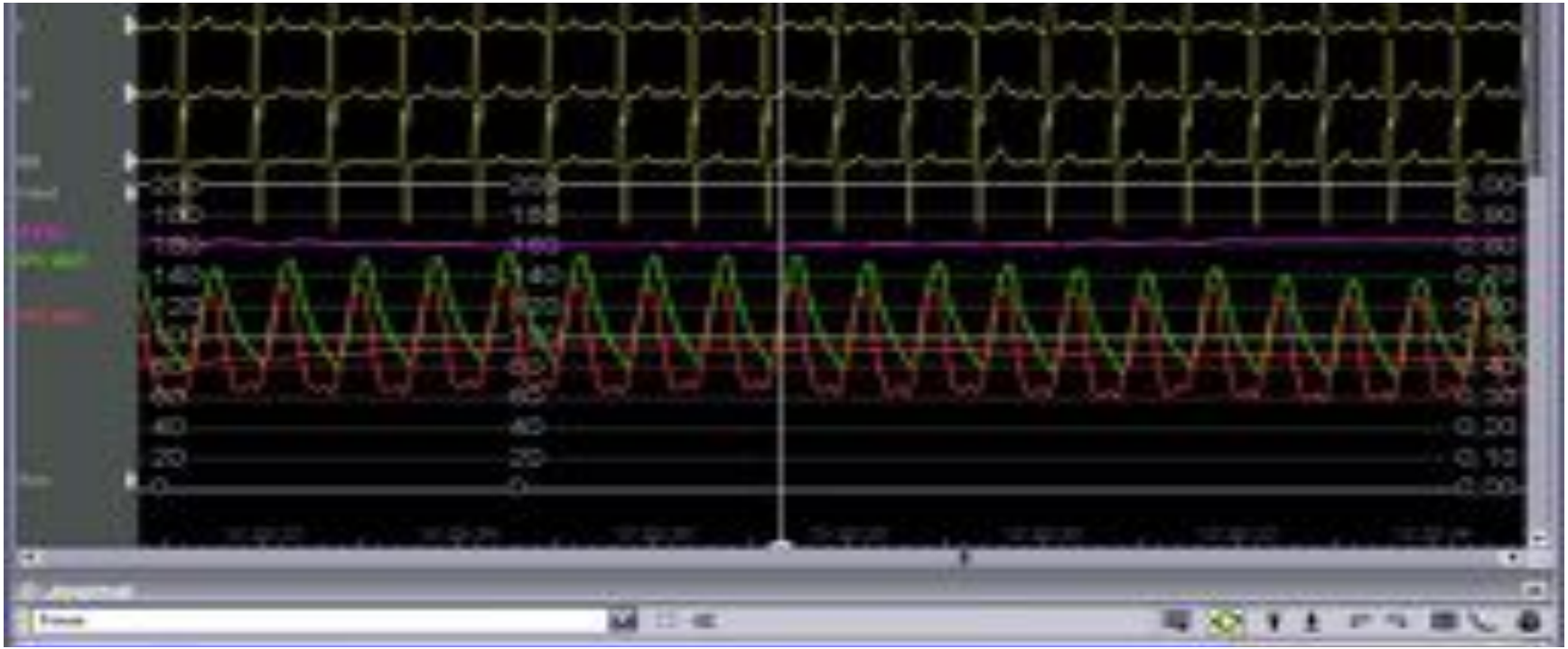
FFR = 0,80 .....



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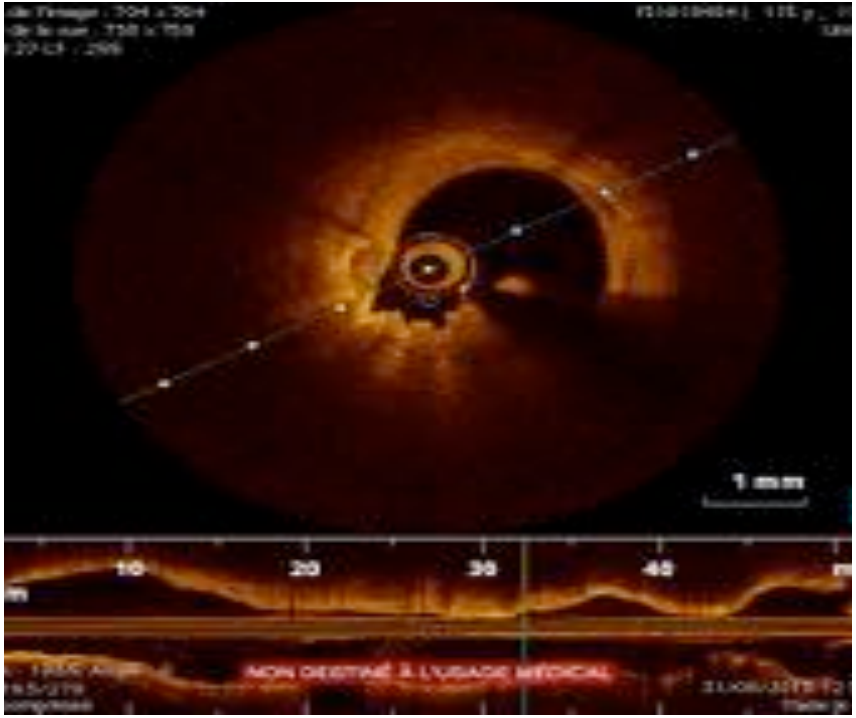
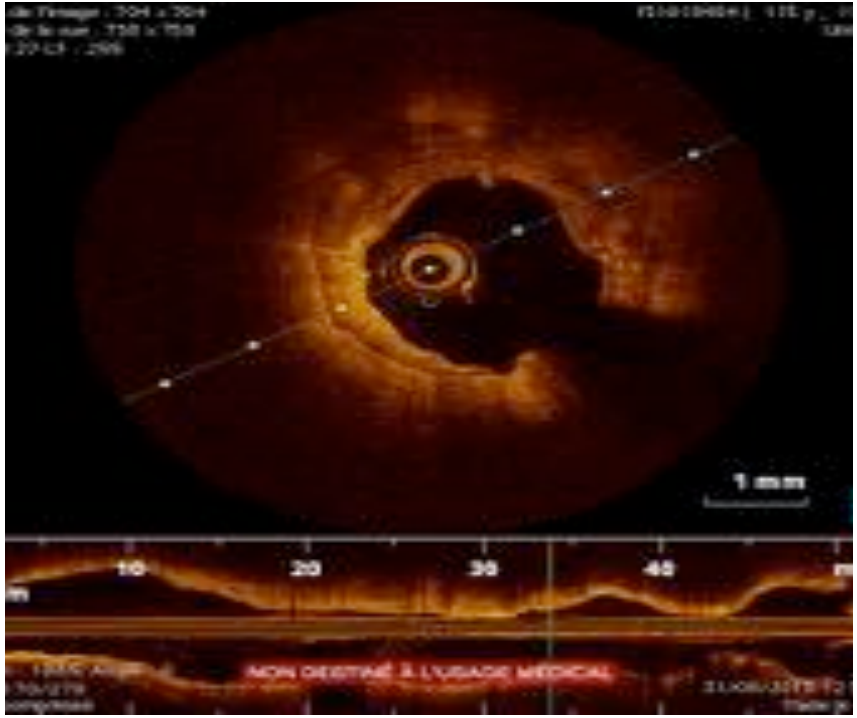
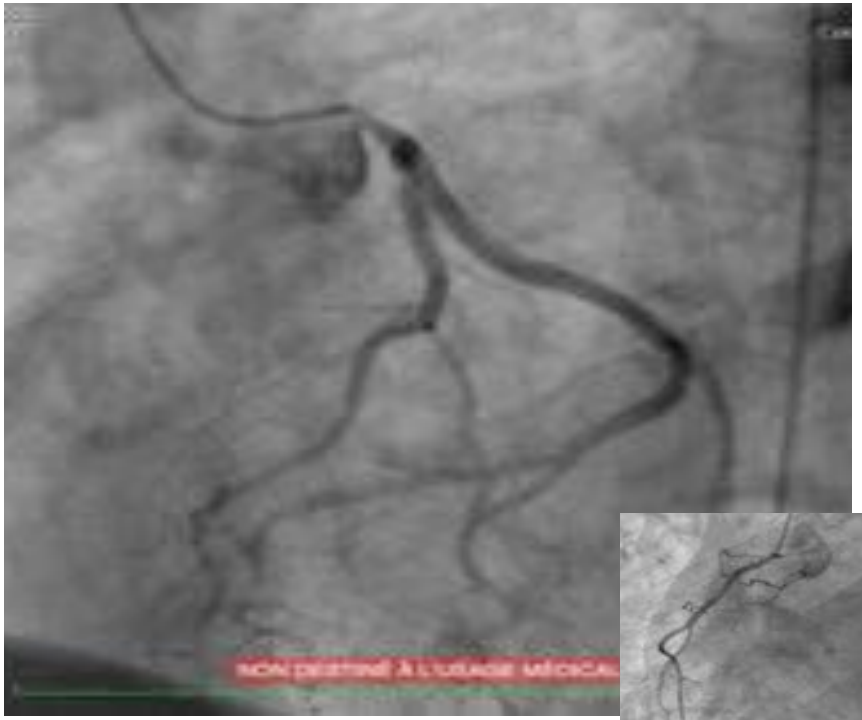
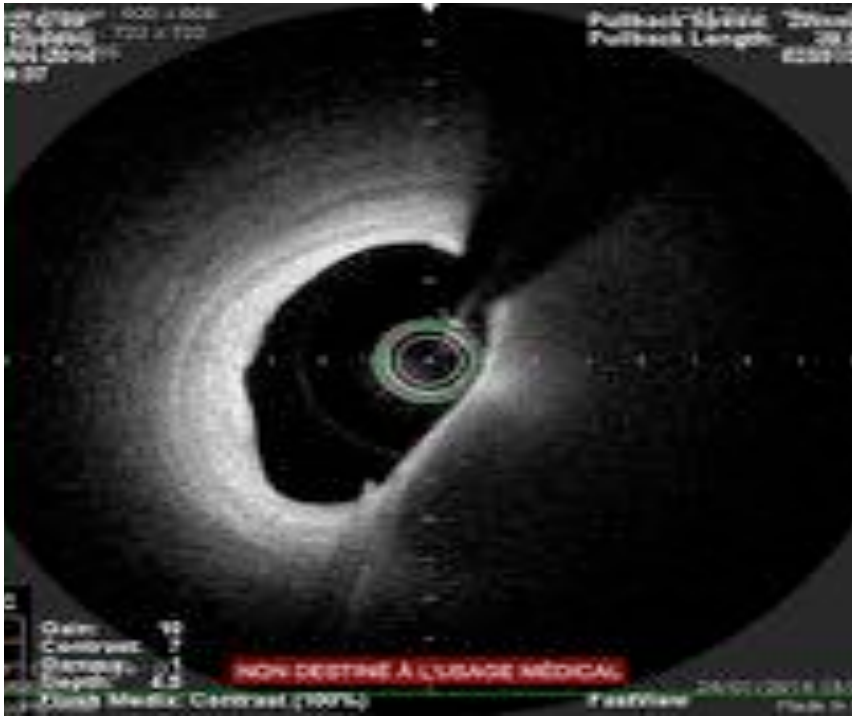


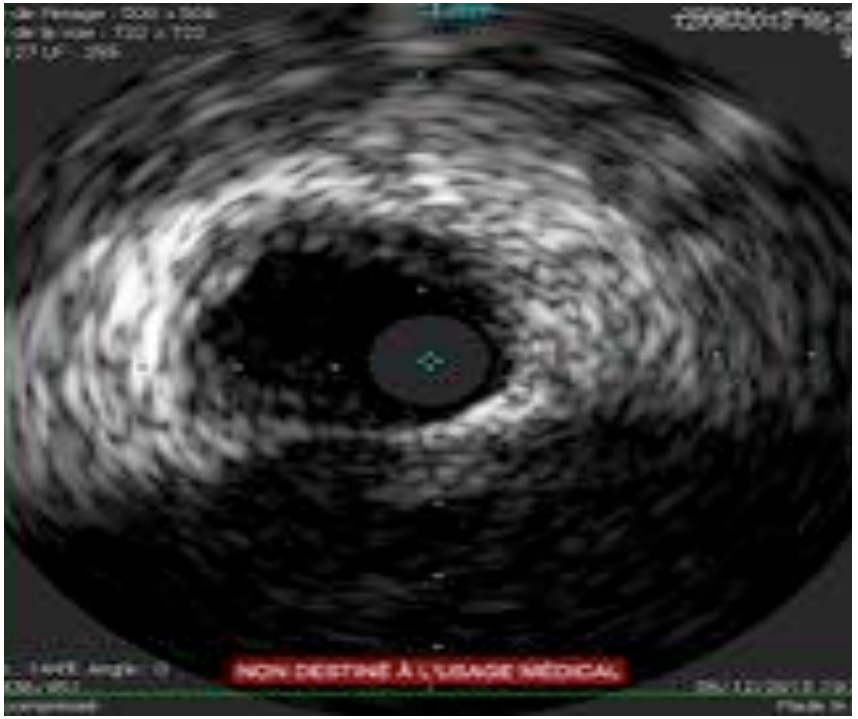


40 y Woman. Chest pain at stress



LM ostium 5 mm^2





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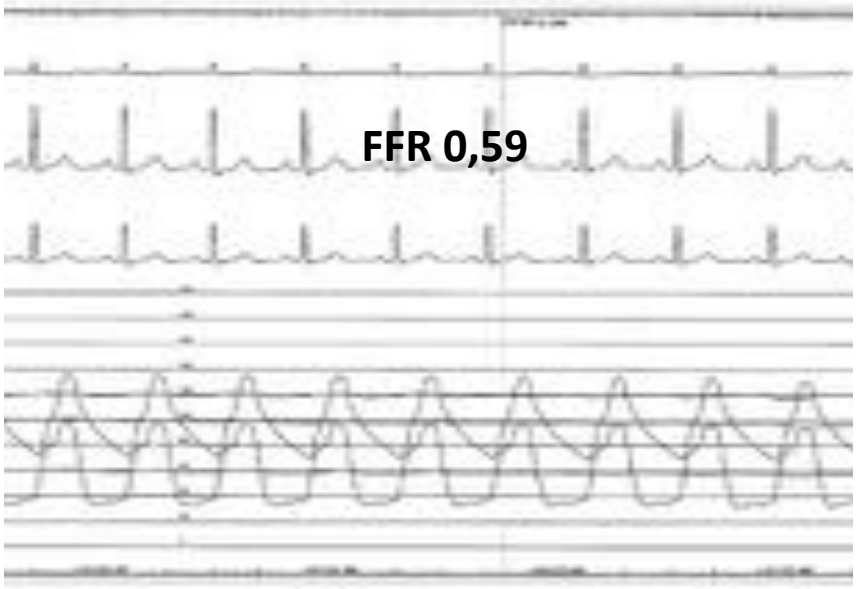
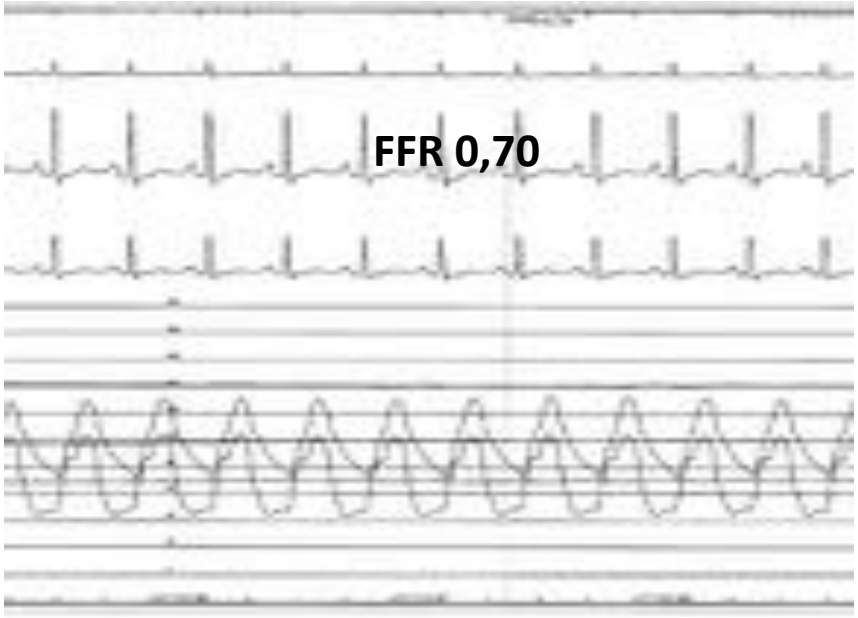
FFR LAD



FFR LCX



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AVANT FFR

	Odds Ratio*	Lower CI	Upper CI	*P* Value
Lesion severity (1% decrease of % stenosis) by angiography*	1.03	1.02	1.04	<0.0001
Number of diseased vessels by angiography				<0.0001
1	2.41	1.52	3.84	
2	2.64	1.64	4.24	
3	3.75	2.31	6.08	
Lesion complexity ACC/AHA: B2/C vs A/B1 by angiography†	1.52	1.20	1.93	0.0005
Diabetes mellitus	1.42	1.13	1.78	0.003
Age (1-y increase)	0.98	0.97	0.99	0.005

APRES FFR

	Estimates	Lower CI	Upper CI	*P* Value
LAD location*	−0.05	−0.06	−0.03	<0.0001
Lesion length (1-mm increase)*	−0.01	−0.01	−0.01	<0.0001
Lesion severity (1% decrease of % stenosis)*	−0.01	−0.01	−0.01	<0.0001
Number of diseased vessels (reference group=0)				<0.0001
1	−0.02	−0.03	−0.01	
2	−0.04	−0.06	−0.03	
3	−0.03	−0.05	−0.02	
Age (1-y increase)	0.01	0.01	0.01	<0.0001
Lesion complexity ACC/AHA: B2/C vs A/B1 by angiography*	−0.01	−0.02	−0.01	0.001

VanBelle, Dupouy et col Circulation. 2014;129:173-185

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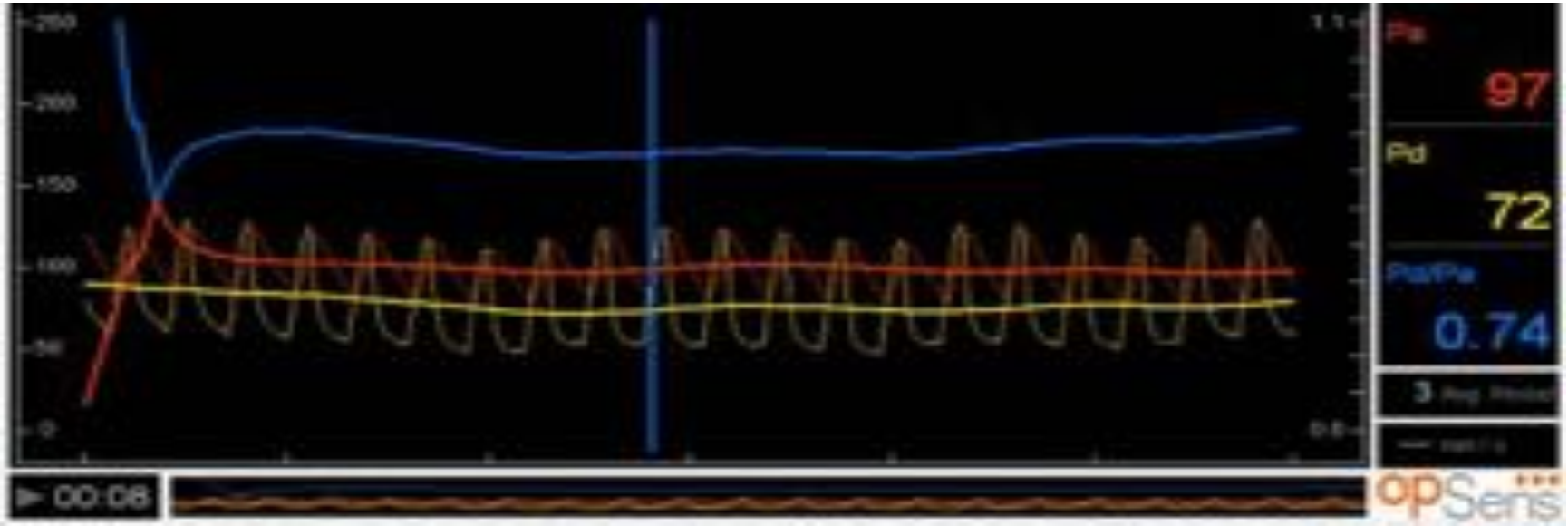
Gradient adenosine



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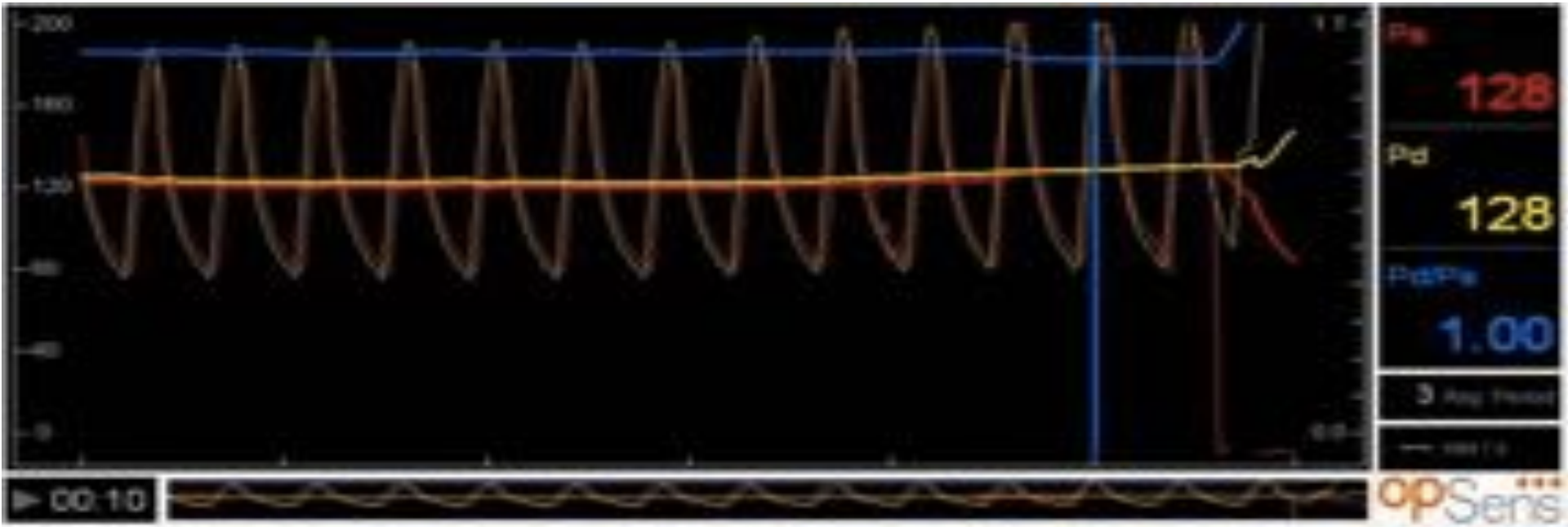

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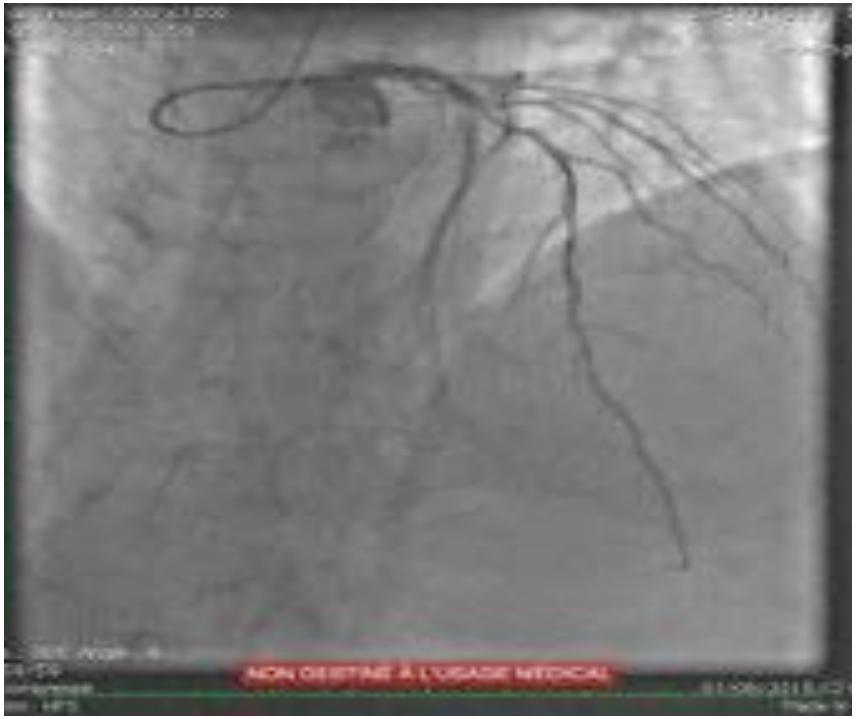
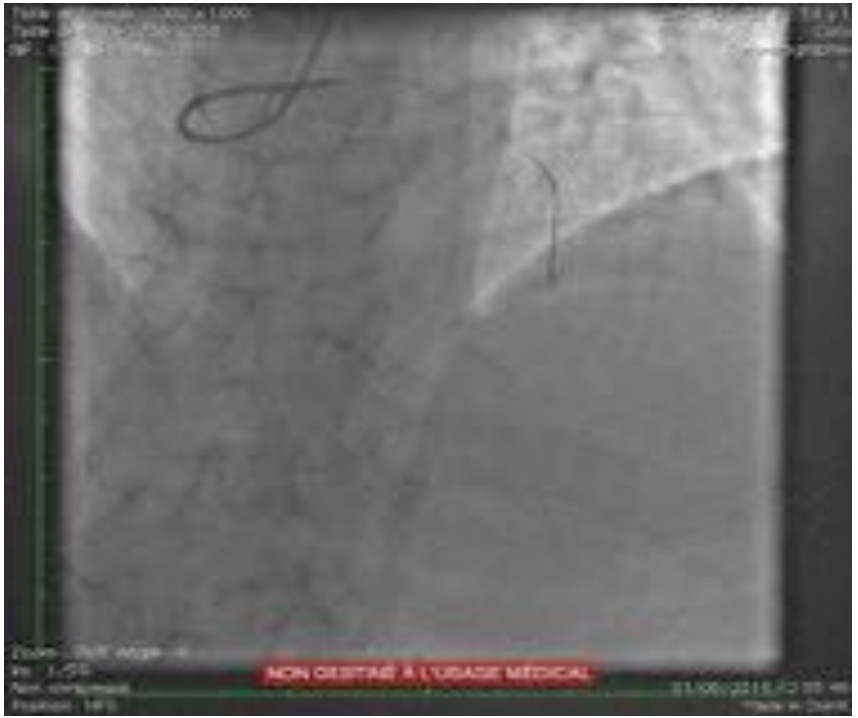
Lésions multiples





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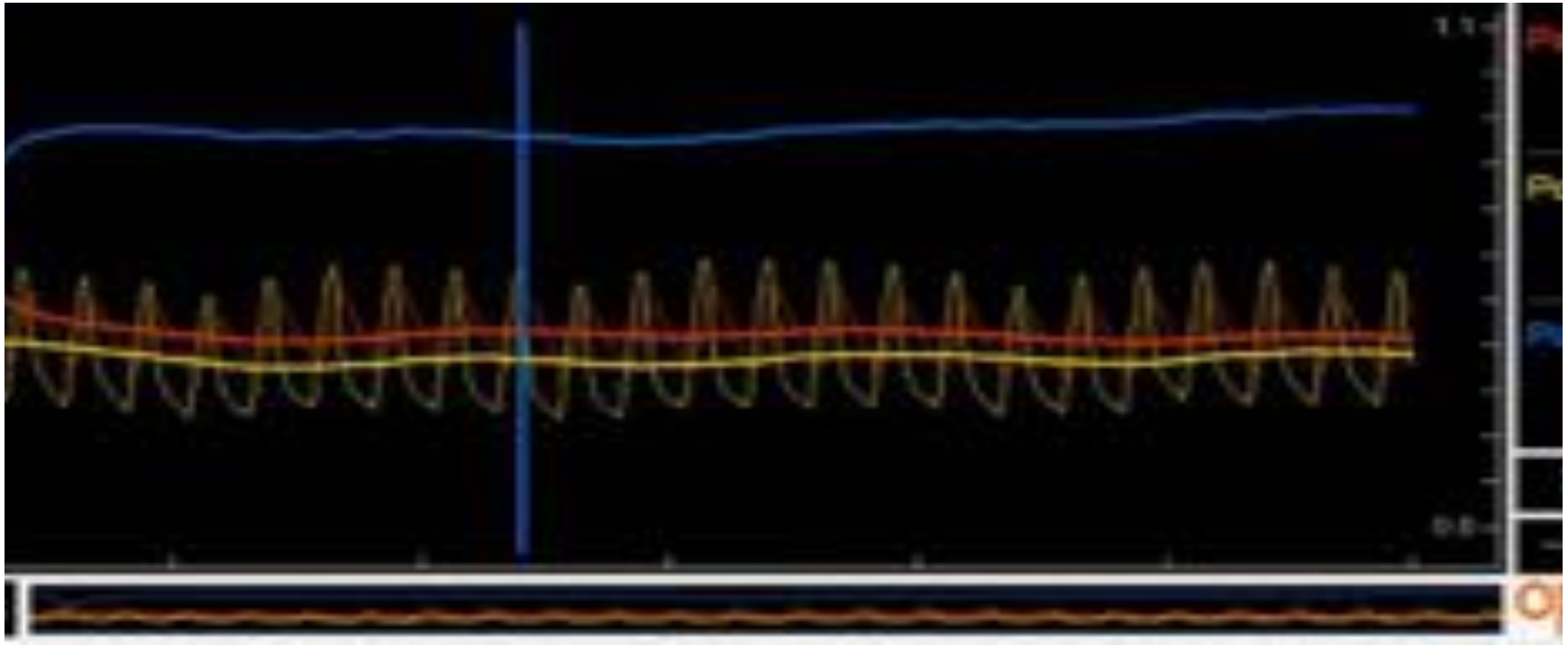
Adénosine



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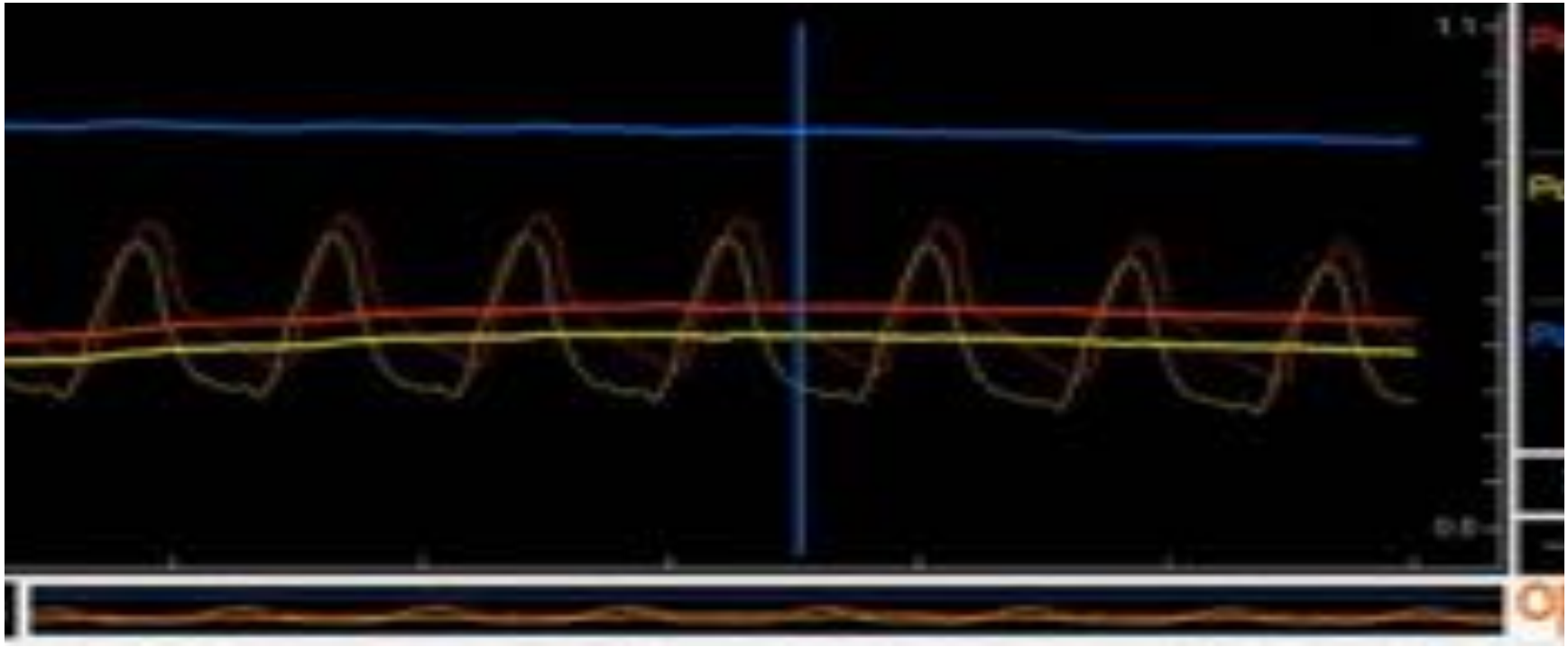

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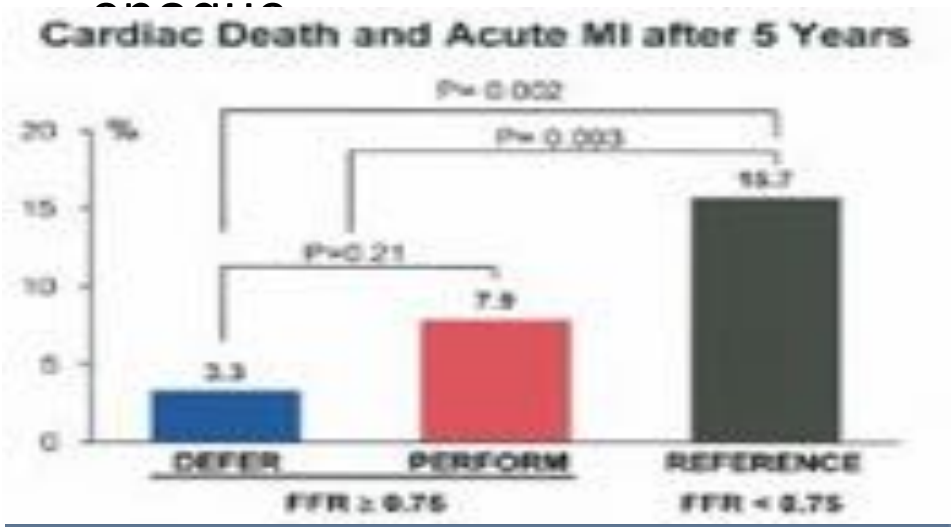
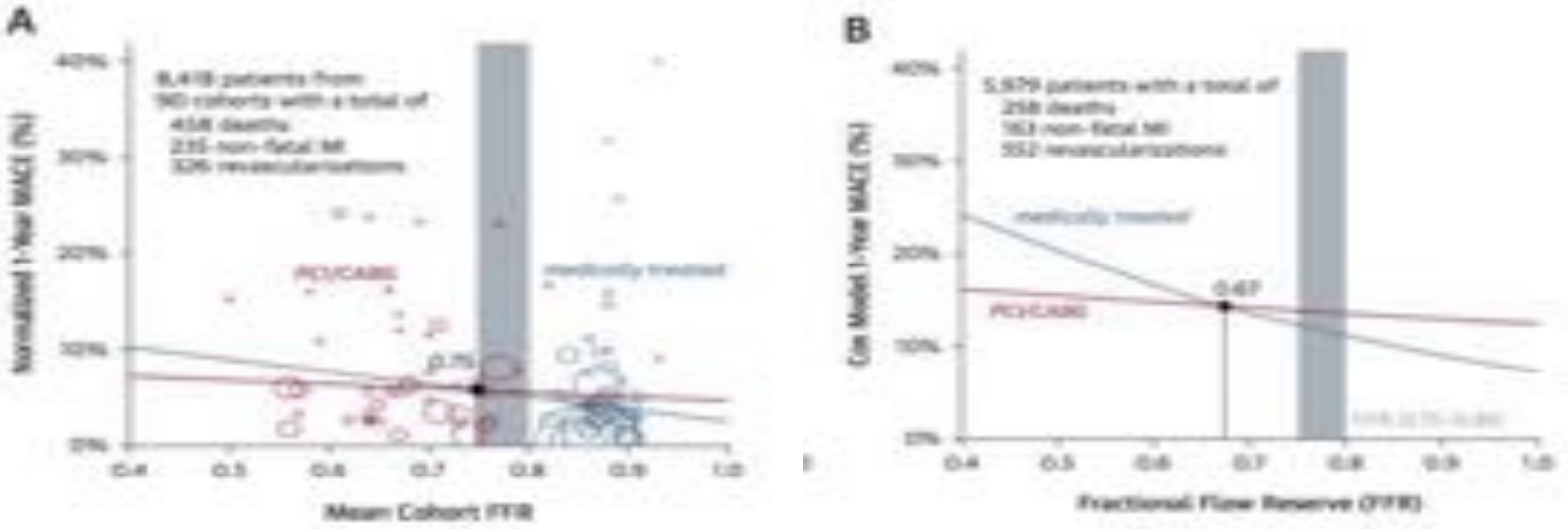
- Traitement médical ?
- Revascularisation .. Quand même ?
- Defer like mais une autre époque



J Am Coll Cardiol 2007;49:2105–11

FFR marqueur d'événements CV



Johnson et col, JACC VOL. 64, NO. 16, 2014

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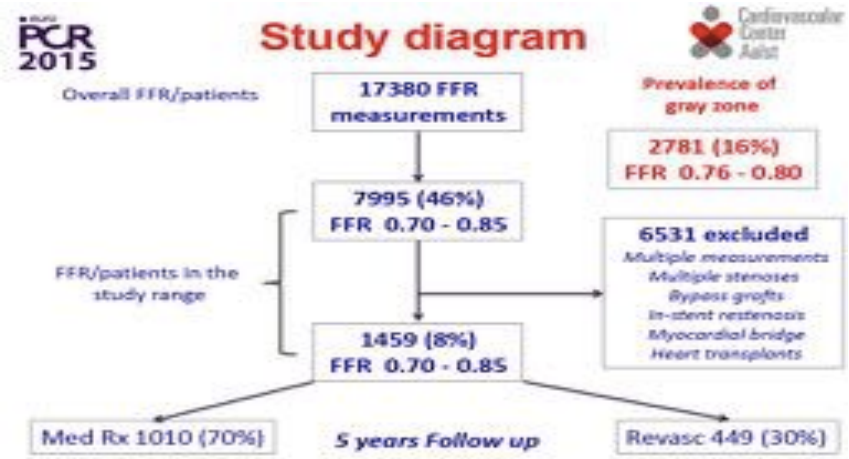

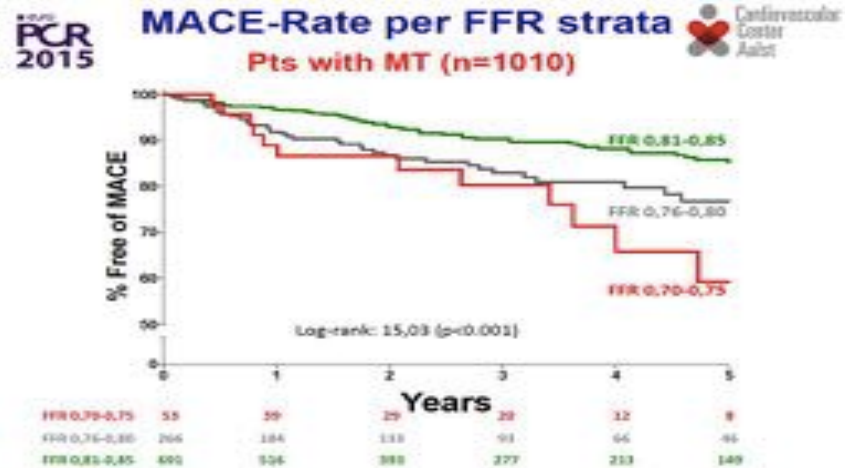

Julien Adjedj, Euro PCR 2015

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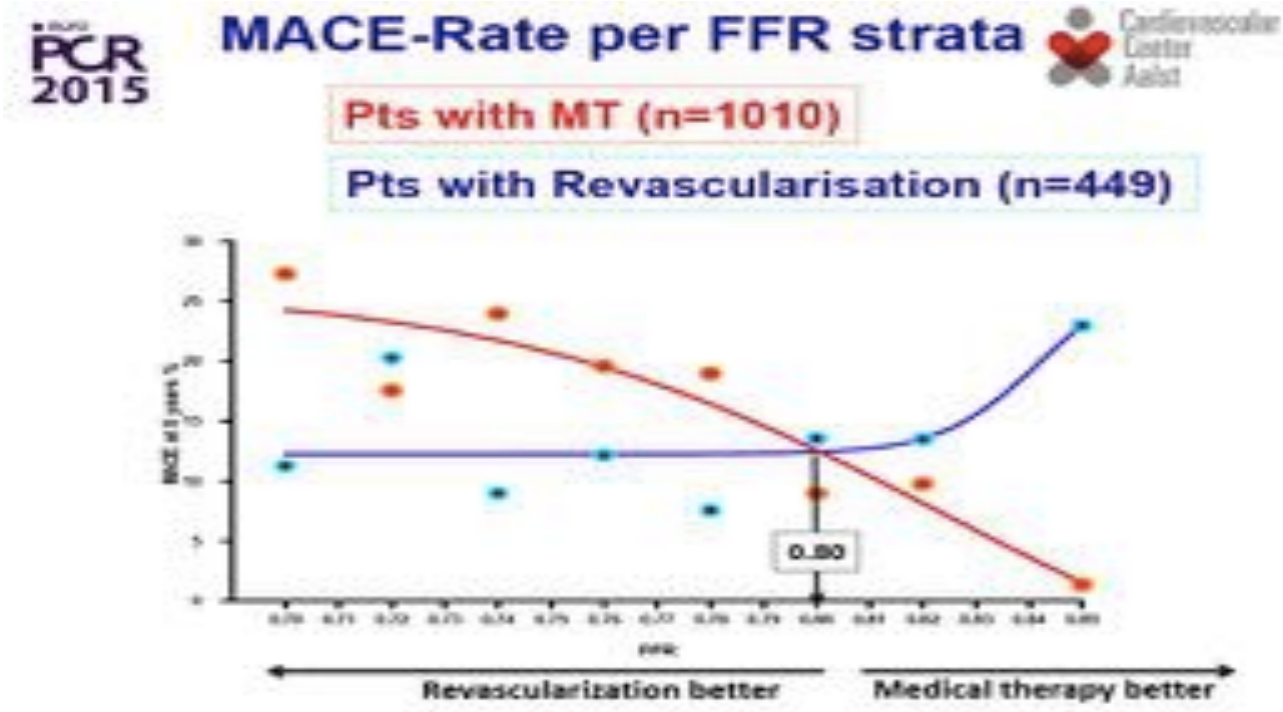
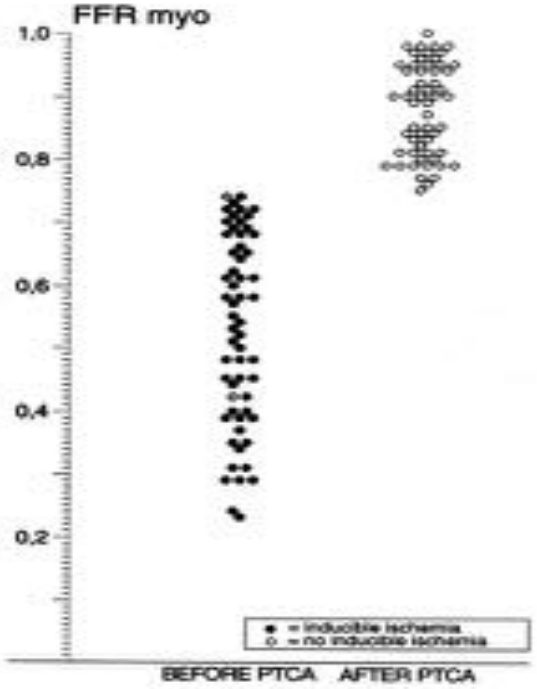


Julien Adjedj, Euro PCR 2015

L'évolution du concept de FFR



Pijls N et al. Circulation

- Concept physiologique
- Concept Fonctionnel
- Concept Pronostic clinique
- Marqueur d'événements