2015 JCR Joint meeting of Coronary Revascularization

OCT Findings in Vasospastic Angina

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Case

53 / M

Clinical Presentations

Sudden collapse, AM 07:30

AED: shockable rhythm,

Defibrillation & Chest compression for 12 mins

→ ROSC

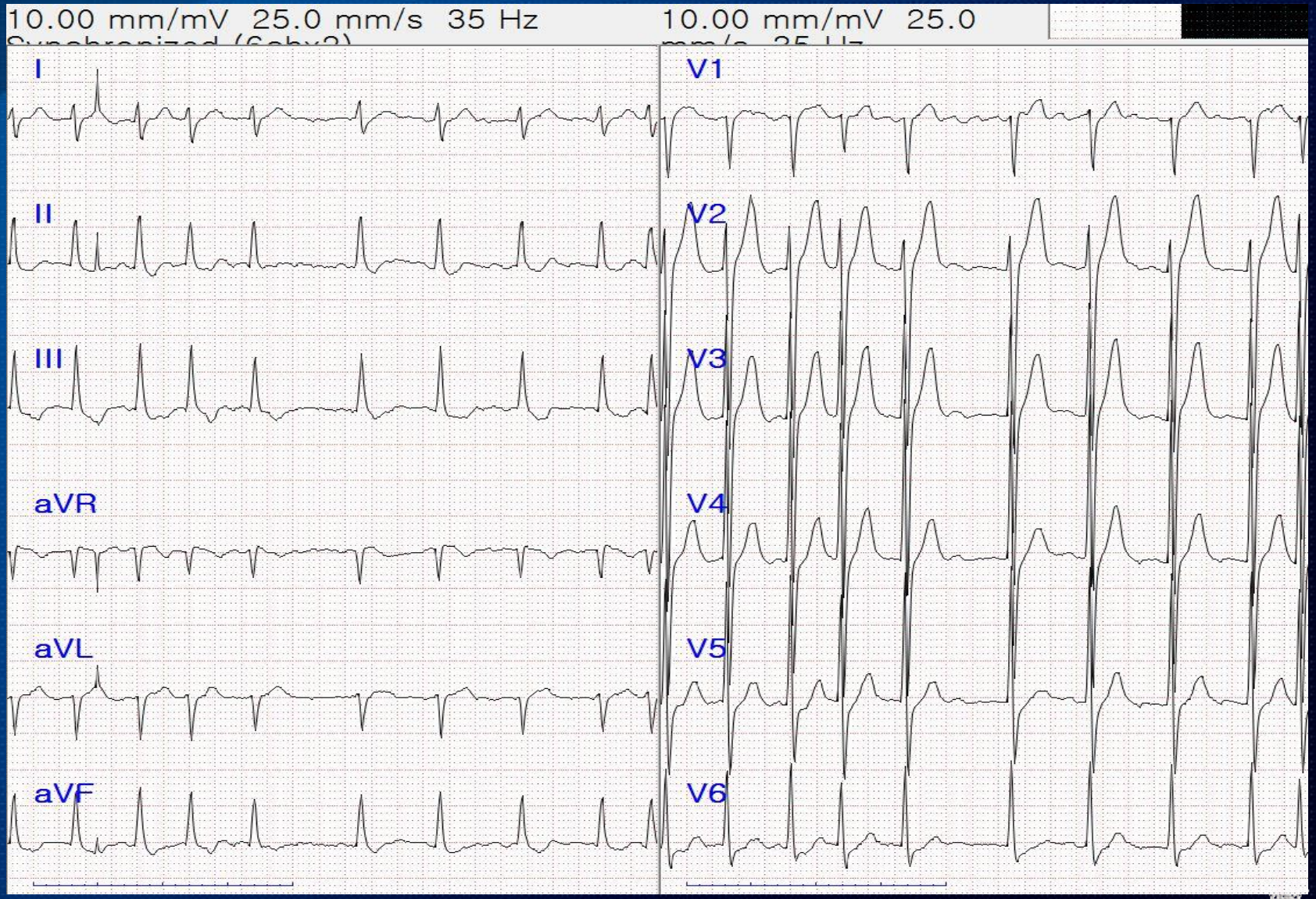
Patient Demographics

Risk factors: Hypertension (-), Diabetes (+)

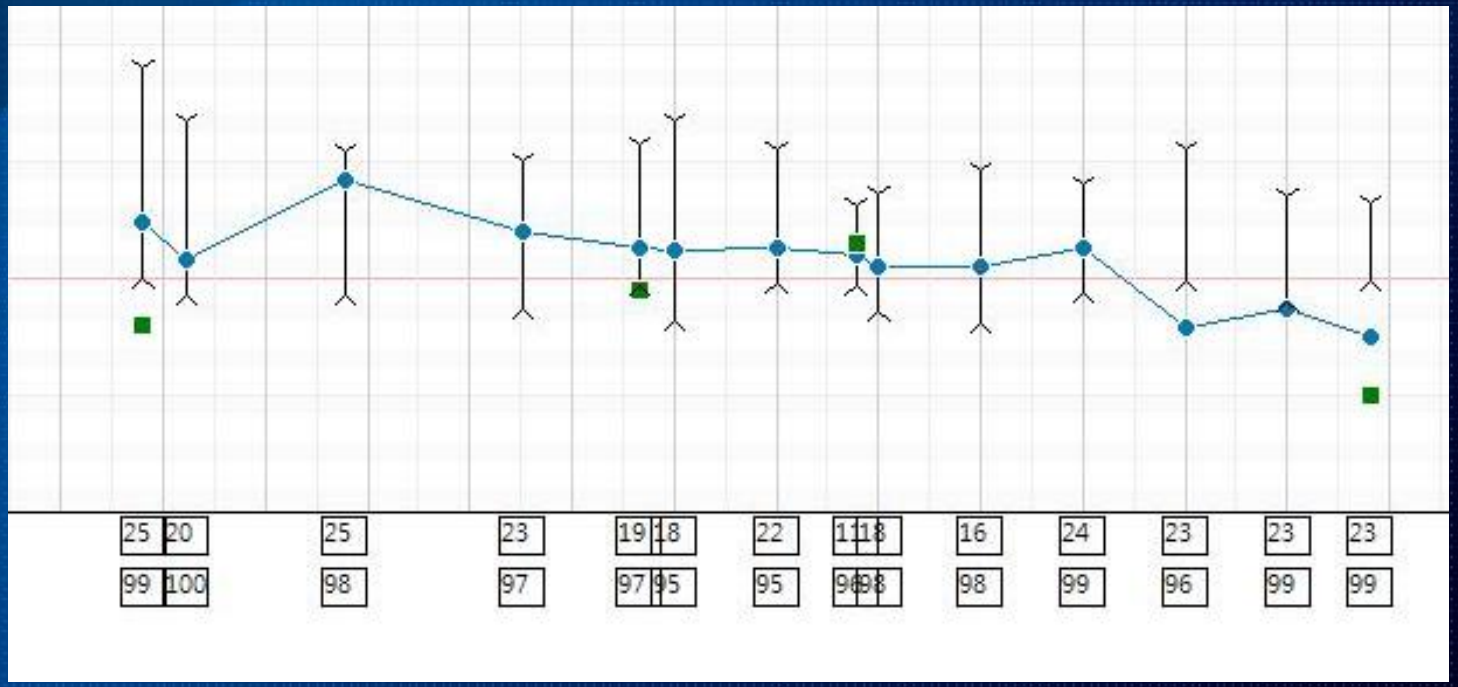
Dyslipidemia(-), Current-Smoker(+)

Family History (-), Alcohol intake: 2~3 times/week

ECG at admission

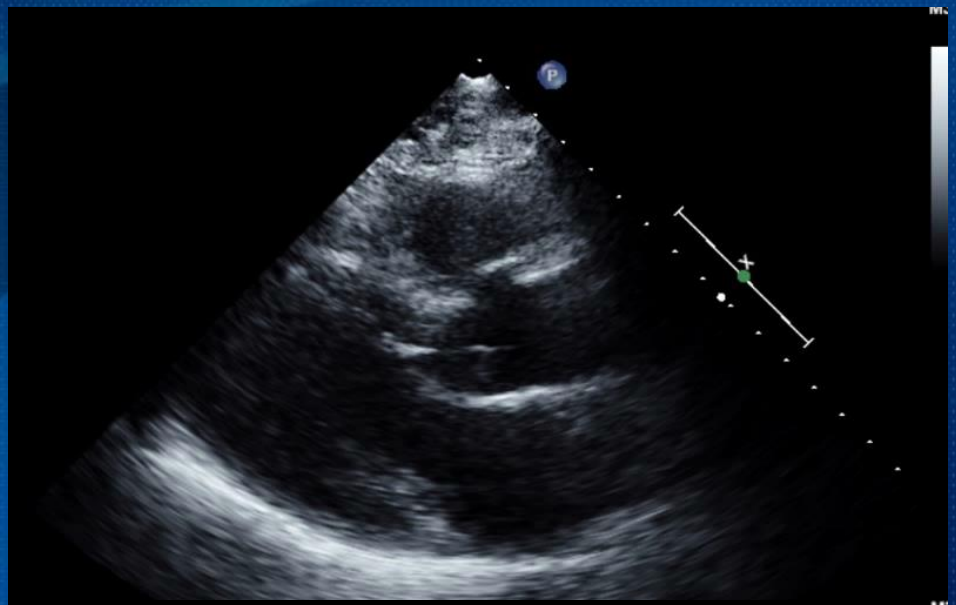


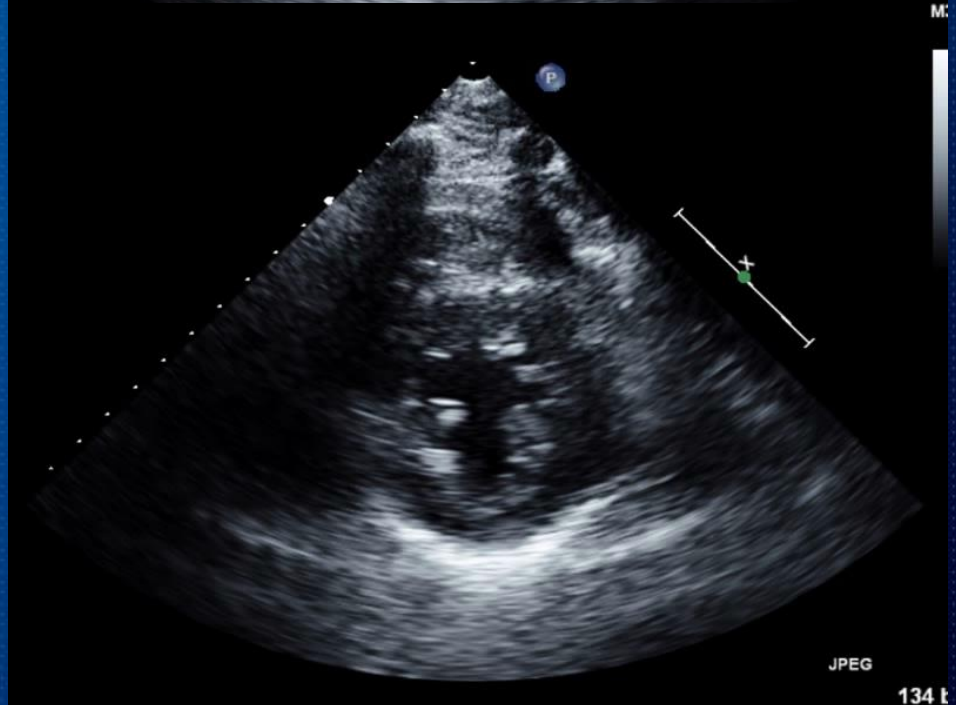
Vital Signs

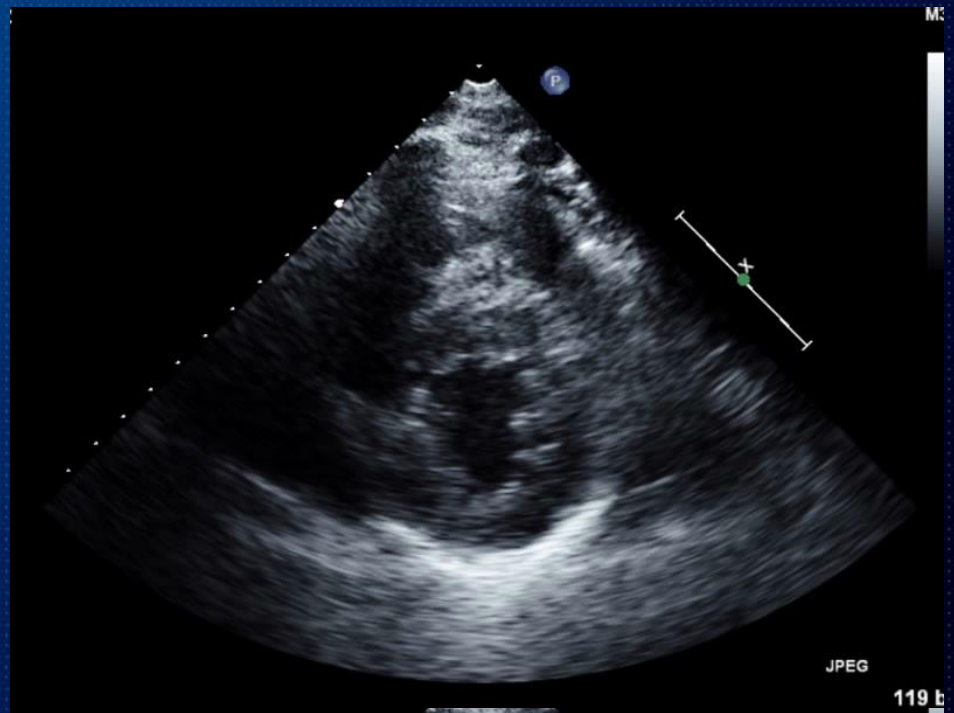


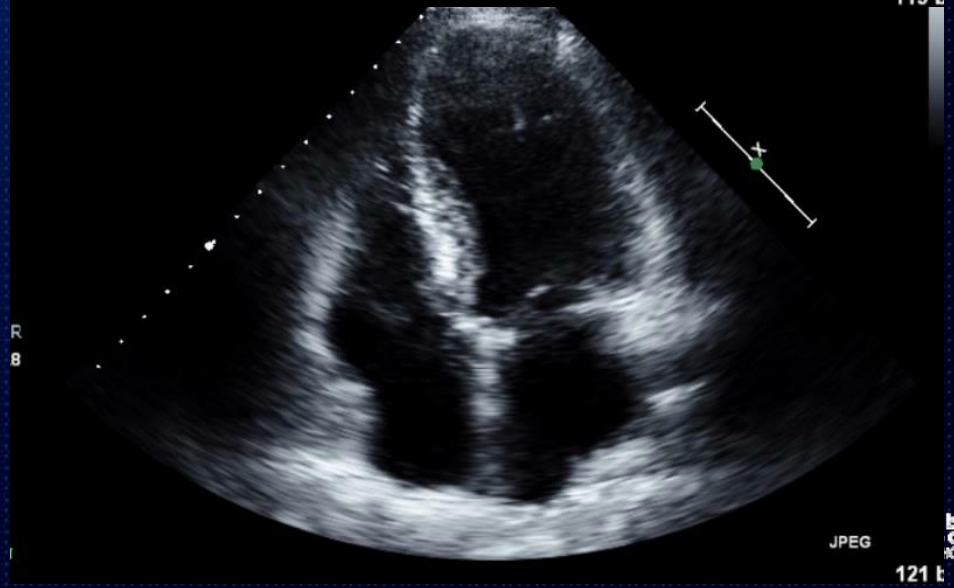
	Conf...	Alert	Alert		Alert	Alert	Alert	Alert	Alert	Alert	Alert	Alert	Alert	
	3/3													
	+/+													
	190	167	154		150	157	167	155	136	146	140	155	135	
	100	93	93		87	97	82	98	86	81	94	99	90	
	124	108	142		120	113	112	113	105	105	113	79	87	
	25	20	25		23	19	18	22	18	16	24	23	23	
	99	100	98		97	97	95	95	98	98	99	96	99	

Echocardiogram

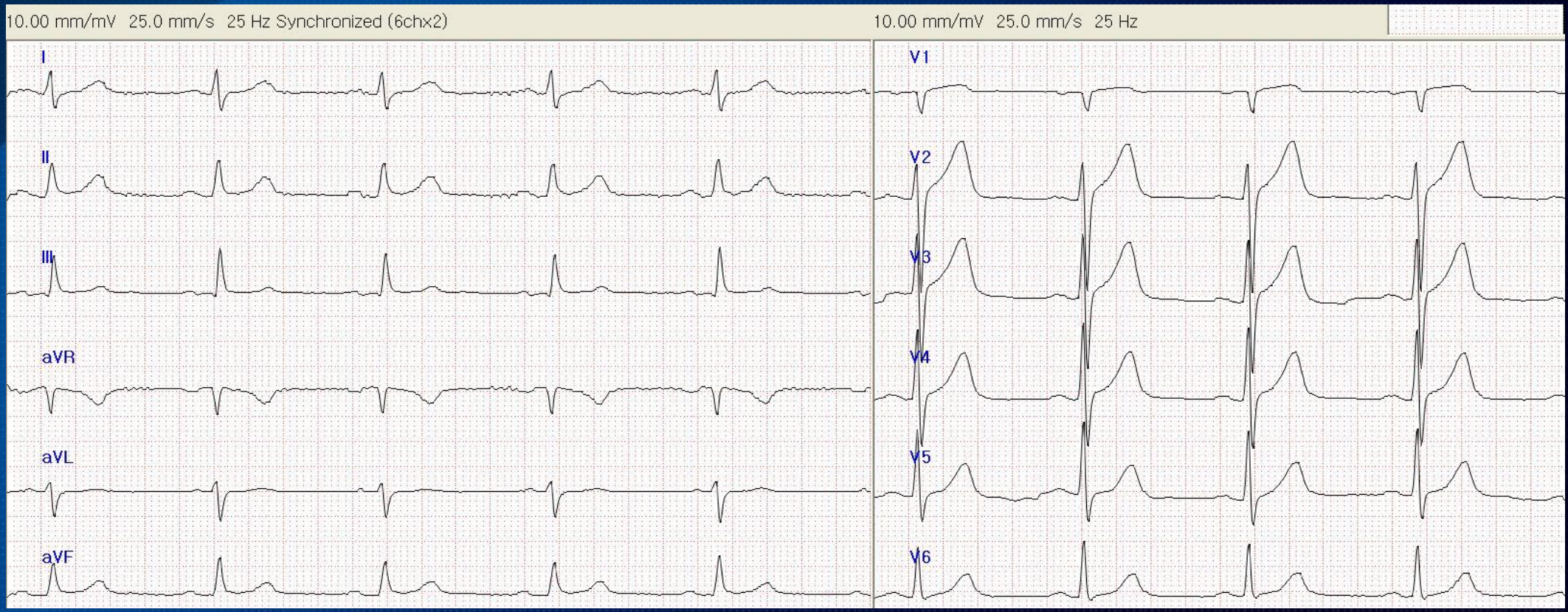








ECG HD#2

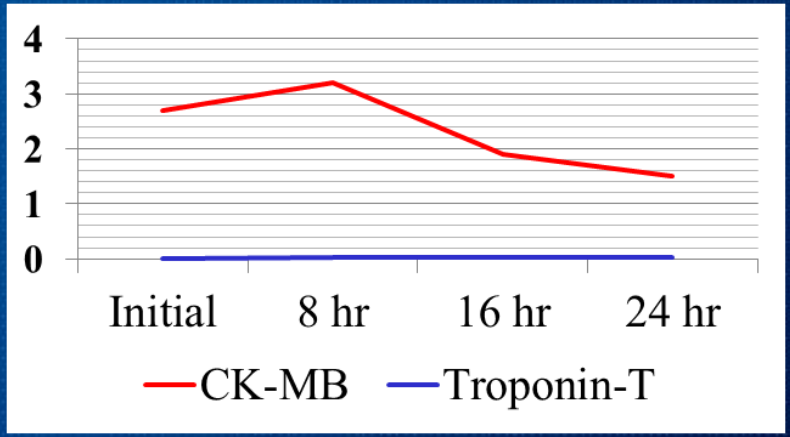


Progress Notes

HD #2

S: “Symptom-free”

O :



A: Aborted Sudden Cardiac Arrest

Paroxysmal Atrial fibrillation

Diabetes

P: Coronary angiography

with Ergonovine provocation test

Diagnosis of vasospastic angina

3 components of Criteria

1. Angiography

: spontaneously or ergonovine provoked

transient total or subtotal (≥90%) occlusion of coronary artery

2. Symptom

: chest pain

3. ECG

: transient ST segment changes

(elevation or depression ≥0.1 mV, at least 2 contiguous leads)

JCS Joint Working Group. Circ J 2010;74:1745-62

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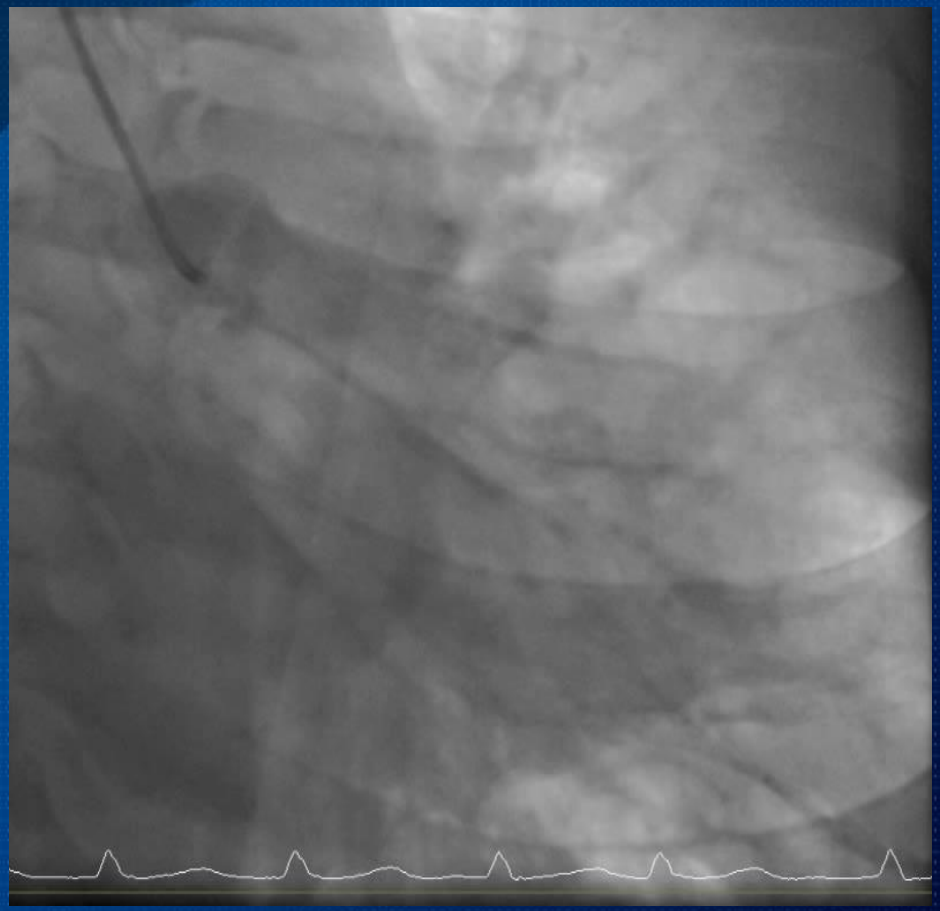
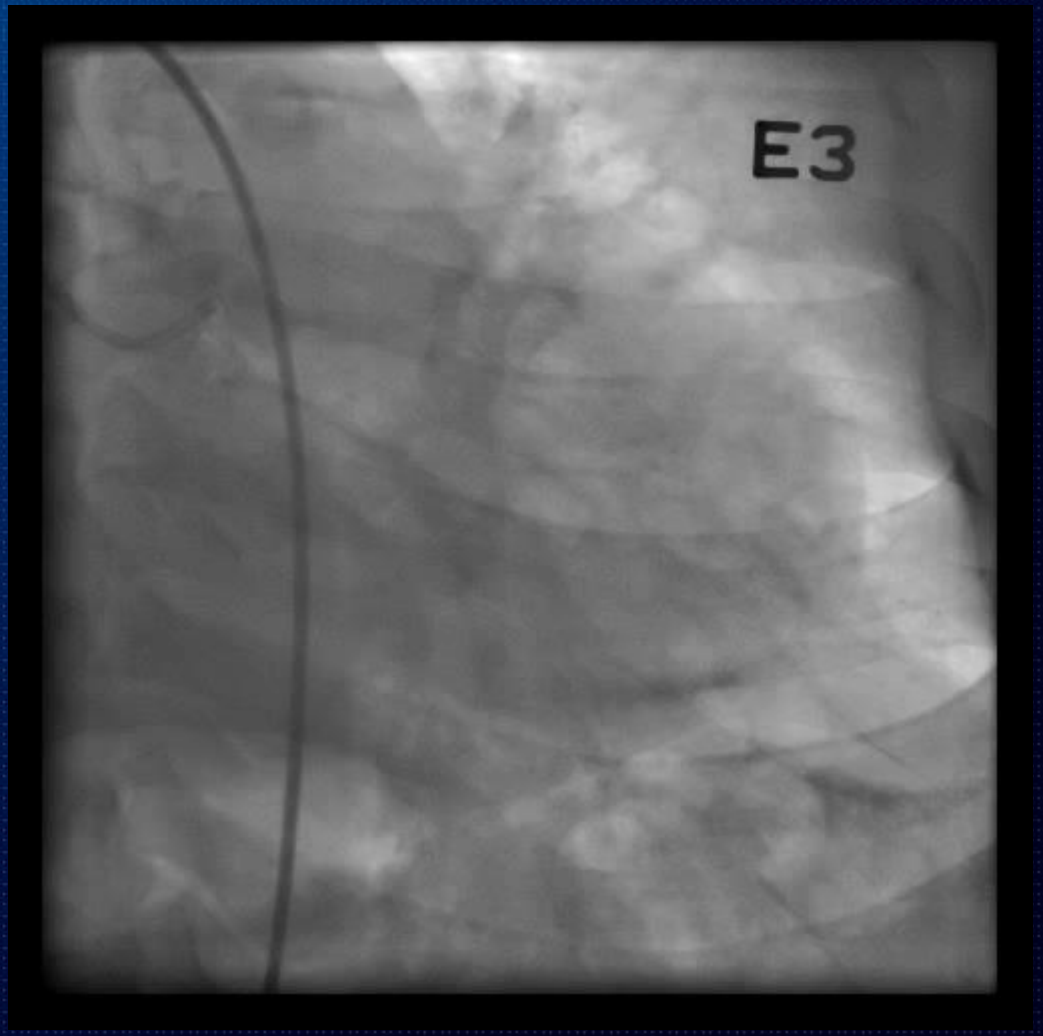
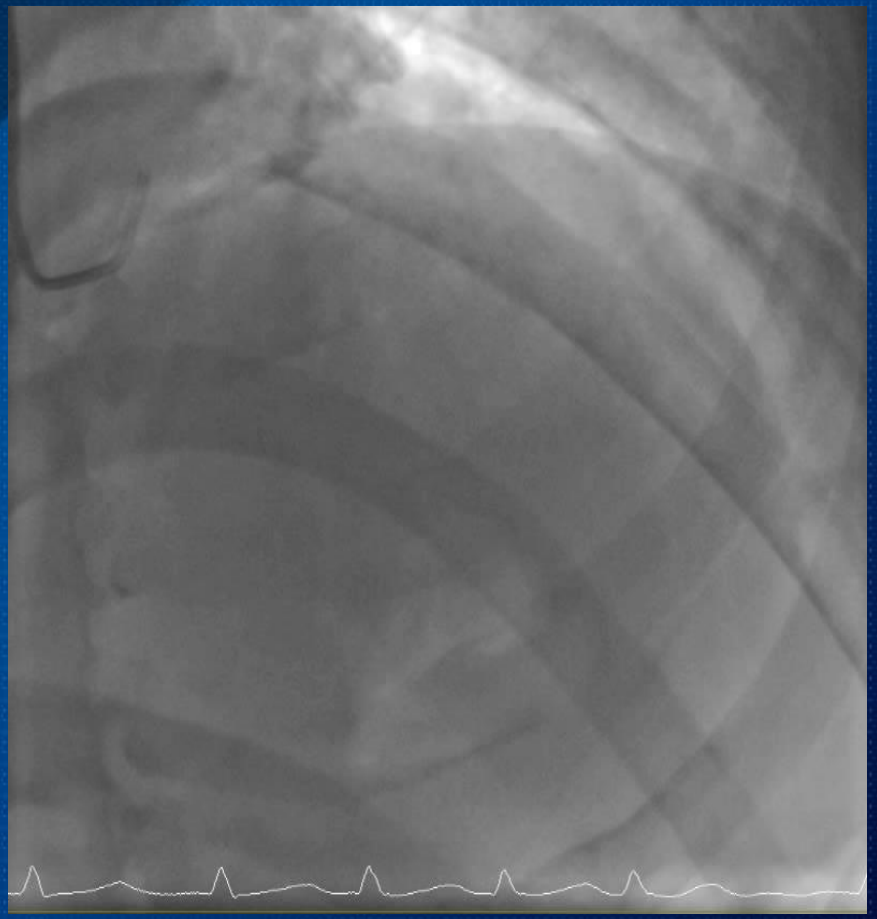
Coronary Angiography with Ergonovine provocation test

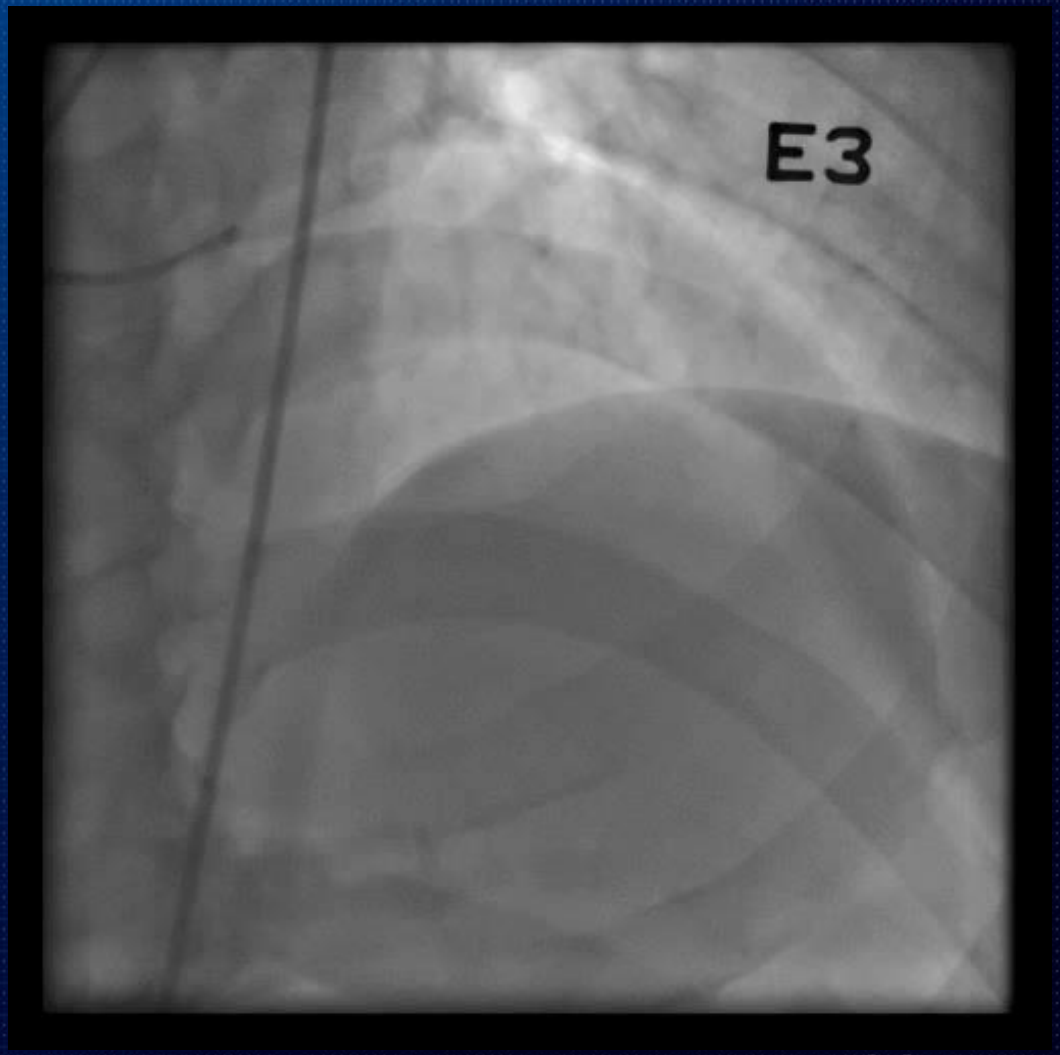




ic injcection: 60μg of Ergonovine

Coronary Angiography with Ergonovine provocation test





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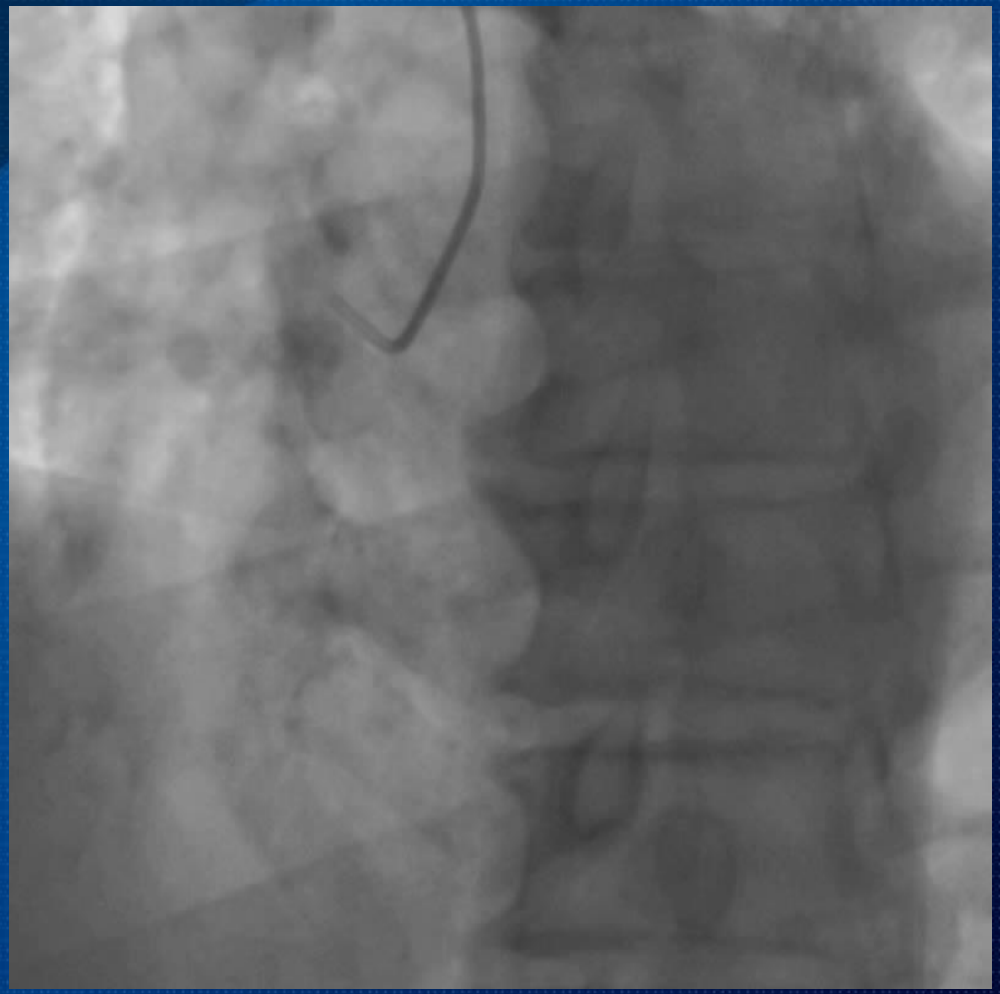
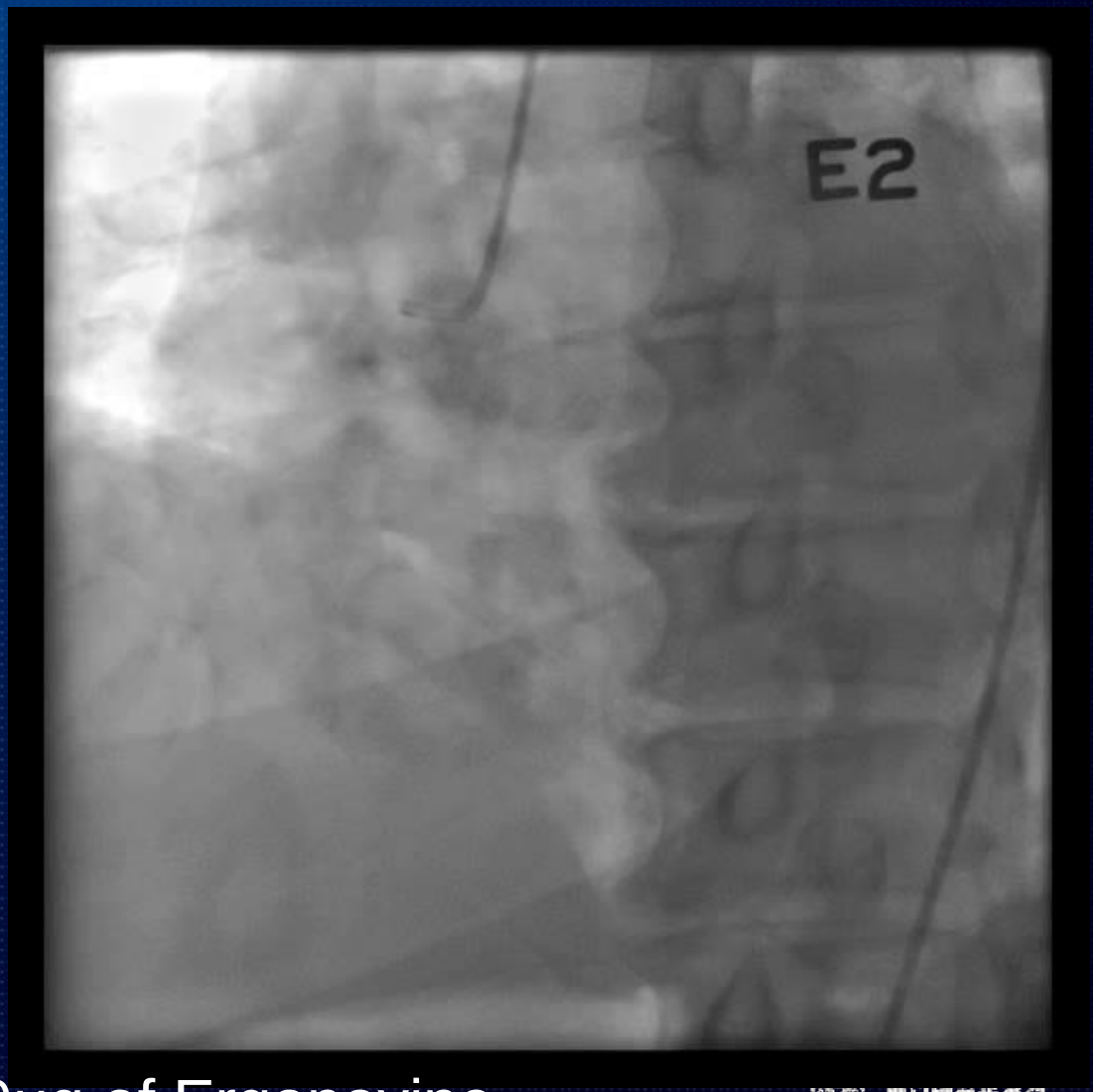
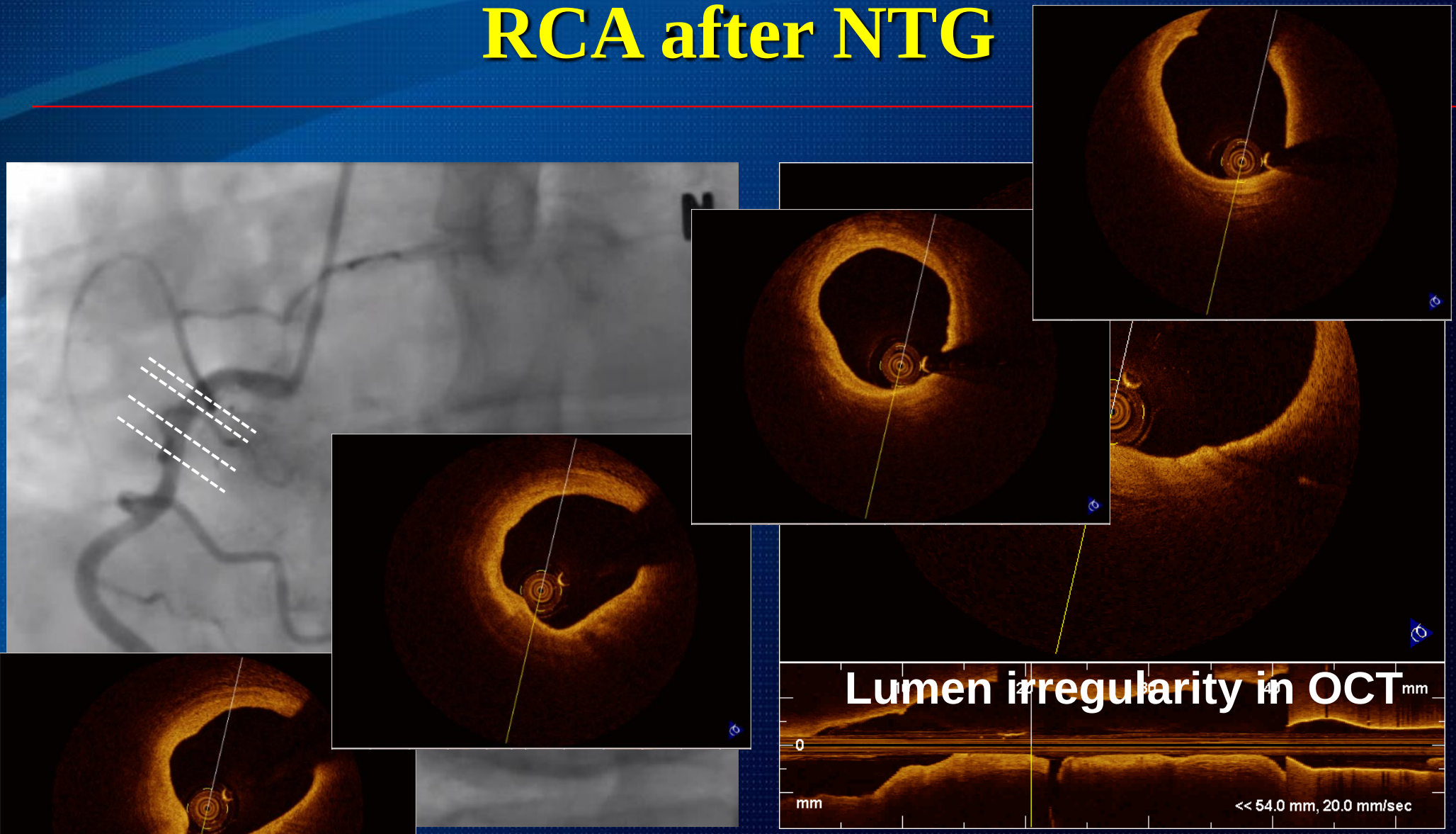
Coronary Angiography with Ergonovine provocation test



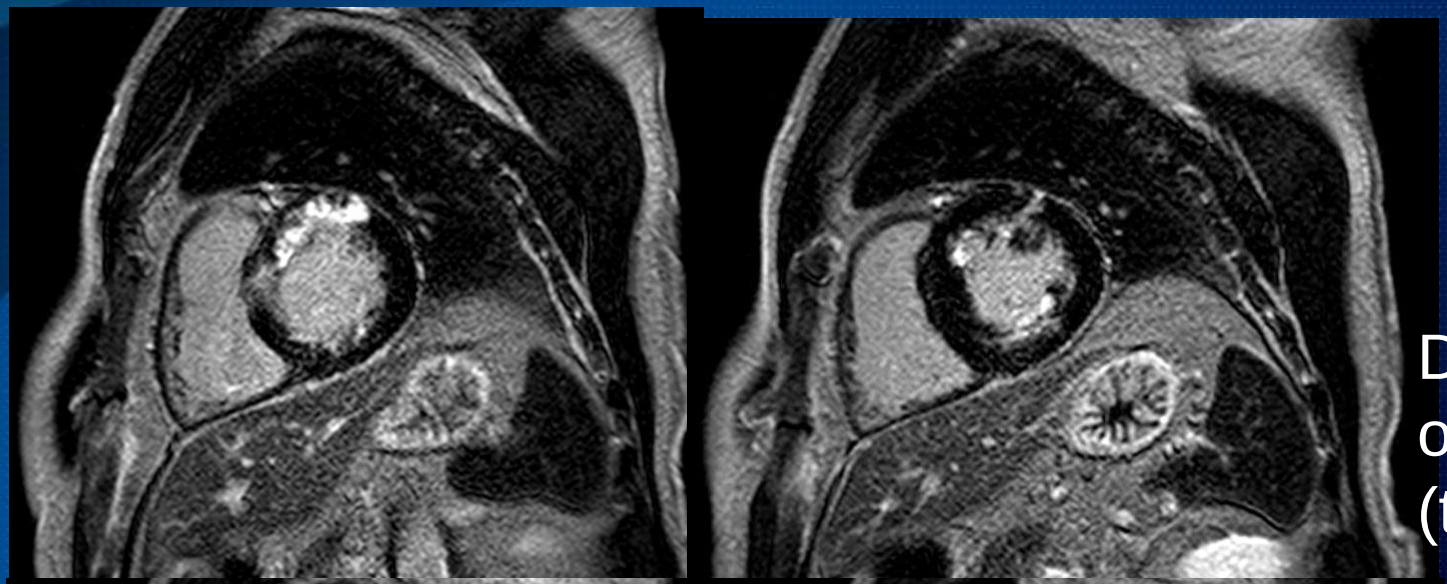


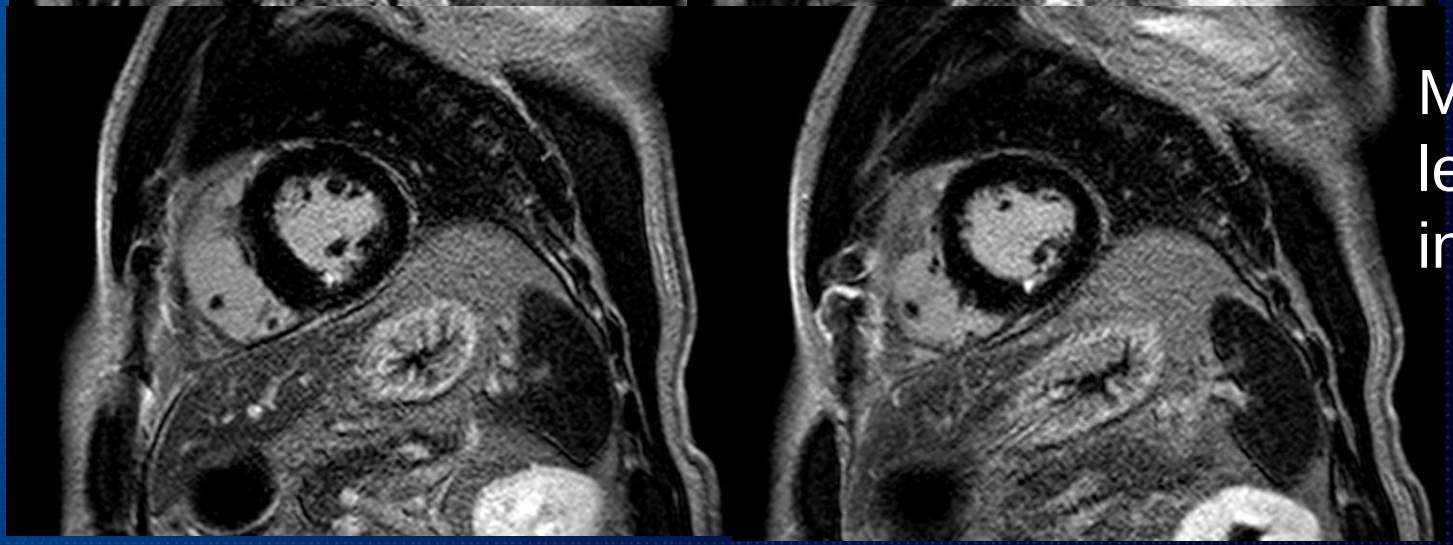
ic injcection: 40μg of Ergonovine

RCA after NTG



Cardiac MR





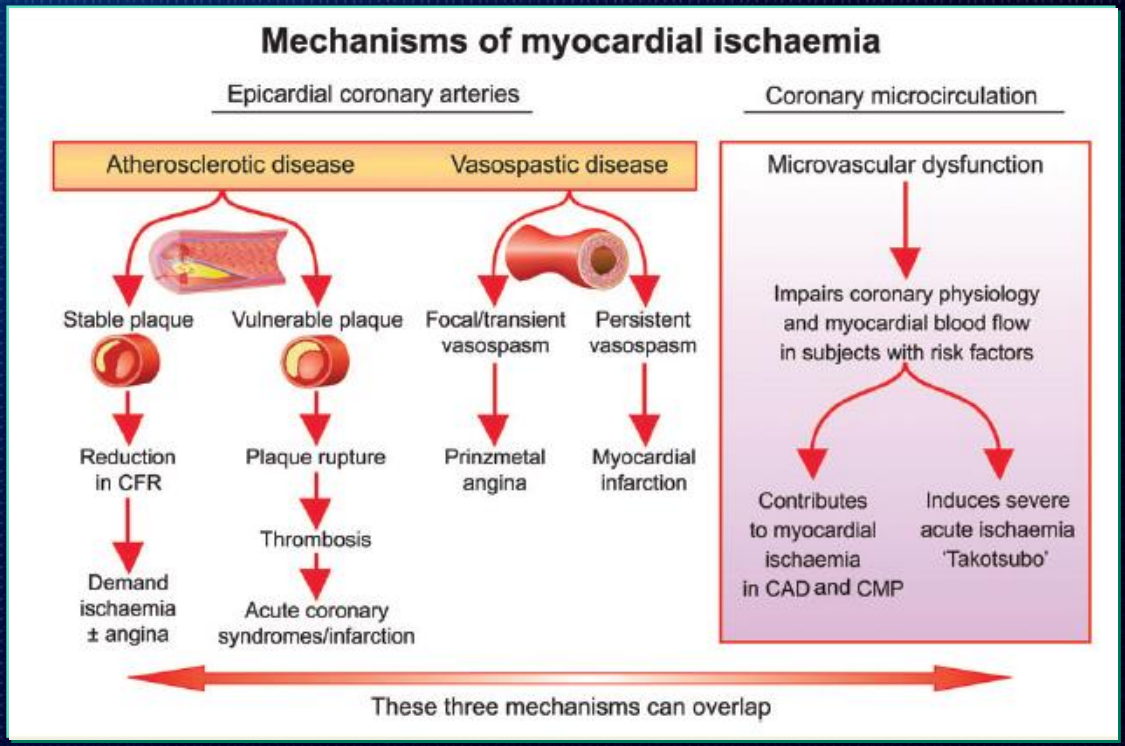
Delayed enhancement
of basal anterior wall
(transmural: 75 - 90%)

Multifocal small enhancing
lesion
in basal to mid inferior wal

Case Summary

- Resuscitated from Out-of-hospital Cardiac arrest
- Myocardial infarction
  d/t Vasospastic angina, documented

Coronary artery spasm plays an important role in the pathogenesis of not only angina but also acute myocardial infarction and even cardiac death.



Filippo Crea, et al. European Heart Journal (2014) 35, 1101–1111

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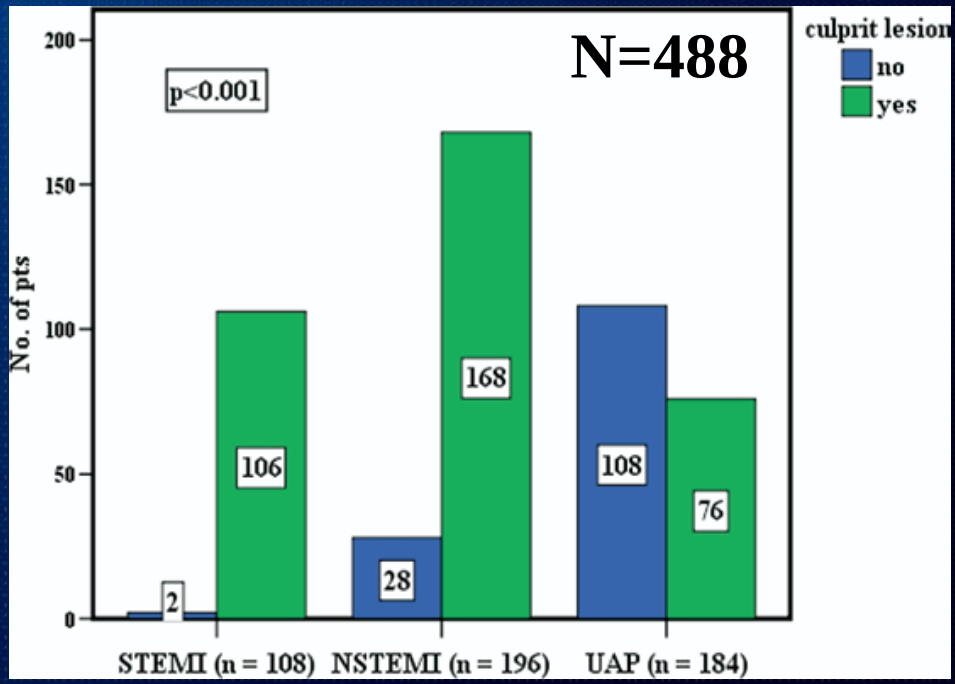
Coronary Artery Spasm as a Frequent Cause of ACS

CASPAR study

ACS is suspected by :

- Elevation of cardiac markers
- Ischemic ECG
- Resting angina



- In pts with suspected ACS
  ~ 30%: non-obstructed

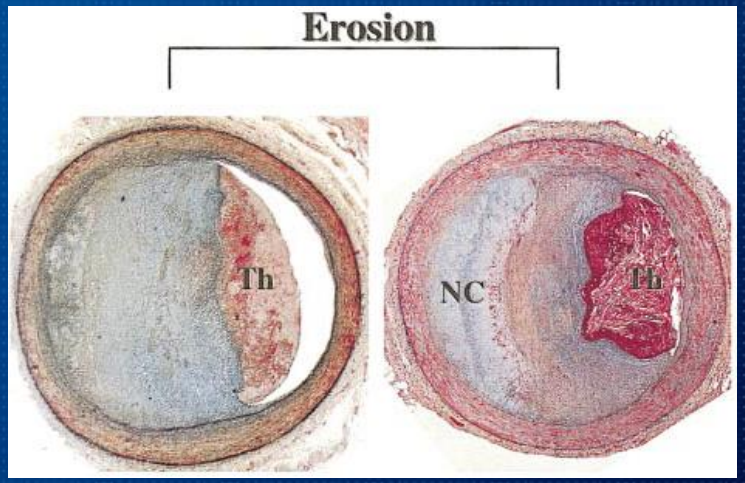
→ intracoronary provocation with acetylcholine (86/138)

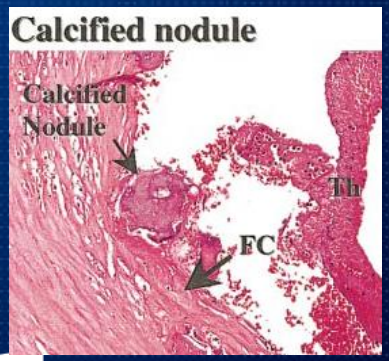
: 42 patients, coronary spasm 진단(42/86, 49%)

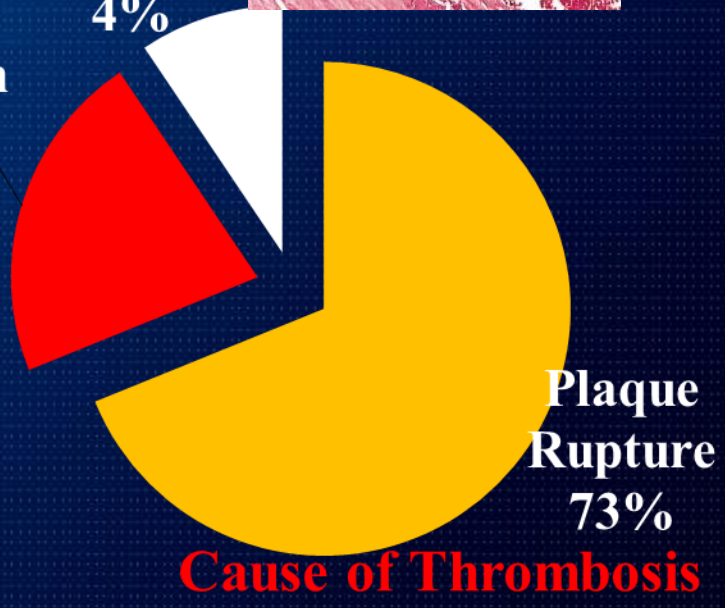
Peter Ong, et al. J Am Coll Cardiol 2008;52:523–7

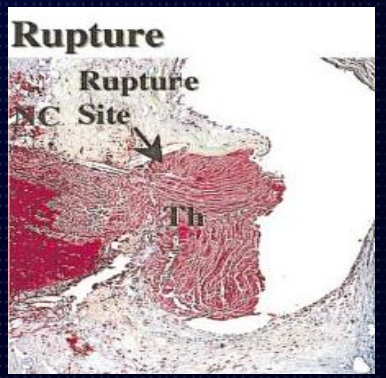
Pathology in Sudden Coronary Death

- Autopsy: Event results from sudden luminal narrowing caused by thrombosis based on plaque rupture, erosion, and calcified nodule.









R. Virmani, et al. European Heart Jorunal, 2013:34;719-728

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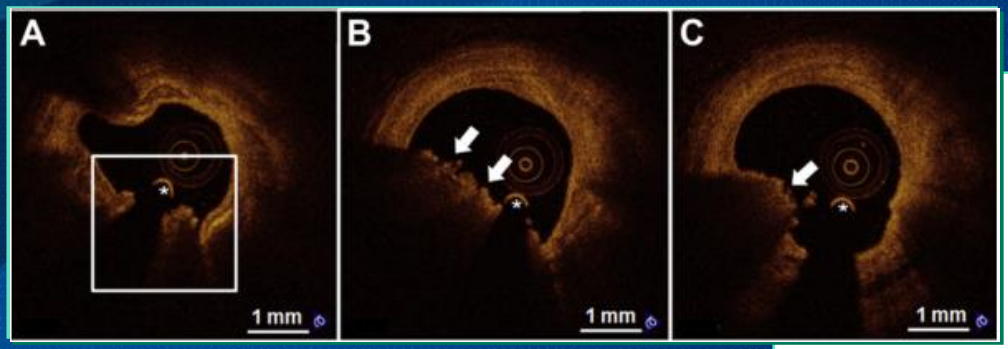
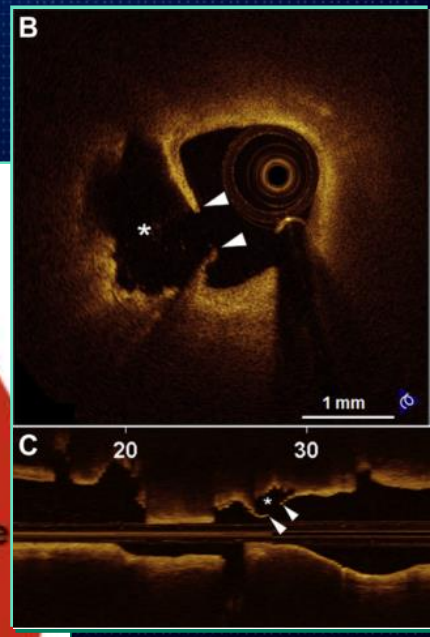
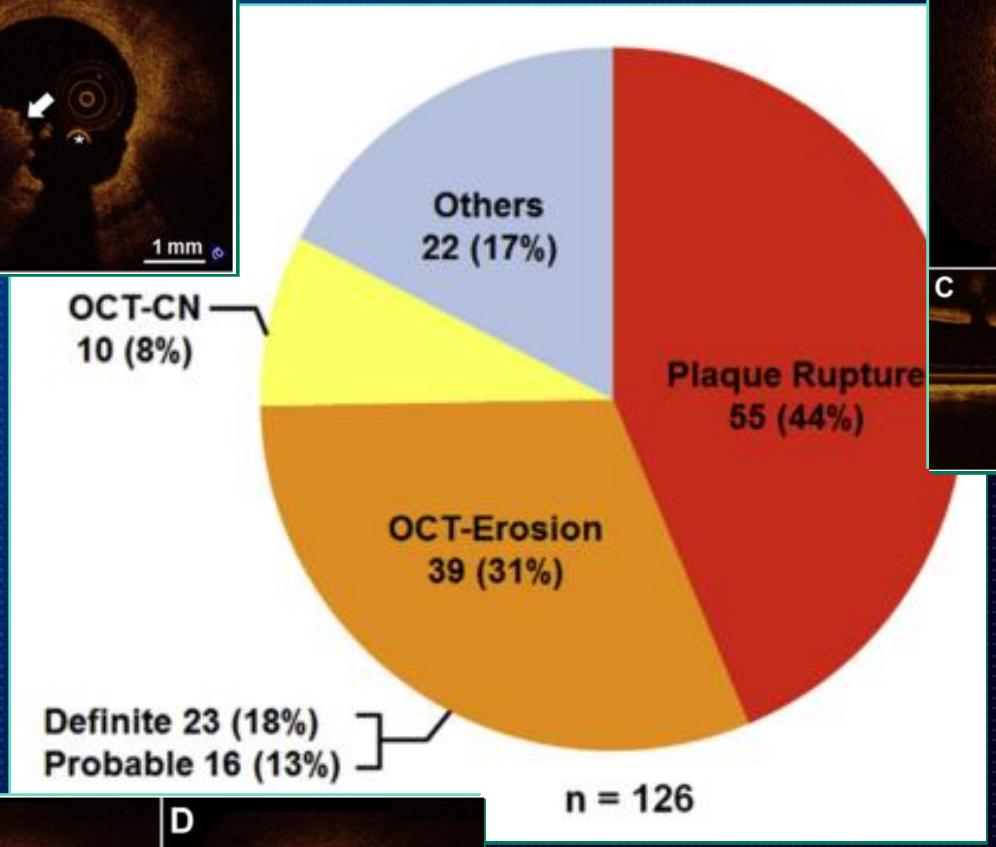
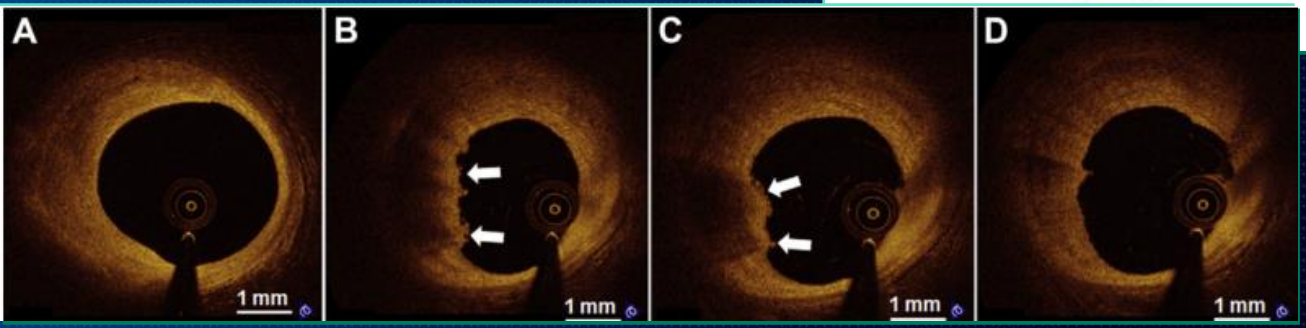
Optical Coherence Tomography in ACS









Haibo Jia, Ik-Kyung Jang, et al.
J Am Coll Cardiol 2013;62:1748–58.

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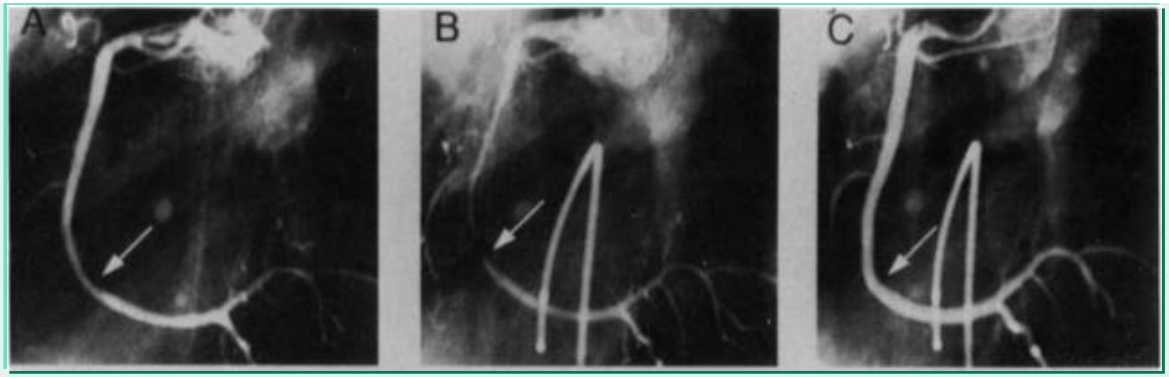
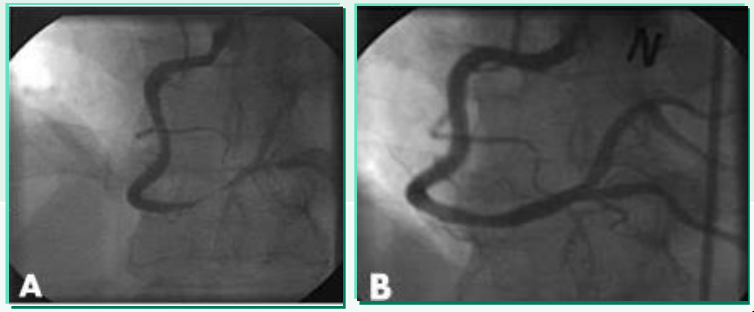
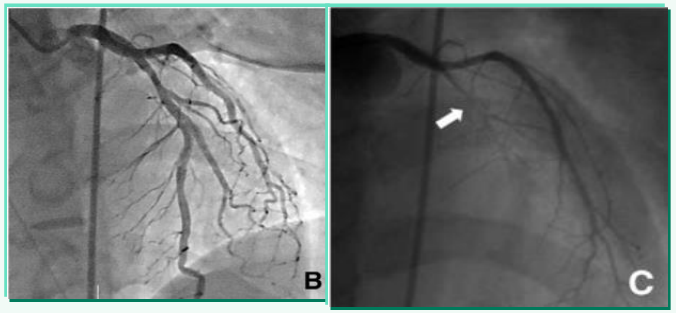
Optical Coherence Tomography in VSA

Coronary Angiography

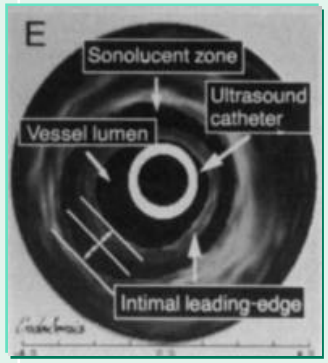


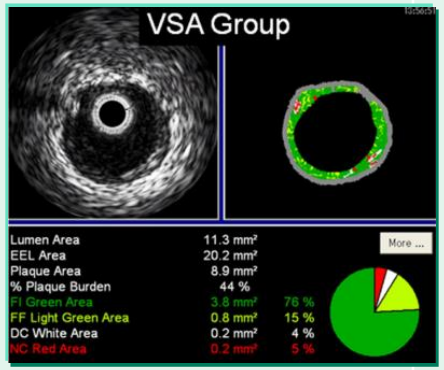
Steven E. Nissen, et al. JACC 1994; 23:352-7





IVUS



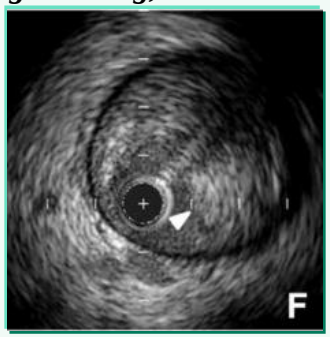


International Journal of Cardiology 168 (2013) 2411–2415

	Proximal reference	Spasm site	Distal reference
EEM CSA (mm^2)	15.5 ± 4.6	14.1 ± 4.5	15.3 ± 4.7
Lumen CSA (mm^2)	10.0 ± 3.8	6.2 ± 2.7	10.2 ± 3.8
P + M CSA (mm^2)	5.5 ± 1.9	7.8 ± 2.7	5.1 ± 2.0
CSN (%)	36 ± 11	56 ± 10	34 ± 10

Myeong-Ki Hong, et al. Am Heart J 2000;140:395-401.

OCT



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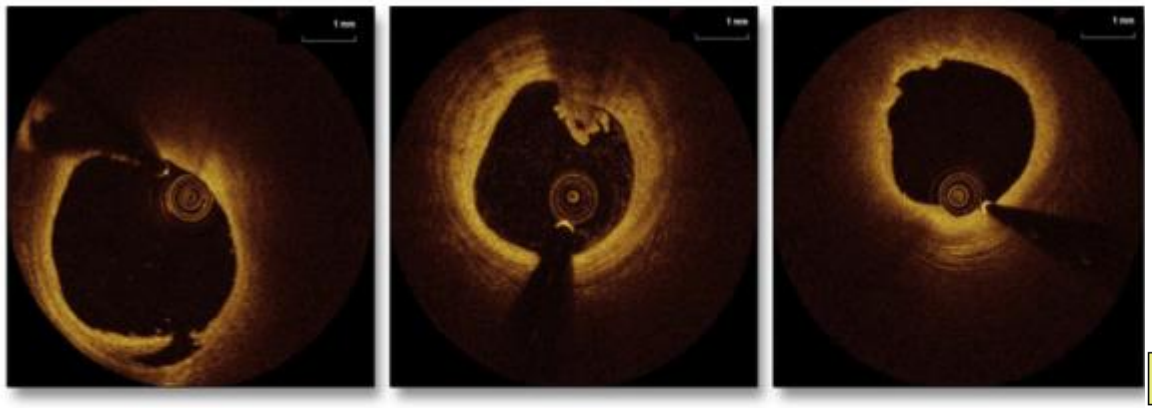
Yae Min Park, Woong Chol Kang, et al. International Journal of Cardiology 154 (2012) e57–e59

OCT–Defined Morphological Characteristics of Coronary Artery Spasm Sites in Vasospastic Angina

Eun-Seok Shin, MD, PhD,* Soe Hee Ann, MD,* Gillian Balbir Singh, MBChB,* Kyung Hun Lim, MD,* Hyuck-Jun Yoon, MD, PhD,† Seung-Ho Hur, MD, PhD,† Ae-Young Her, MD, PhD,‡ Bon-Kwon Koo, MD, PhD,§ Takashi Akasaka, MD, PhD‖

J Am Coll Cardiol Img 2015

69 consecutive VSA patients (80 spasm sites)
- **Ulsan University Hospital**
- **Keimyung University Dongsan Medical Center**

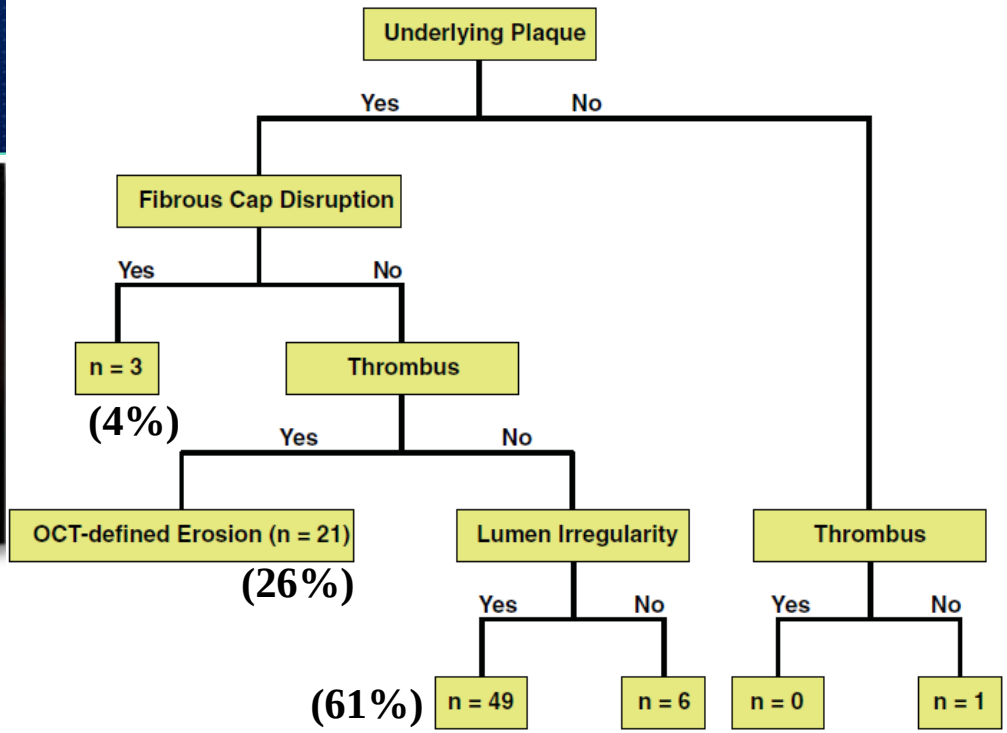


Fibrous Cap Disruption: Fibrous cap discontinuity with or without a cavity formed inside the plaque

OCT-defined Erosion: Underlying visualized plaque with intact fibrous cap, lumen irregularity and thrombus

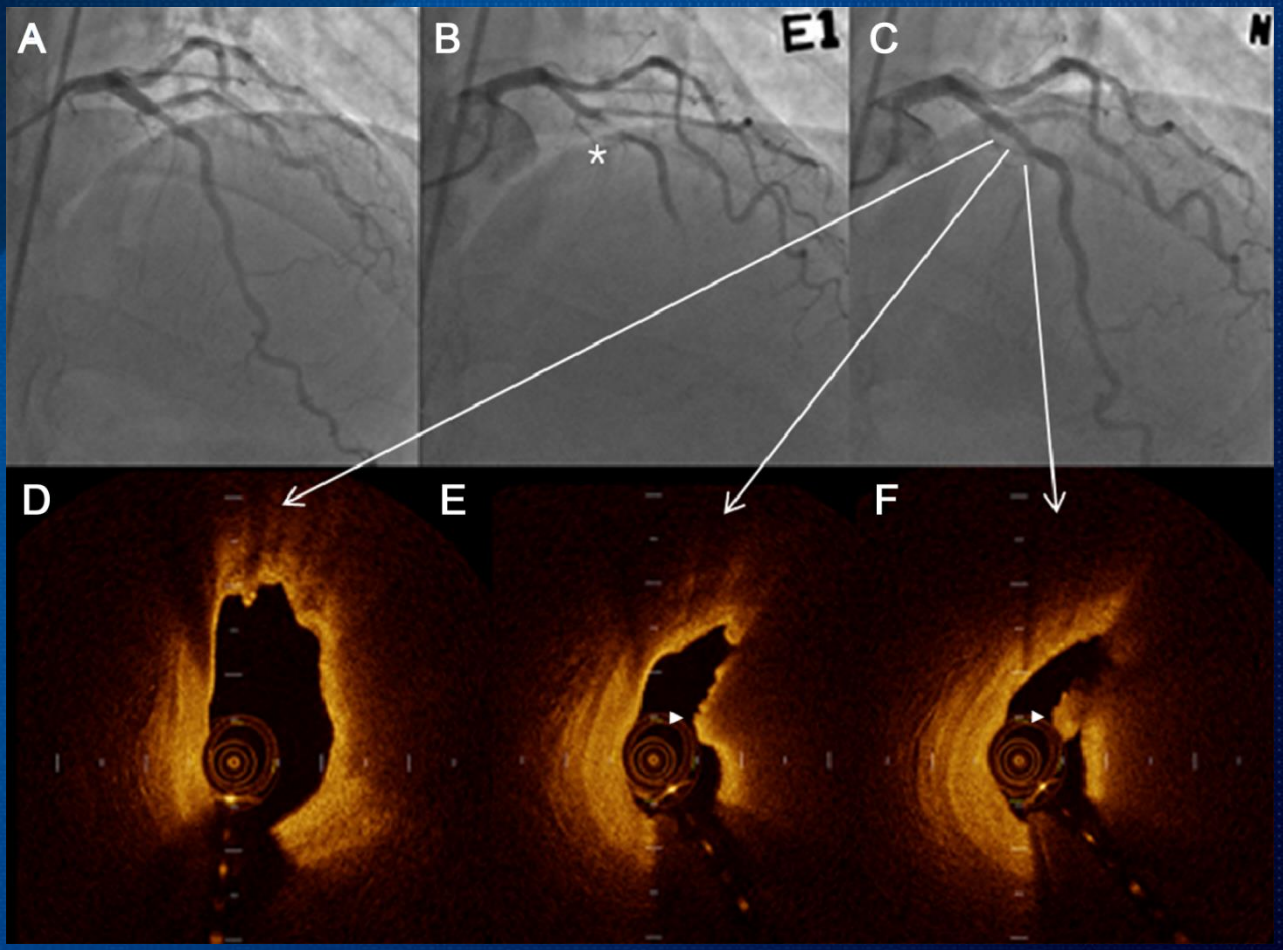
Luminal irregularity

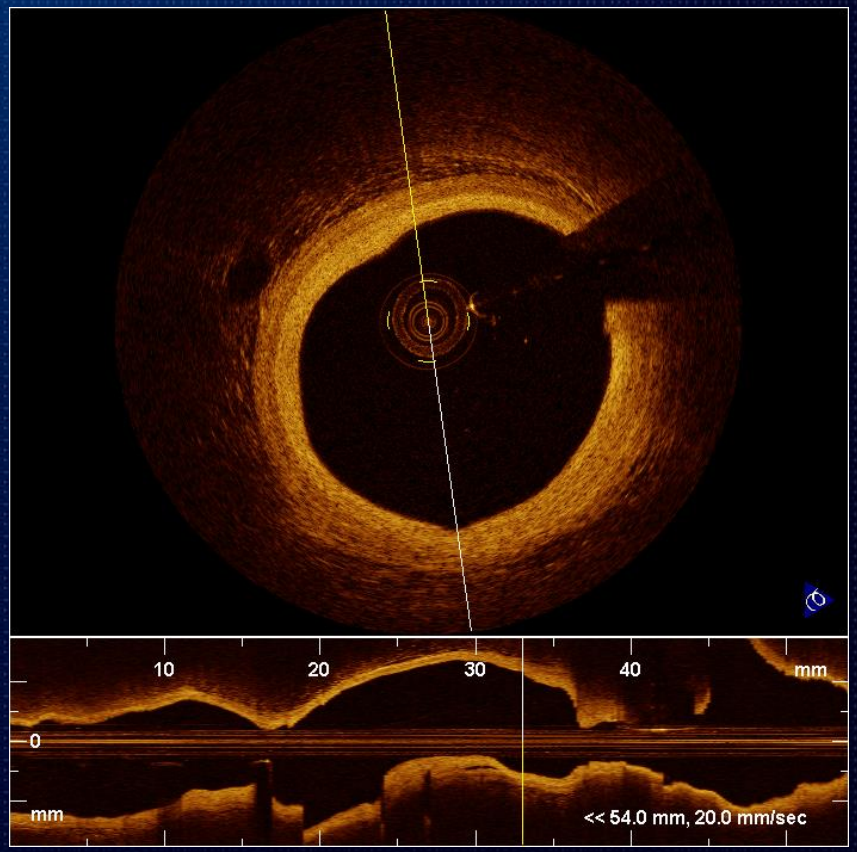
FIGURE 1 OCT-Defined Morphological Characteristics of Spasm Sites in Vasospastic Angina **(80 sites)**



Case of Vasospastic angina

57/M





Thrombus+ Intact fibrous cap= OCT defined Erosion

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Clinical Manifestations of Fibrous Cap Disruption & OCT-Defined Erosion

Patient #	OCT Findings	Clinical Manifestation	Age (yrs)/Sex	Ergonovine Provocation	Vessel	ECG on Admission	Braunwald Chest Pain Class	Smoking Status	Peak CK-MB (ng/ml)	Peak Trop-T (ng/ml)	Area of Thrombus (mm^2)
1	Fibrous cap disruption	AMI	58/M	–	RCA	ST-segment elevation	-	Nonsmoker	32.6	3.15	-
2	Fibrous cap disruption	AMI	50/M	+	RCA	ST-segment elevation	-	Current	192.1	3.44	0.14
3	OCT-defined erosion	AMI, OHCA	54/M	–	LAD	ST-segment elevation	-	Current	78.0	1.53	0.03
4	OCT-defined erosion	AMI, OHCA	53/M	–	RCA	ST-segment elevation	-	Current	491.6	4.85	0.64
5	OCT-defined erosion	AMI, OHCA	54/F	+	RCA	ST-segment elevation	-	Current	9.4	0.53	0.07
6	OCT-defined erosion	AMI	59/M	–	RCA	ST-segment elevation	-	Current	11.8	0.42	0.07
7	Fibrous cap disruption	UA	46/F	+	LAD	Normal	III	Nonsmoker	1.4	0.04	0.01
8	OCT-defined erosion	UA	59/M	–	LAD	ST-segment depression	II	Nonsmoker	1.3	0.02	1.15
9	OCT-defined erosion	UA	45/M	+	LAD	T inversion	III	Current	0.7	0.05	2.49
10	OCT-defined erosion	UA	76/F	–	RCA	T inversion	II	Current	0.8	0.01	0.03
11	OCT-defined erosion	UA	57/M	+	LAD	Normal	III	Ex-smoker	1.1	0.01	0.23
12	OCT-defined erosion	UA	55/M	–	RCA	Normal	II	Ex-smoker	2.0	0.08	0.20
13	OCT-defined erosion	UA	58/M	–	LAD	Normal	III	Current	0.9	0.01	0.10
14	OCT-defined erosion	UA	61/M	+	RCA	Normal	I	Current	2.5	0.01	0.01
15	OCT-defined erosion	UA	43/M	+	RCA	Normal	III	Current	1.2	0.01	0.06
16	OCT-defined erosion	UA	53/M	+	RCA	Normal	III	Nonsmoker	2.6	0.02	0.08
17	OCT-defined erosion	UA	53/M	+	LAD	Normal	II	Current	0.5	0.01	0.15
18	OCT-defined erosion	UA	49/M	–	LCx	Normal	III	Nonsmoker	NA	NA	0.02
19	OCT-defined erosion	UA	43/M	+	RCA	Normal	II	Nonsmoker	0.6	0.02	0.03
20	OCT-defined erosion	UA	47/M	+	LAD	Normal	III	Nonsmoker	0.9	0.01	0.04
21	OCT-defined erosion	UA	51/F	–	LAD	Normal	II	Nonsmoker	0.4	0.01	0.05
22	OCT-defined erosion	UA	43/M	+	RCA	Normal	II	Nonsmoker	0.7	0.01	0.17
23	OCT-defined erosion	UA	45/F	+	LAD	Normal	III	Current	0.6	0.02	0.83
24	OCT-defined erosion	UA	59/M	+	RCA	Normal	I	Current	NA	NA	0.11

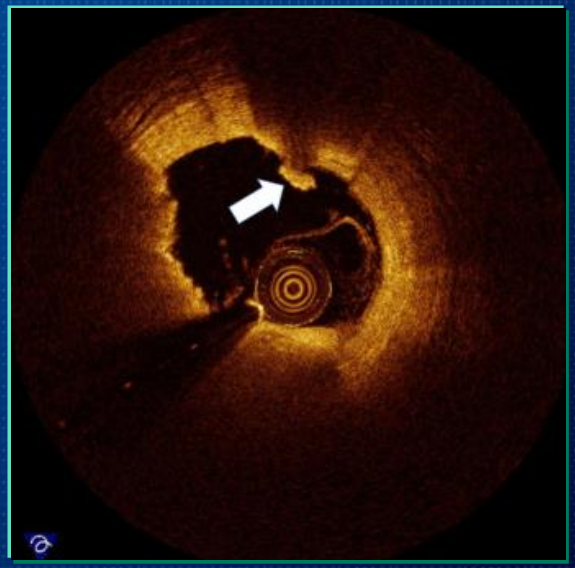
Comparison of morphologic findings obtained by optical coherence tomography in acute coronary syndrome caused by vasospasm and chronic stable variant angina

Hwan-Cheol Park · Jeong Hun Shin · Woo Kyoung Jeong · Sung Il Choi · Soon-Gil Kim

Int J Cardiovasc Imaging (2015) 31:229–237

ACS group
(39 patients visited in emergency clinic)
(1) Sustained chest pain (≥20 min)
(2) Transient ST elevations at initial presentation
(3) No significant fixed lesion (<50 % DS by QCA)
(4) Ergonovine provocation test

VA group
(41 patients visited in out-patient clinic)
(1) Elective CAG with Ergonovine provocation test



Variables n (%)	ACS group (n = 39)	VA group (n = 41)	*P* value
TCFA	17 (44)	6 (15)	0.004
Intima erosion	27 (69)	11 (27)	<0.001
Intima tear	18 (46)	3 (7)	<0.001*
Intraluminal thrombi	11 (28)	2 (5)	0.006*
Calcification	14 (36)	7 (17)	0.056

TCFA thin cap fibroatheroma

Why do thrombi exist in spasm segment in Vasospastic Angina ?

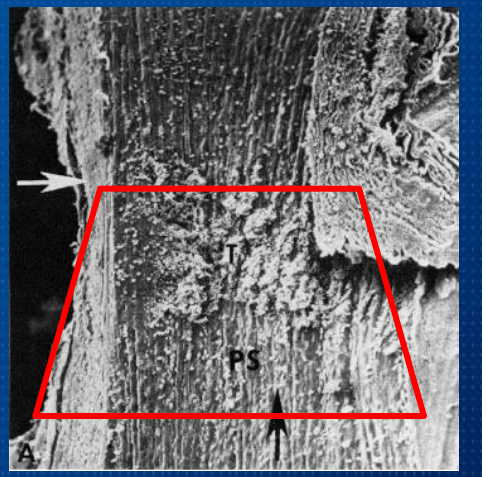
Uncertainty about the cause-and-effect relationship between the occurrence of vasospasm and the denudation of the endothelium, followed by thrombus formation.

Endothelial cell damage and thrombus formation

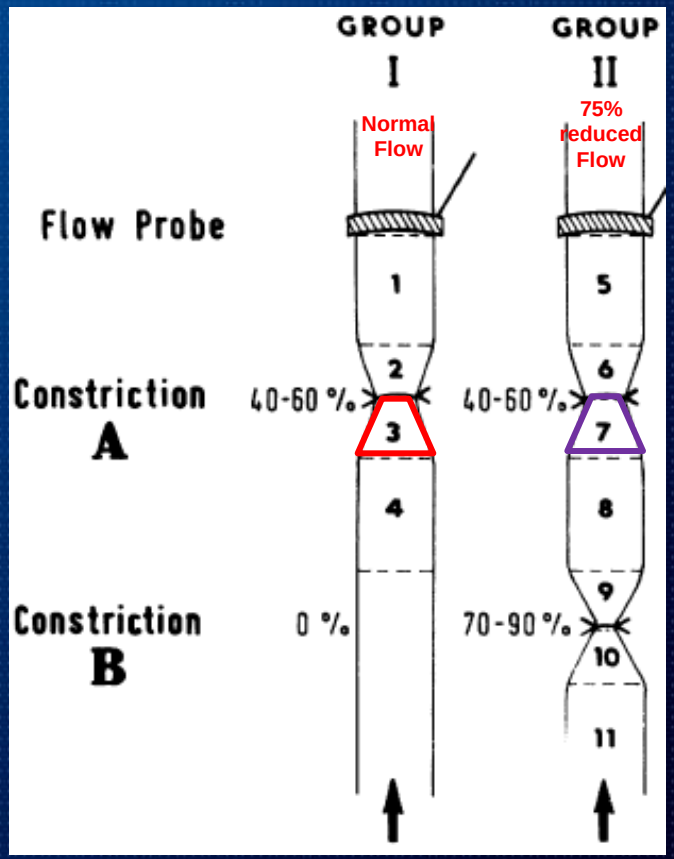
15 carotid arteries of rabbits & 4 LAD arteries of dogs

→ **40-60% of luminal reduction by ligation for 1 hour**

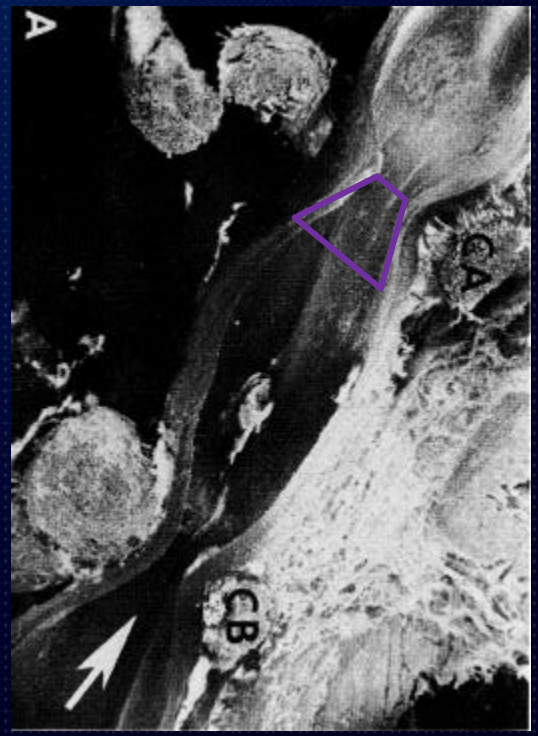
Electron Microscopy



Microthrombi, Endothelial desquamation

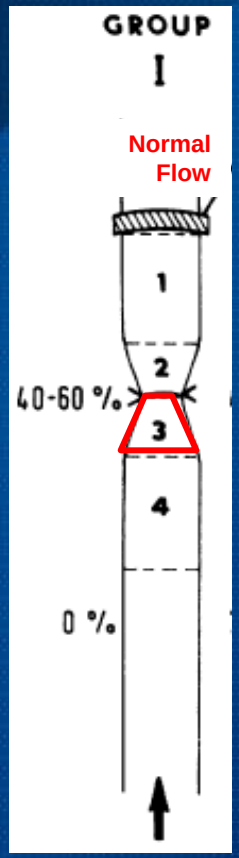


No endothelial damage



S D Gertz, et al. Circulation. 1981;63:476-486

Endothelial cell damage and thrombus formation



Shear stress (T, dyn/cm^2) by Poiseuille's law

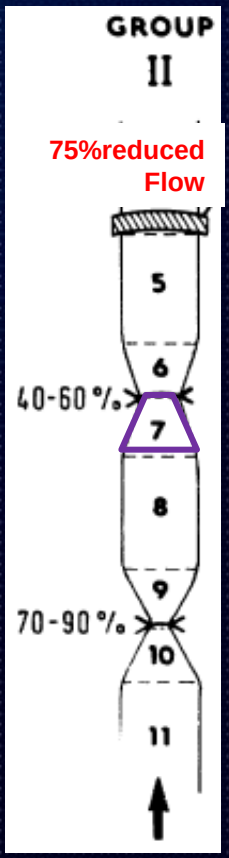
(Assumption: Steady Laminar Flow)

$$T=4Q\eta/\pi r^3$$

Q: Flow (ml/s)

η: Viscosity in poise (=0.03)

r: radius (cm)



$4x(16.7)x(0.03)/(3.14)x(0.05)^3$

= **85** dyn/cm^2

$4x(3.1)x(0.03)/(3.14)x(0.05)^3$

= **15** dyn/cm^2

If reduction of diameter is not sufficient to reduce distal flow, coronary vasospasm could result in myocardial ischemia from endothelial damage with microthrombi formation.

S D Gertz, et al. Circulation. 1981;63:476-486

What is the clinical implication of OCT findings in Vasospastic Angina ?

Potential benefits of anti-platelet therapy in clinical outcome

Prognostic Stratification of Patients With Vasospastic Angina

A Comprehensive Clinical Risk Score Developed by the Japanese Coronary Spasm Association

Yusuke Takagi, MD,* Jun Takahashi, MD,* Satoshi Yasuda, MD,† Satoshi Miyata, PHD,* Ryusuke Tsunoda, MD,‡ Yasuhiro Ogata, MD,‡ Atsushi Seki, MD,§ Tetsuya Sumiyoshi, MD,§ Motoyuki Matsui, MD,‖ Toshikazu Goto, MD,‖ Yasuhiko Tanabe, MD,¶ Shozo Sueda, MD,# Toshiaki Sato, MD,** Satoshi Ogawa, MD,** Norifumi Kubo, MD,†† Shin-ichi Momomura, MD,†† Hisao Ogawa, MD,‡‡ Hiroaki Shimokawa, MD,* for the Japanese Coronary Spasm Association

J Am Coll Cardiol 2013;62:1144–53

Multicenter Registry
(Japanese Coronary Spasm Association)

Median FU=32months

Table 2 Primary and Secondary Outcomes During the Follow-Up Period (N = 1,429)

MACE	85 (6)
Cardiac death	6 (0.4)
Nonfatal myocardial infarction	9 (1)
Unstable angina	68 (5)
Heart failure	4 (0.3)
Appropriate ICD shock	2 (0.1)
All-cause death	19 (1)

Values are n (%).

ICD = implantable cardioverter-defibrillator; MACE = major adverse cardiac event; other abbreviations as in Table 1.

Table 3 Correlated Factors for MACE in VSA Patients and Assigned Score

	Univariable Analysis			Multivariable Analysis			
	HR	95% CI	p Value	HR	95% CI	p Value	Assigned Score
Age	0.99	0.97–1.01	0.38				
Male	1.07	0.64–1.79	0.79				
Hypertension	0.90	0.58–1.38	0.62				
Dyslipidemia	1.17	0.76–1.79	0.48				
Diabetes mellitus	1.57	0.94–2.61	0.09				
Smoking	1.96	1.21–3.19	0.006	1.71	1.04–2.79	0.034	2
Previous myocardial infarction	2.19	1.10–4.38	0.026				
Angina at rest alone	1.49	0.95–2.35	0.09	1.71	1.08–2.72	0.023	2
ST-segment elevation during angina attack	1.50	0.93–2.42	0.09	1.54	0.95–2.50	0.08	1
History of OHCA	3.98	1.73–9.13	0.001	3.79	1.61–8.94	0.002	4
Significant organic stenosis	2.28	1.39–3.73	0.001	2.24	1.33–3.78	0.002	2
LAD spasm	1.28	0.81–2.02	0.29				
LCx spasm	1.16	0.75–1.80	0.50				
RCA spasm	1.05	0.68–1.61	0.83				
Multivessel spasm	1.51	0.94–2.45	0.09	1.69	1.03–2.78	0.039	2
Calcium-channel blocker	0.73	0.35–1.51	0.39				
Long-acting nitrate	1.35	0.89–2.07	0.17				
Antiplatelet	1.43	0.94–2.20	0.10				
Beta-blocker	2.34	1.08–5.06	0.032	2.00	0.88–4.54	0.09	1

CI = confidence interval; HR = hazard ratio; other abbreviations as in Table 1.

J Am Coll Cardiol 2013;62:1144–53

Treatment of Vasospastic angina

- Calcium channel blocker
- Nitrates

In patients with suspected/confirmed vasospastic angina, calcium channel blockers and nitrates should be considered and beta-blockers avoided.	IIa	B

2015 ESC Guidelines

RESEARCH

Efficacy of Cilostazol on Uncontrolled Angina: A Pilot Study

Sang-Yong Yoo,[1] Sung-Gook Song,[2] Jae-Hwan Lee,[3] Eun-Seok S
Jun Kim,[5] Kook-Jin Chun[5] & June-Hong Kim[5,*]

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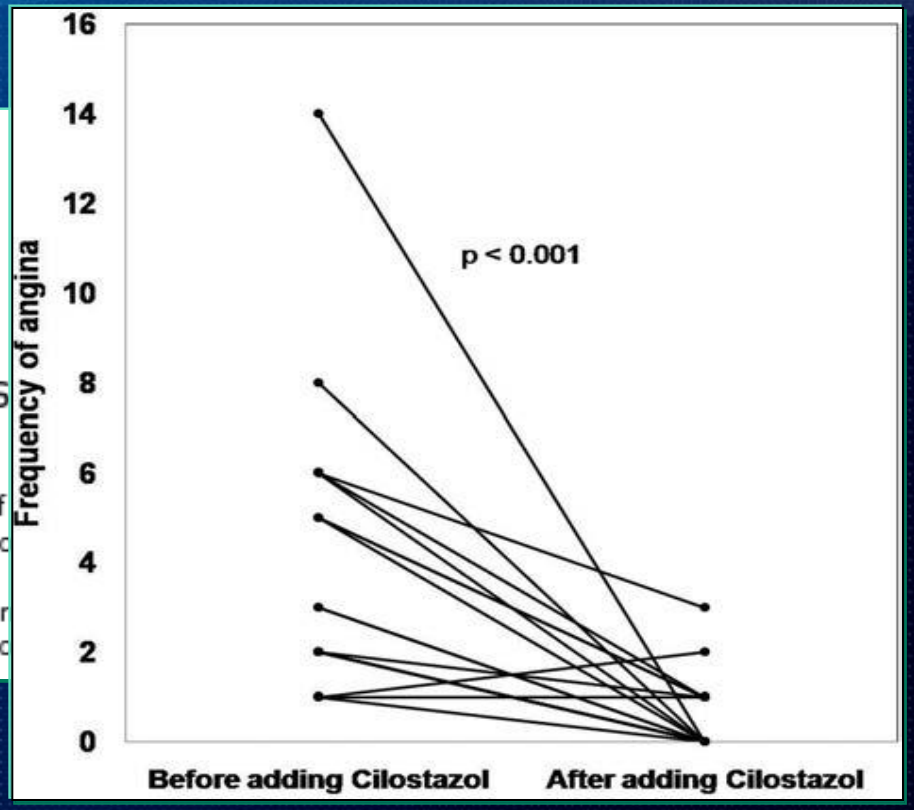
3 Cardiovascular Center, Chungnam National University Hospital, Daejeon, South Korea
4 Division of Cardiology, Ulsan University Hospital, University of Ulsan College of Medicir
5 Cardiovascular Center, Pusan National University Yangsan Hospital, Yangsan, South Ko



* Cilostazol: selective inhibitor of phosphodiesterase -3
→ Intracellular cAMP → Increse in coronary nitric oxide production

* 21 patients (13 men, 57 ± 9 yearold) with uncontrolled VSA

Conclusion: Cilostazol appears to be an effective therapy in VSA uncontrolled with conventional medical treatment.

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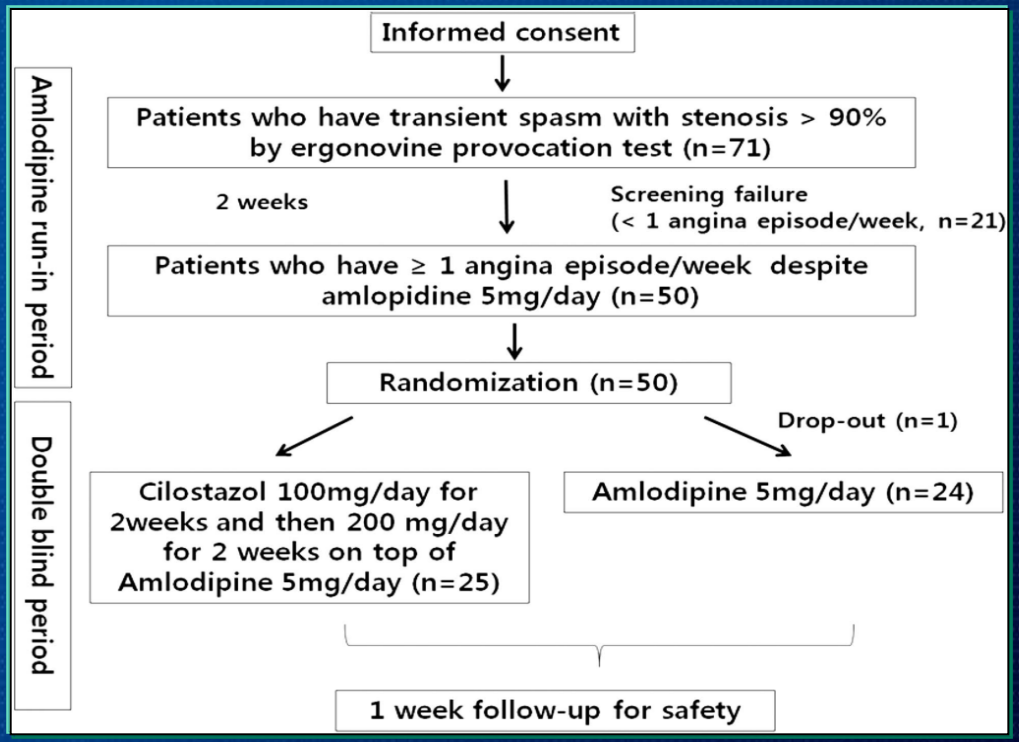
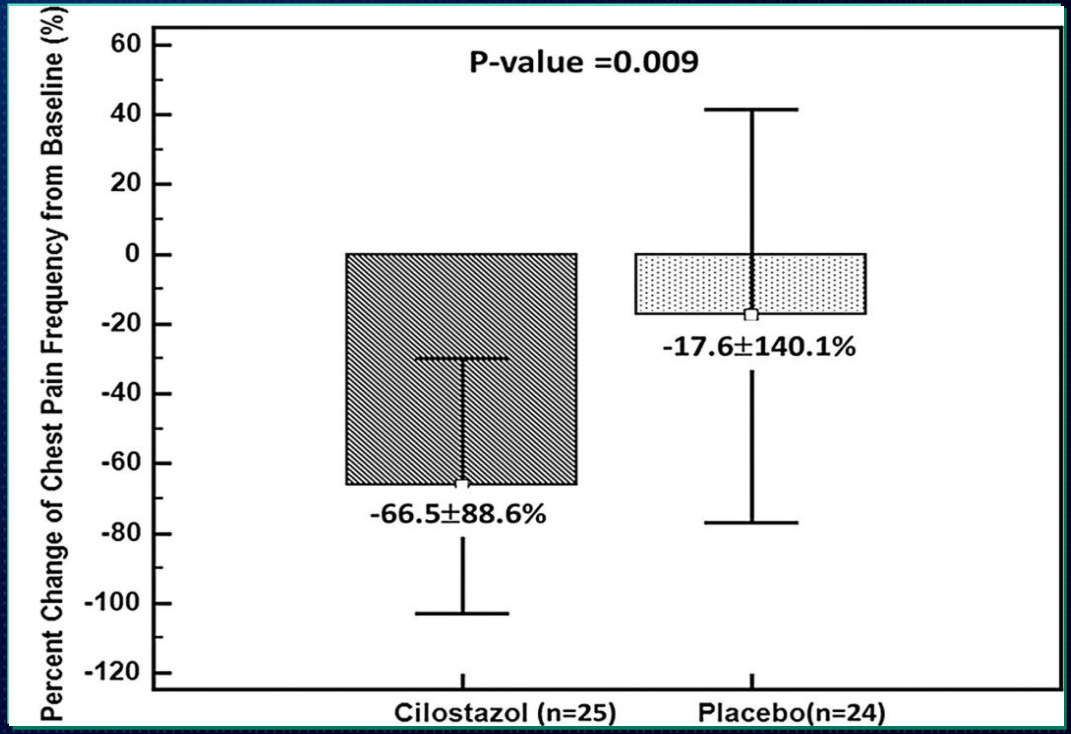
A randomised, multicentre, double blind, placebo controlled trial to evaluate the efficacy and safety of cilostazol in patients with vasospastic angina

Eun-Seok Shin,[1] Jae-Hwan Lee,[2] Sang-Yong Yoo,[3] Yongwhi Park,[4] Young Joon Hong,[5] Moo Hyun Kim,[6] Jong-Young Lee,[7] Chang-Wook Nam,[8] Seung-Jea Tahk,[9] Jeong-Su Kim,[10] Young-Hoon Jeong,[4] Cheol Whan Lee,[7] Hwa Kyoung Shin,[11] June-Hong Kim[10]

Heart. 2014

To assess the efficacy and safety of cilostazol in patients with VSA





Cilostazol is effective in treating VSA refractory to conventional amlodipine therapy.

Provoked Coronary Spasm Predicts Adverse Outcome in Patients With Acute Myocardial Infarction

A Novel Predictor of Prognosis After Acute Myocardial Infarction

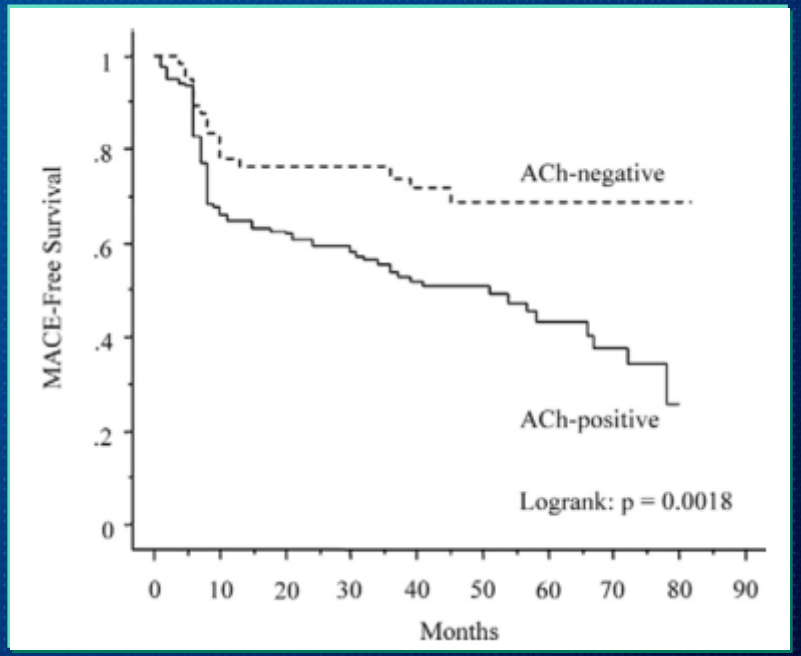
Kohei Wakabayashi, MD, PHD,* Hiroshi Suzuki, MD, PHD,* Yuki Honda, MD,* Daisuke Wakatsuki, MD,* Keisuke Kawachi, MD,* Kei Ota, MD,* Shinji Koba, MD, PHD,† Nobuyuki Shimizu, MD, PHD,* Fuyuki Asano, MD, PHD,* Tokutada Sato, MD, PHD,* Youichi Takeyama, MD, PHD*

Yokohama and Tokyo, Japan

J Am Coll Cardiol 2008;52:518–22

Ach provocation tests: 10~20 days after the onset of AMI

- Ach positive: in IRA and/or non-IRA (72.5%, 174/240 patients)
- Ach negative: both IRA and non-IRA (27.5%, 66/240 patients)



Variables	Exp (B)	Hazard Ratio (95% Confidence Interval)	p Value
Provoked coronary spasm	2.632	1.504–4.604	0.0007
3-vessel disease	2.379	1.425–3.971	0.0009
Hypertension	1.694	1.102–2.604	0.0163
Smoking	0.811	0.499–1.316	0.3958
Male gender	1.024	0.597–1.756	0.9310
Nitrates	1.093	0.661–1.808	0.7291

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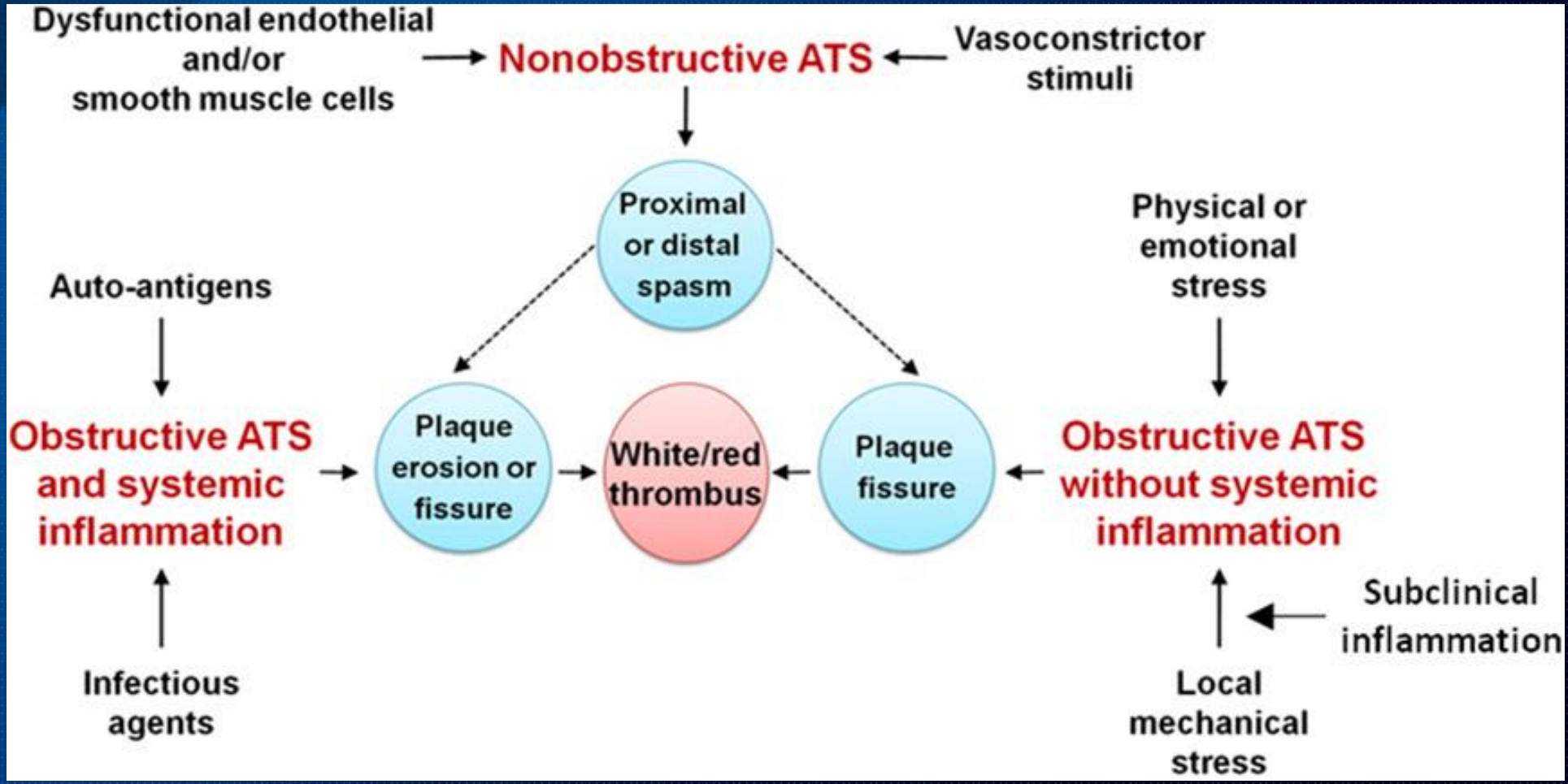
Pathogenetic classification of ACS



Filippo Crea, et al. J Am Coll Cardiol 2013;61:1–11

2015 JCR Joint meeting of Coronary Revascularization

Thank you for your attention !

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