

# Plaque erosion assessed by OCT in patients with vasospastic angina

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# Presenter Disclosure Information

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**Presenter: Ann Soe Hee, M.D.**

**Title: Plaque erosion assessed by OCT  
in patients with vasospastic angina**

**No relationships to disclose**

**No industry sponsorship**

# Background

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- \* Coronary spasm plays an important role in the pathogenesis of variant angina, and unstable angina, acute myocardial infarction, ventricular arrhythmia and sudden cardiac death.

Nakamura M, et al. Circulation. 1987;75:1110-16.

Oliva PB, et al. N Engl J Med 1973;288:745-51.

# Background

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- \* Even when no stenotic lesions are visible on coronary angiography, IVUS reveals clear arteriosclerotic lesions in locations consistent with regions of coronary spasm.

*Yamagishi M, J Am Coll Cardiol 1994; 23:352 – 357.*

- \* Plaque characteristics of vasospastic sites have not been investigated by OCT in vivo.

# Aims

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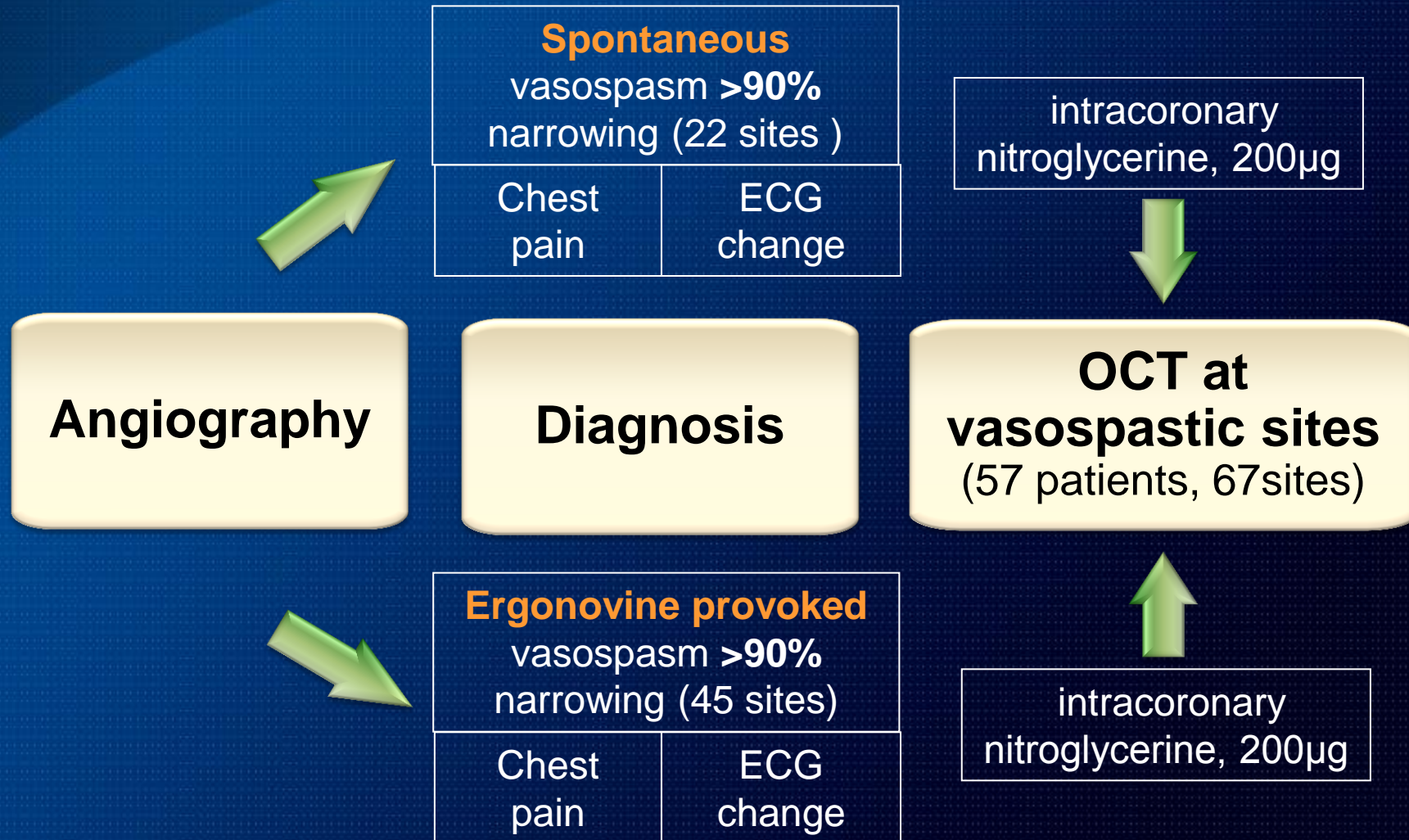
To characterize the morphological features of plaque on the spasm sites with OCT in patients with vasospastic angina

# Study population

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- 2011.10 ~ 2013.7
- Prospective OCT registry
- 57 patients with vasospastic angina
  - : Ulsan University Hospital (n=48)
  - Keimyung University Dongsan Medical Center(n=9)

# Study Design



# Methods

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## Diagnosis of vasospastic angina

### - Including 3 components of Criteria

#### 1. Angiography

: spontaneously or ergonovine provoked  
transient total or subtotal ( $\geq 90\%$ ) occlusion of coronary artery

#### 2. Symptom

: chest pain

#### 3. ECG

: transient ST segment changes  
( elevation or depression  $\geq 0.1$  mV, at least 2 contiguous leads)



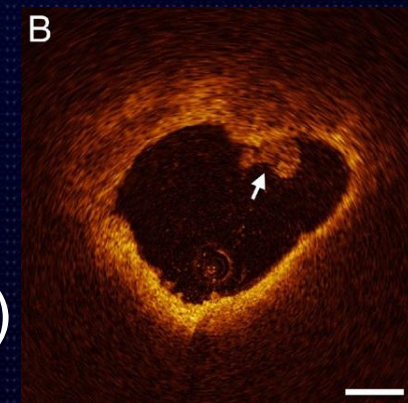
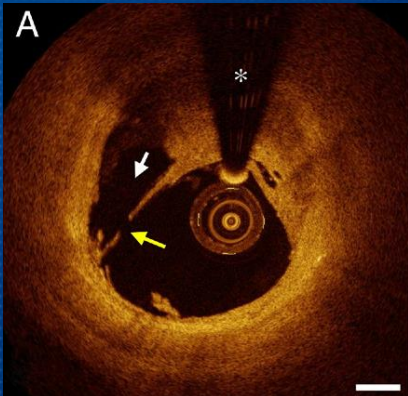
# Methods

## Ergonovine Provocation test & OCT acquisition

- (1) Left & Right control angiography
- (2) Injection of Ergonovine (20~60  $\mu\text{g}$  in saline)  
in the **left coronary artery**
- (3) 2 minutes later, perform left coronary angiography  
at ECG change or chest pain, perform left coronary angiography  
if negative result, (5 minutes later)
- (4) Injection of Ergonovine (20~40  $\mu\text{g}$  in saline)  
in the **right coronary artery**
- (5) 2 minutes later, perform right coronary angiography  
at ECG change or chest pain, perform right coronary angiography
- (6) Injection of nitrate (200  $\mu\text{g}$  in saline) into each coronary artery
- (7) Perform angiography & OCT acquisition

# Definition in OCT images

- \* **Thrombus:** mass (diameter  $> 250 \mu\text{m}$ ) attached to the luminal surface or floating within the lumen, including red thrombus (high backscattering & high attenuation) or white thrombus (homogeneous backscattering & low attenuation)
- \* **Erosion:** thrombus+ lumen irregularity + intact fibrous cap at multiple adjacent OCT frames
- \* **Plaque rupture:** broken fibrous cap  
(by intima tearing, disruption or dissection)  
→ remnant cavity

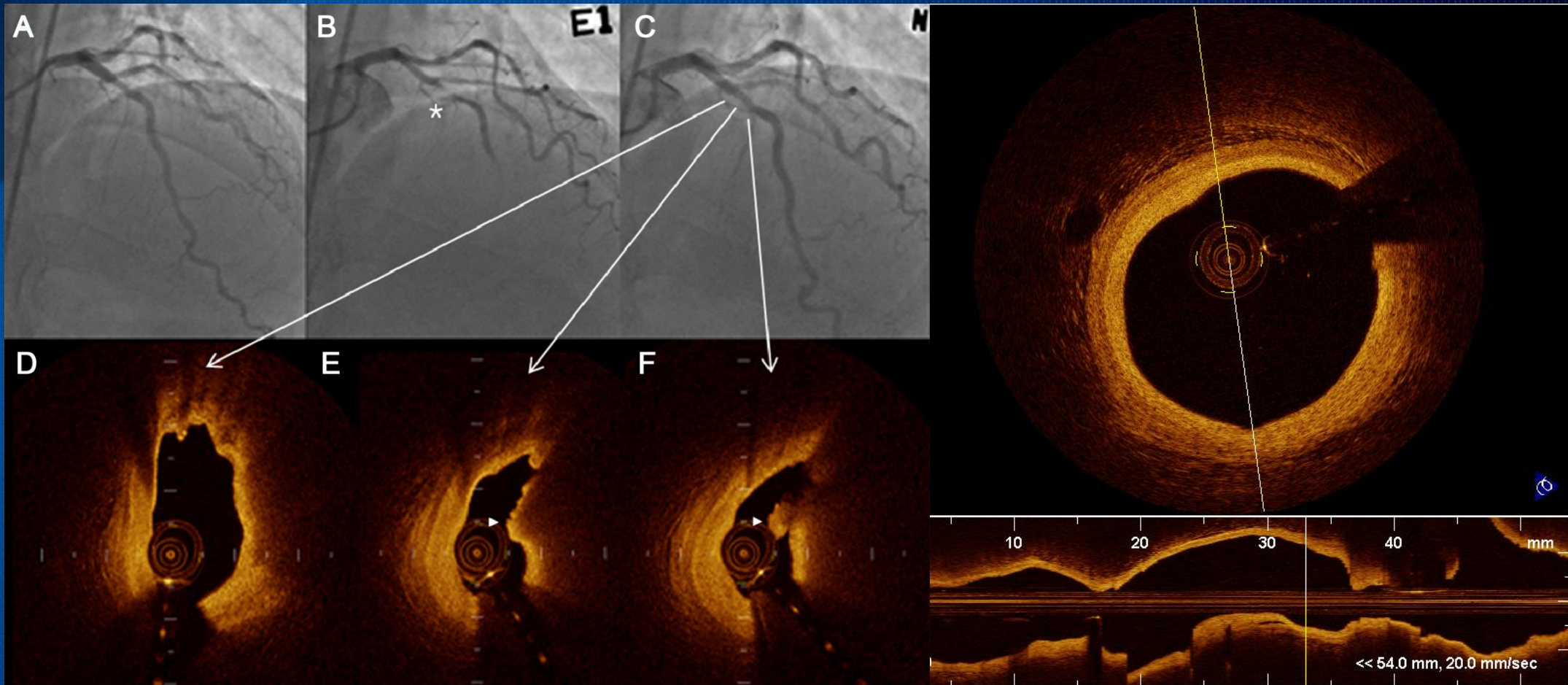


Guillermo J. Tearney et al.

*J Am Coll Cardiol* 2012;59:1058–72

# A representative case

57/M with vasospastic angina



Thrombus+ Lumen irregularity + Intact fibrous cap= **Erosion**

# Methods

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## Optical Coherence Tomography

: Fourier-domain C7XR OCT

with the non-occlusive technique,

pullback rate: 20 mm/s



## Statistical Analysis

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SPSS 18.0 (SPSS Inc., Chicago, IL, USA)

# Clinical demographics

| Variables                          | (N=57)     |
|------------------------------------|------------|
| Male                               | 45 (78.9%) |
| Age(yrs)                           | 54.8±7.8   |
| Range                              | 40-73      |
| BMI(Kg/m <sup>2</sup> )            | 24.1±2.6   |
| <b>Cardiovascular risk factors</b> |            |
| Diabetes                           | 5 (8.8%)   |
| Dyslipidemia                       | 23 (40.4%) |
| Smoking                            |            |
| Ex-smoker                          | 10 (17.5%) |
| Current smoker                     | 24 (42.1%) |
| Hypertension                       | 23 (40.4%) |
| Family History                     | 0          |
| Previous PCI                       | 0          |
| Previous stroke                    | 0          |

| Laboratory findings       |             |
|---------------------------|-------------|
| Creatinine (mg/dL)        | 1.1±0.3     |
| Total cholesterol (mg/dL) | 179.0±35.6  |
| Triglyceride (mg/dL)      | 137.7±116.0 |
| HDL cholesterol (mg/dL)   | 48.5±9.5    |
| LDL cholesterol (mg/dL)   | 97.3±29.7   |
| peak CK-MB (ng/mL)        | 7.4±28.5    |
| peak Troponin-T (ng/mL)   | 0.25±0.75   |
| <b>Echocardiography</b>   |             |
| Ejection fraction(%)      | 65.2±5.3    |
| <b>Medication</b>         |             |
| β-blocker                 | 3 (5.3%)    |
| Calcium channel blocker   | 48 (84.2%)  |
| Nitrate                   | 33 (57.9%)  |
| Nicorandil                | 37 (64.9%)  |
| ACEi / ARB                | 7 (12.3%)   |
| Statin                    | 37 (64.9%)  |

# Angiographic findings

| Vasospastic sites (N=67)           |                   |
|------------------------------------|-------------------|
| Diagnosis based on                 |                   |
| <b>Ergonovine</b> proved vasospasm | <b>45 (67.2%)</b> |
| provoked diameter stenosis (%)     | 96.1±6.2          |
| post-nitrate diameter stenosis (%) | 28.8±16.5         |
| <b>Spontaneous</b> vasospasm       | <b>22 (32.8%)</b> |
| initial diameter stenosis (%)      | 86.4±12.3         |
| post-nitrate diameter stenosis (%) | 27.6±14.9         |
| Slowest TIMI flow                  |                   |
| TIMI 0                             | 19 (28.4%)        |
| TIMI 1                             | 3 (4.5%)          |
| TIMI 2                             | 11 (16.4%)        |
| TIMI 3                             | 34 (50.7%)        |
| Location of vasospasm              |                   |
| Left anterior descending, n(%)     | 31 (46.3%)        |
| Left circumflex, n(%)              | 5 (7.5%)          |
| Right coronary, n(%)               | 31 (46.3%)        |

# IVUS & VH findings

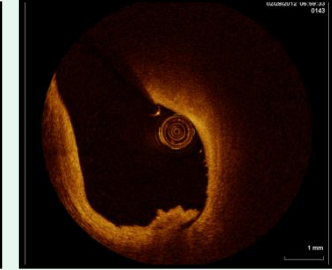
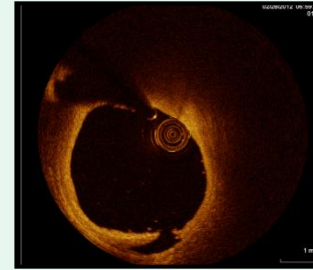
| IVUS (N=42 sites)                           |                |
|---|----------------|
| Lesion length (mm)                          | 5.7±2.9        |
| Mean Vessel area (mm <sup>2</sup> )         | 15.0±5.3       |
| Mean Lumen area (mm <sup>2</sup> )          | 7.6±3.4        |
| Mean Plaque & Media area (mm <sup>2</sup> ) | 7.4±3.1        |
| Minimal Lumen area (mm <sup>2</sup> )       | 5.7±2.9        |
| Plaque burden (%)                           | 49.0±10.9      |
| Plaque burden ≥ 40%, n (%)                  | 37 /42 (88.1%) |
| Fibrous tissue (%)                          | 63.7±12.8      |
| Fibro-fatty tissue (%)                      | 15.2±9.8       |
| Necrotic core (%)                           | 13.0±9.7       |
| Dense calcium (%)                           | 8.1±9.1        |

# OCT findings

## Vasospastic 67 sites

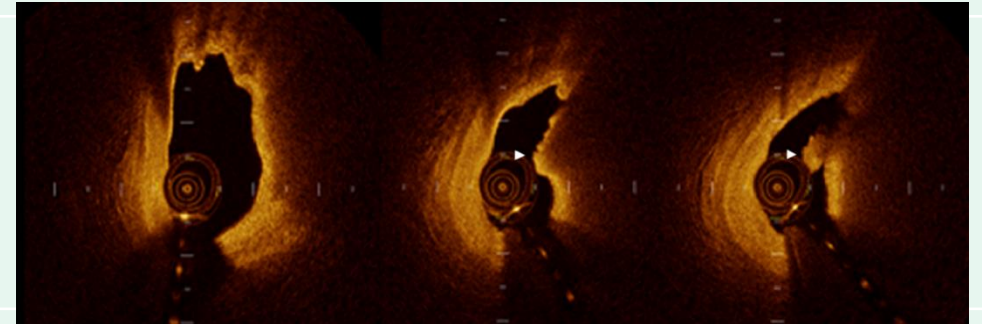
**Dissection**

4 (6.0%)



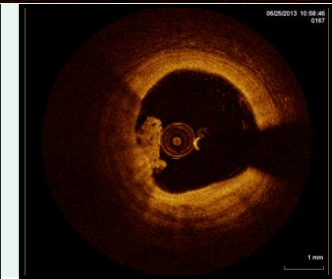
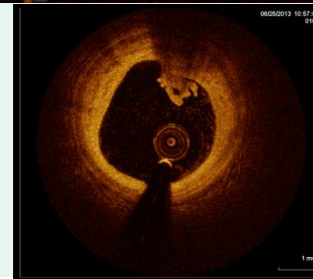
**OCT\_Erosion**

13 (19.4%)



**Thrombi only**

5 (7.5%)



**Irregularity only**

26 (38.8%)





# OCT findings

## Vasospastic 67 sites

|                                 |            |
|---------------------------------|------------|
| <b>Thrombus, n(%)</b>           | 20 (29.9%) |
| length (mm)                     | 0.24±0.55  |
| maximal diameter (mm)           | 0.62±0.50  |
| minimal diameter (mm)           | 0.25±0.25  |
| <b>Lipid-laden plaque, n(%)</b> | 60 (89.6%) |
| Cap thickness < 65 (µm)         | 7 (10.4%)  |
| Cap thickness (µm)              | 166.1±81.1 |

# Limitations

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1. Small study population
2. Limited resolution of OCT  
to detect endothelial denudation

# Conclusion

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- \* Plaque erosion assessed by OCT is a frequent findings in patients with vasospastic angina.
- \* Further investigation are needed to clarify if these findings are unique in VSA and the clinical implication of these findings.

**Thank you for your attention !**





# OCT findings

| Vasospastic 67 sites            | Erosion site (n=13) | Non-erosion site (n=54) | p-value |
|---------------------------------|---------------------|-------------------------|---------|
| Erosion                         | 13 (100.0%)         | -                       |         |
| Rupture                         | -                   | 4 (7.4%)                |         |
| Irregularity only               | -                   | 26 (48.1%)              |         |
| Thrombi only                    | -                   | 5 (9.3%)                |         |
| Normal                          | -                   | 19 (35.2%)              |         |
| <b>Thrombus, n(%)</b>           | 13 (100.0%)         | 7 (13.0%)               | <0.001  |
| length (mm)                     | 0.27±0.67           | 0.18±0.21               | 0.643   |
| maximal diameter (mm)           | 0.64±0.56           | 0.58±0.39               | 0.775   |
| minimal diameter (mm)           | 0.24±0.29           | 0.27±0.15               | 0.707   |
| <b>Lipid-laden plaque, n(%)</b> | 13 (100.0%)         | 47 (87.0%)              | 0.330   |
| Cap thickness < 65 (μm)         | 3 (23.1%)           | 4 (8.3%)                | 0.159   |
| Cap thickness (mm)              | 153.1±108.0         | 169.6±73.3              | 0.611   |

# Clinical demographics between 2 groups

| Variables                          | Erosion group<br>(n=12) | Non-erosion group<br>(n=45) | p-value |
|------------------------------------|-------------------------|-----------------------------|---------|
| Male                               | 11 (91.7%)              | 34 (75.6%)                  | 0.427   |
| Age(yrs)                           | 53.3±5.5                | 55.3±8.3                    | 0.325   |
| BMI(Kg/m <sup>2</sup> )            | 23.8±2.5                | 24.2±2.6                    | 0.632   |
| <b>Cardiovascular risk factors</b> |                         |                             |         |
| Diabetes                           | 1 (8.3%)                | 4 (8.9%)                    | 1.0     |
| Dyslipidemia                       | 7 (58.3%)               | 16 (35.6%)                  | 0.153   |
| Smoking                            |                         |                             | 0.716   |
| Ex-smoker                          | 3 (25.0%)               | 7 (15.6%)                   |         |
| Current smoker                     | 5 (41.7%)               | 19 (42.2%)                  |         |
| Hypertension                       | 5 (41.7%)               | 18 (40.0%)                  | 0.917   |
| Past history                       | 0                       | 0                           |         |
| <b>Medication</b>                  |                         |                             |         |
| β-blocker                          | 0 (5.3%)                | 3 (6.7%)                    | 1.0     |
| CCB                                | 10 (83.3%)              | 38 (84.4%)                  | 1.0     |
| Nitrate                            | 6 (50.0%)               | 27 (60.0%)                  | 0.533   |
| Nicorandil                         | 8 (66.7%)               | 29 (64.4%)                  | 1.0     |
| Statin                             | 6 (50.0%)               | 31 (68.9%)                  | 0.223   |

# Angiographic findings between 2 groups

| 67 sites                           | Erosion site<br>(n=13) | Non-erosion site<br>(n=54) | p-value          |
|------------------------------------|------------------------|----------------------------|------------------|
| Diagnosis based on                 |                        |                            |                  |
| Provocation test                   | 6 (46.2%)              | 39 (72.2%)                 | 0.072            |
| provoked diameter stenosis (%)     | 99.8±0.4               | 95.5±6.58                  | <b>&lt;0.001</b> |
| post-nitrate diameter stenosis (%) | 20.8±19.1              | 24.6±23.3                  | 0.674            |
| Without provocation test           | 7 (53.8%)              | 15 (27.8%)                 |                  |
| initial diameter stenosis (%)      | 81.3±17.6              | 88.8±8.6                   | 0.317            |
| post-nitrate diameter stenosis (%) | 24.3±26.4              | 28.0±20.9                  | 0.75             |
| Slowest TIMI flow                  |                        |                            | 0.622            |
| TIMI 0                             | 5 (38.5%)              | 14 (25.9%)                 |                  |
| TIMI 1                             | 1 (7.7%)               | 2 (3.7%)                   |                  |
| TIMI 2                             | 1 (7.7%)               | 10 (18.5%)                 |                  |
| TIMI 3                             | 6 (46.2%)              | 28 (51.9%)                 |                  |
| Location of vessel                 |                        |                            | 0.813            |
| Left anterior descending, n (%)    | 7 (53.8%)              | 24 (44.4%)                 |                  |
| Left circumflex, n(%)              | 1 (7.7%)               | 4 (7.4%)                   |                  |
| Right coronary, n(%)               | 5 (38.5%)              | 26 (48.1%)                 |                  |