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# OCT in Atherogenesis: Biologic Understanding

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# Disclosure

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## FINANCIAL DISCLOSURE:

Grants/Research Support: LightLab Imaging/St. Jude Medical, Medtronic, Astra Zeneca, InfraReDx

Consulting: LightLab Imaging/St. Jude, Japan Stent Technology

# OCT

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- 1. Native Vessel Atherosclerosis**
- 2. A tool for Biology Studies**
- 3. Neoatherosclerosis inside Stents**



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# OCT

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**1. Native Vessel Atherosclerosis**

**2. A tool for Biology Studies**

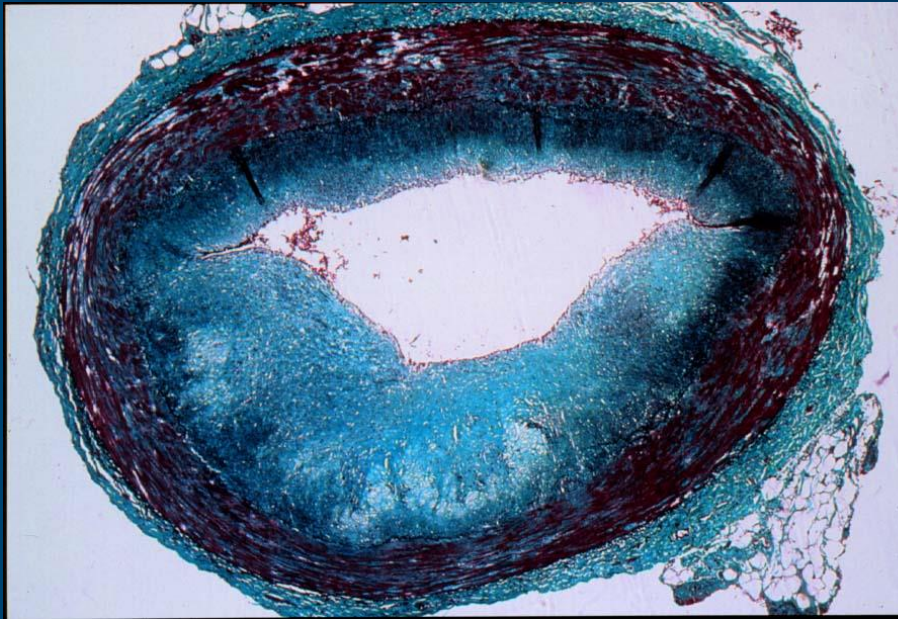
**3. Neoatherosclerosis inside Stents**



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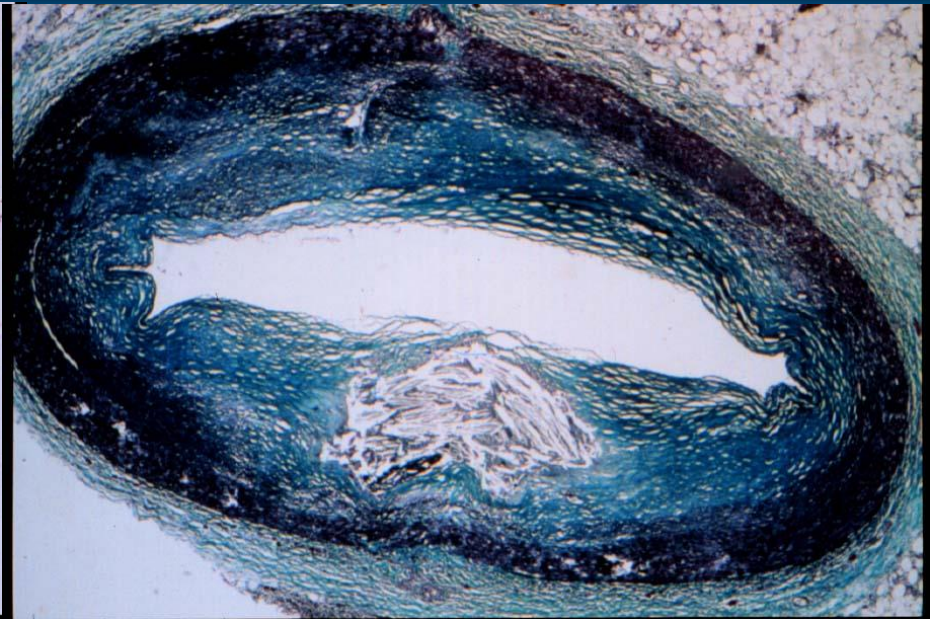
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# Stable vs Vulnerable Plaque



## Stable Plaque

- Low lipid conc.
- Thick fibrous cap
- Low m $\phi$  density



## Vulnerable Plaque

- High lipid conc.
- Thin fibrous cap
- High m $\phi$  density



# Ex Vivo Study Results

Fibrous	SENS	<b>.87</b>	PPV	<b>.88</b>
	SPEC	<b>.97</b>	NPV	<b>.96</b>
Calcific	SENS	<b>.95</b>	PPV	<b>1.0</b>
	SPEC	<b>1.0</b>	NPV	<b>.95</b>
Lipid pool	SENS	<b>.92</b>	PPV	<b>.81</b>
	SPEC	<b>.94</b>	NPV	<b>.97</b>

Interobserver  $k = 0.88$ , Intraobserver  $k = 0.91$

Yabushita, .. Jang, Bouma, Tearney. Circulation 2002

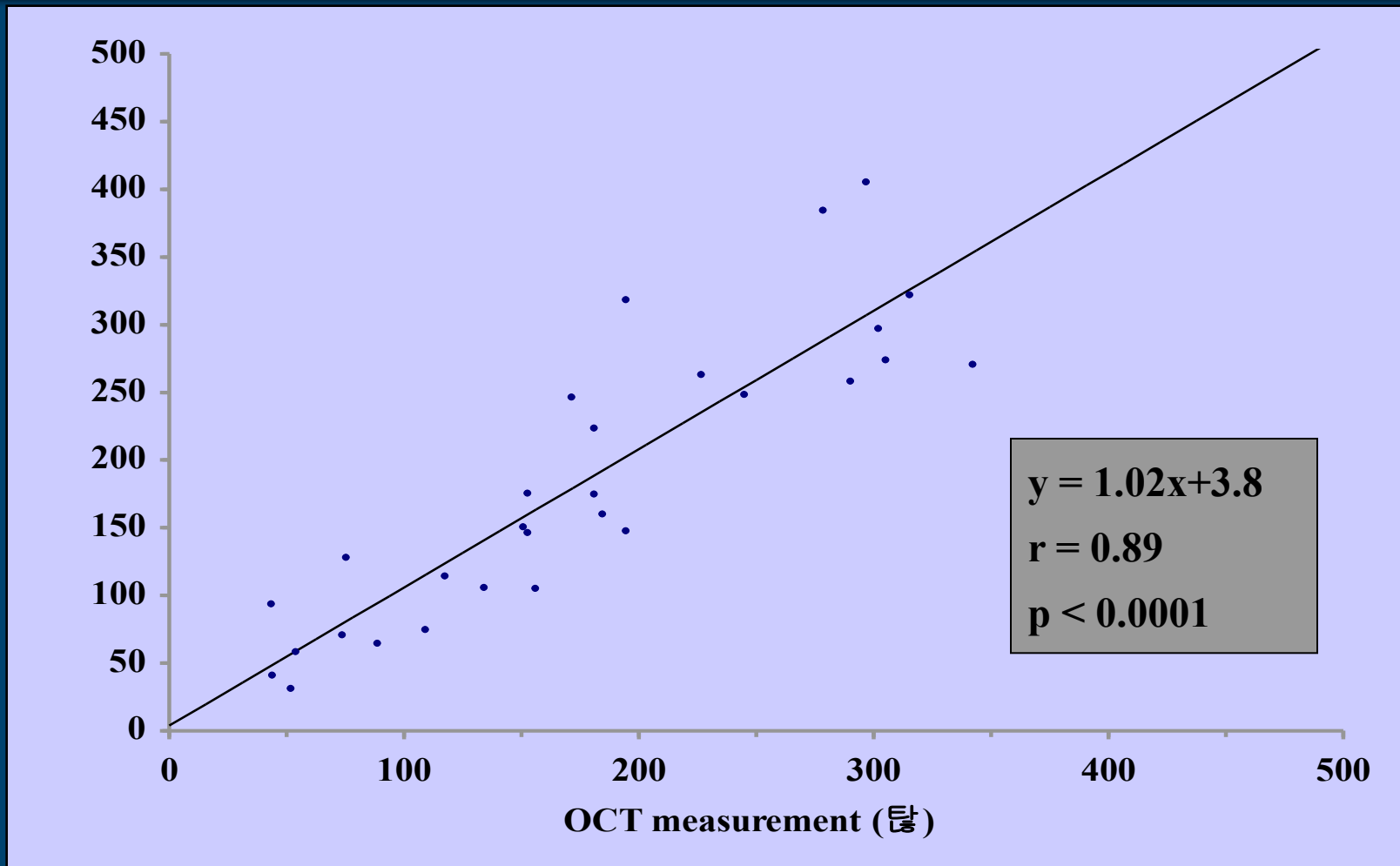


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# Fibrous cap thickness

## Correlation between OCT and histology





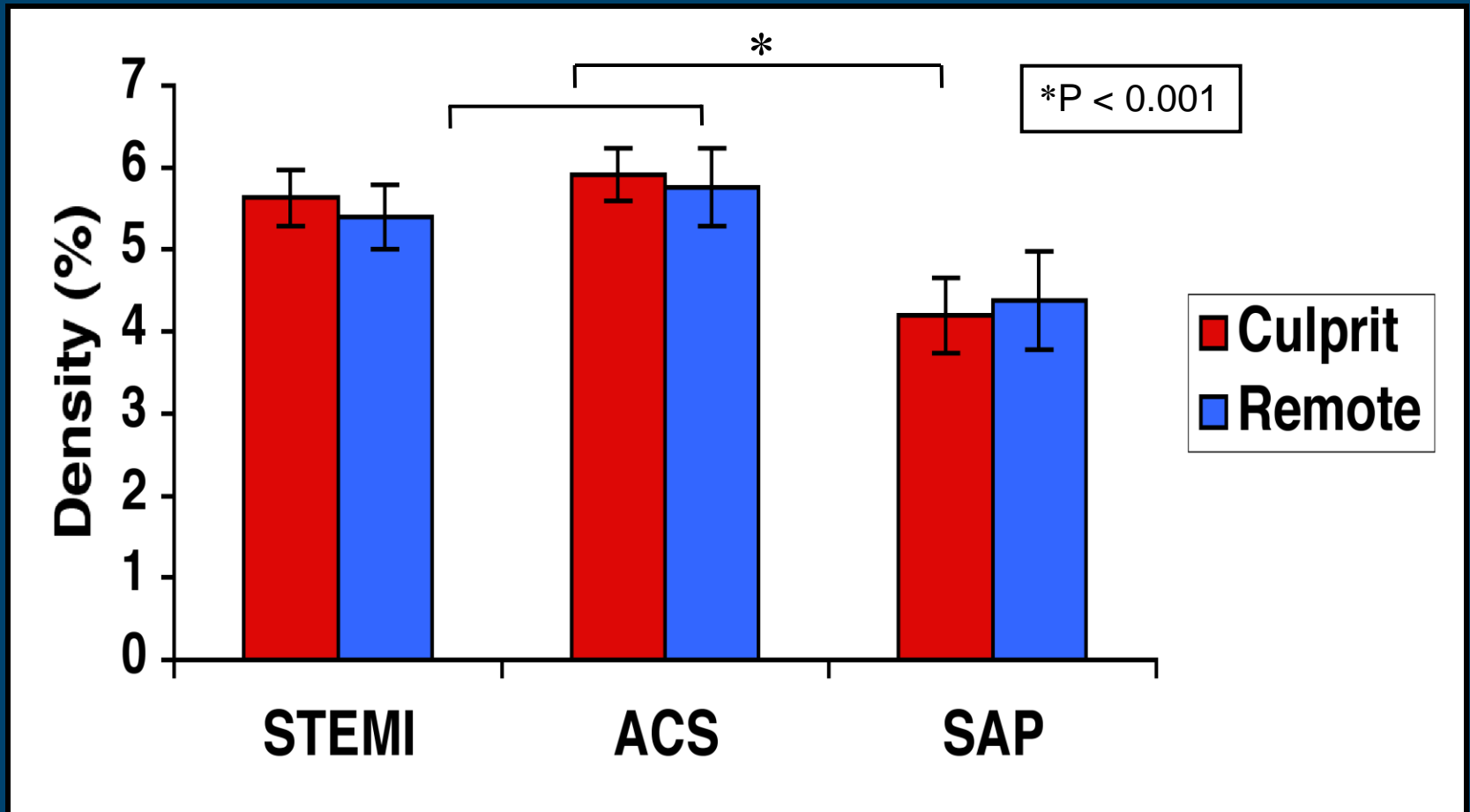


# AMI v ACS v SAP

	AMI (n=20/30/35)	ACS (n=20/24/--)	SAP (n=17/31/20)
LRP (%)	<b>90/93/--</b>	<b>75/71/--</b>	<b>58/42/--</b>
FCT (µm)	<b>47/49/--</b>	<b>54/79/--</b>	<b>103/196/--</b>
TCFA (%)	<b>72/83/77</b>	<b>50/46/--</b>	<b>20/3/25</b>

Jang(2005)/Akasaka (2007,8)/Fujii(2008)

# Macrophage Density



# OCT

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# Systemic Inflammation

- ~ Local Inflammation
- ~ Plaque Characteristics



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# Aim of the study

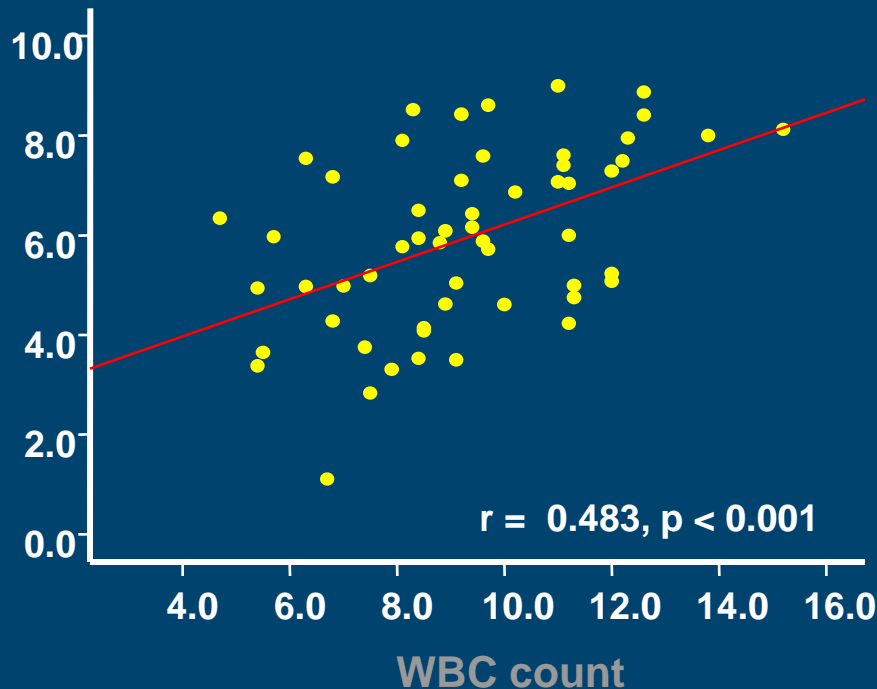
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- Evaluate the relationships between the peripheral WBC count, local plaque fibrous cap macrophage density, and the plaque characteristics including TCFA identified by OCT

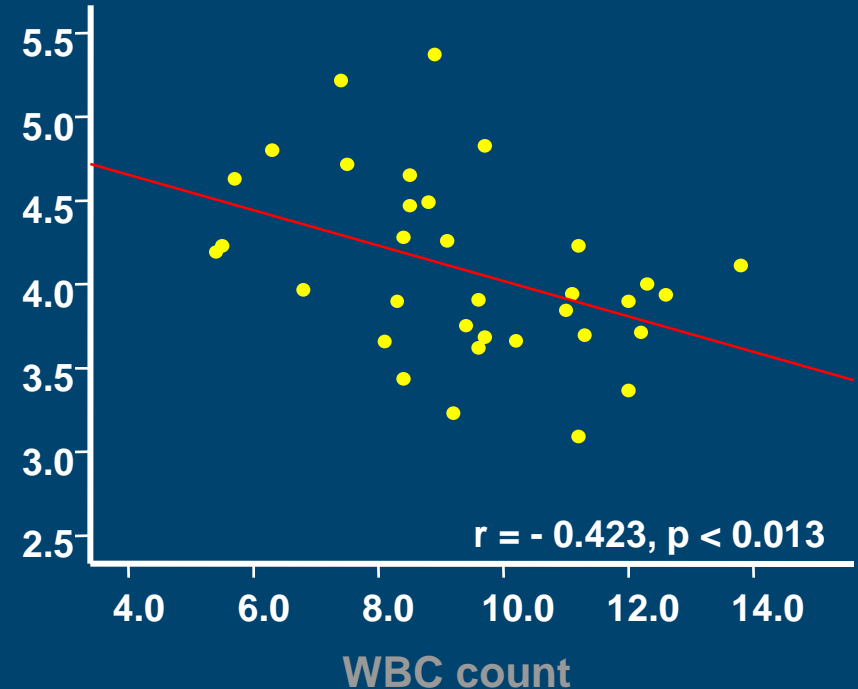


# Correlation of WBC count with Macrophage Density and Fibrous Cap Thickness

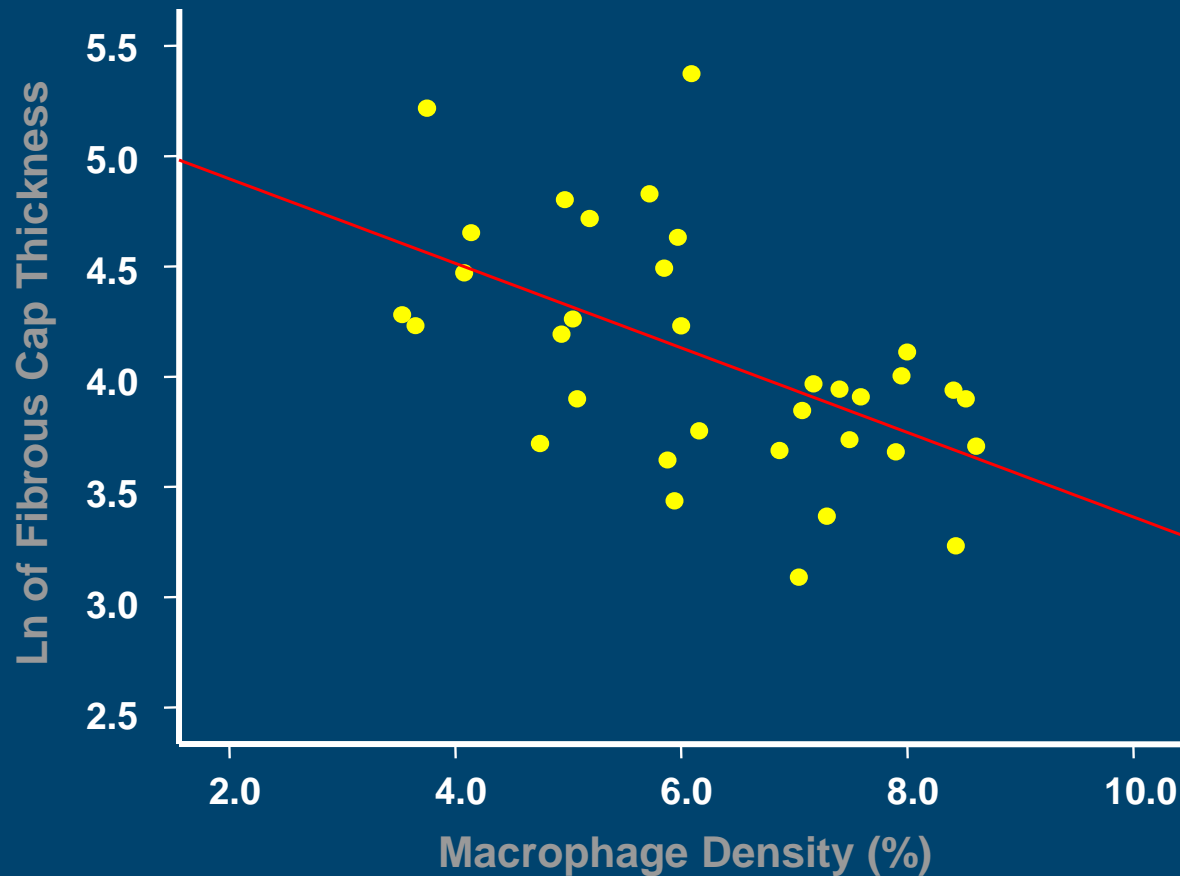
Macrophage Density (%)



Fibrous Cap Thickness (Ln)



# Association Between Macrophage Density and Fibrous Cap Thickness

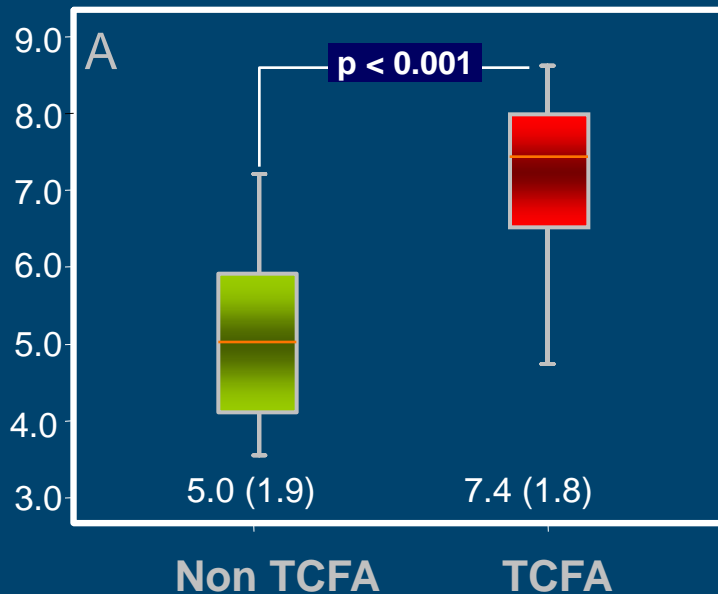


Raffel, Jang. ATVB 2007.

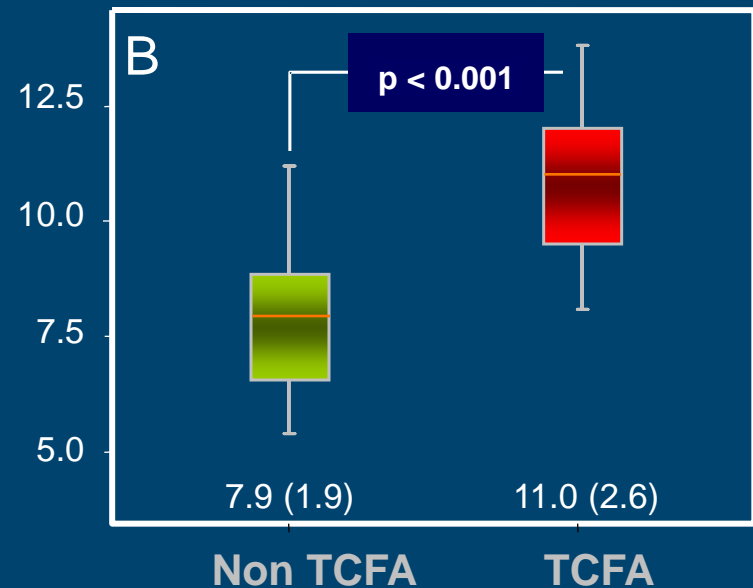


# Macrophage Density and the WBC Count: Non TCFA vs TCFA

Macrophage Density (%)



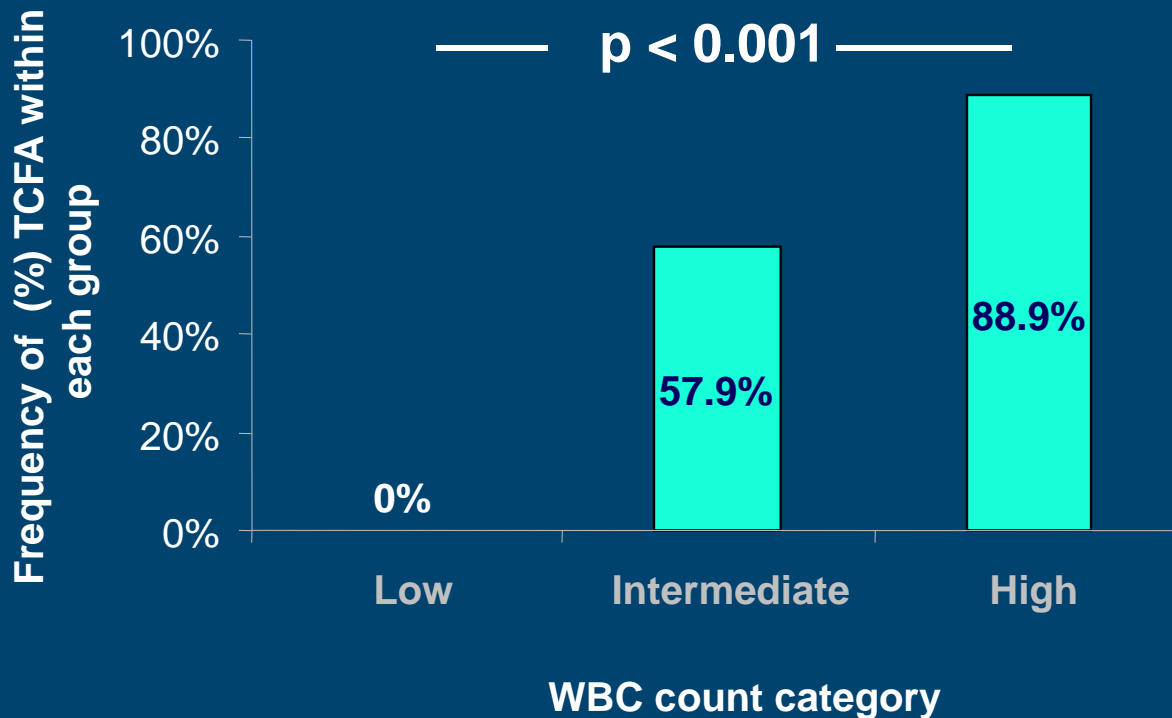
WBC count



Values are median (interquartile range)



# Frequency of TCFA in relation to baseline WBC count categories





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# Vascular Remodeling ~ Plaque Characteristics



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# Aim of the study

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- Evaluate the association between coronary artery remodeling assessed by IVUS and underlying plaque characteristics identified by OCT

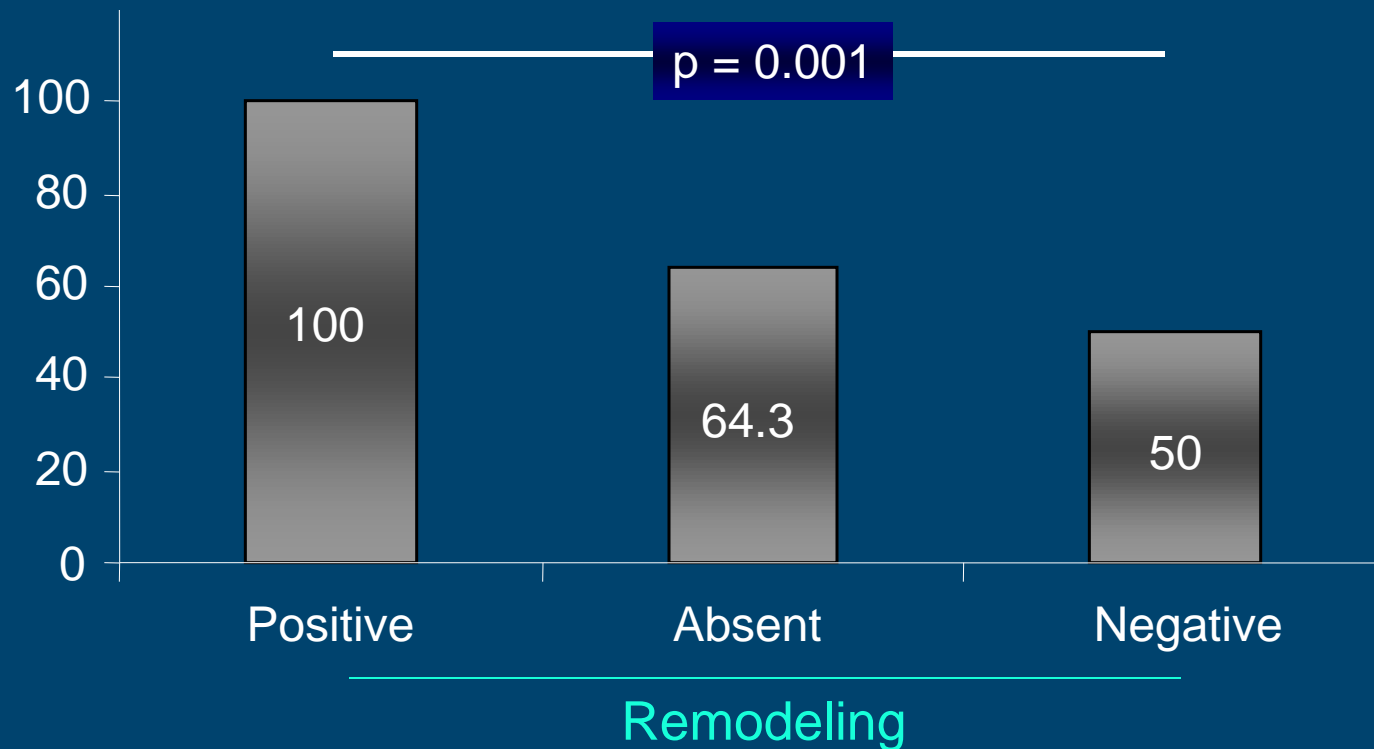


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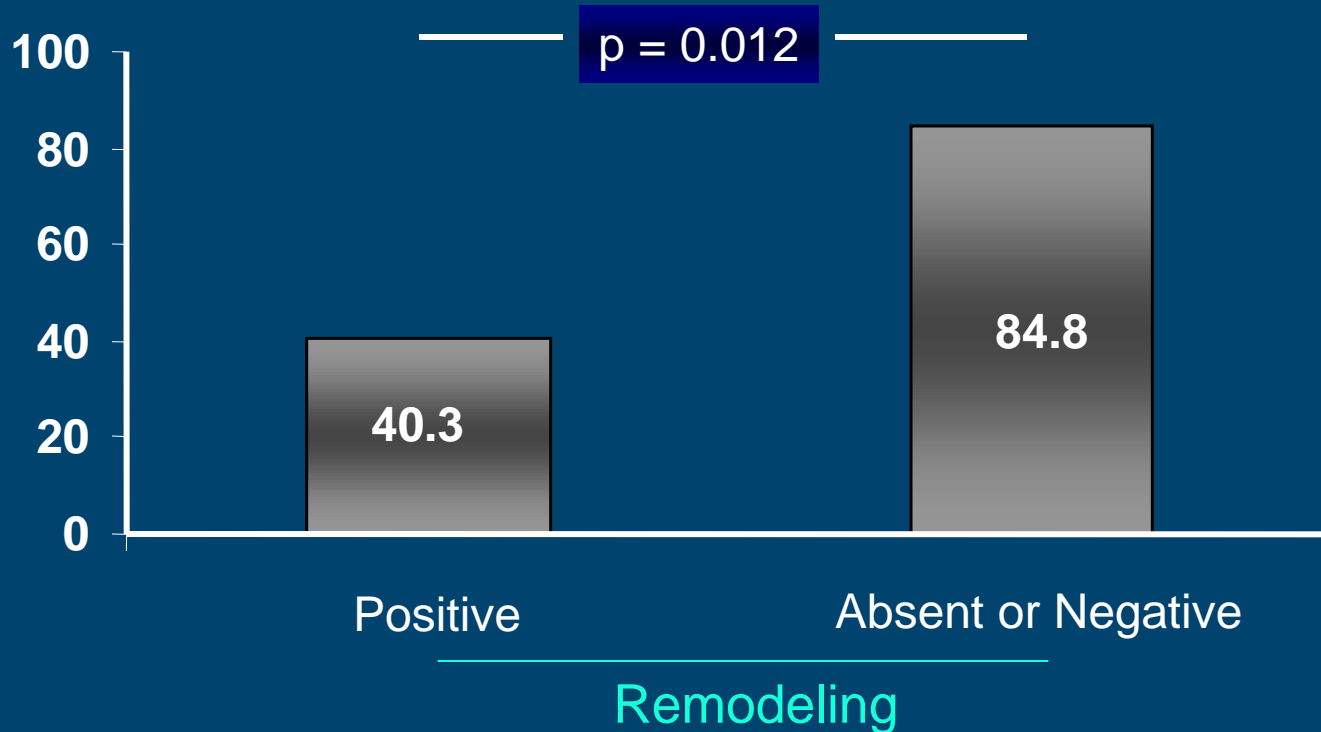
# Association between type of remodeling and frequency of Lipid Rich Plaque

% of Lipid Rich Plaque within each group



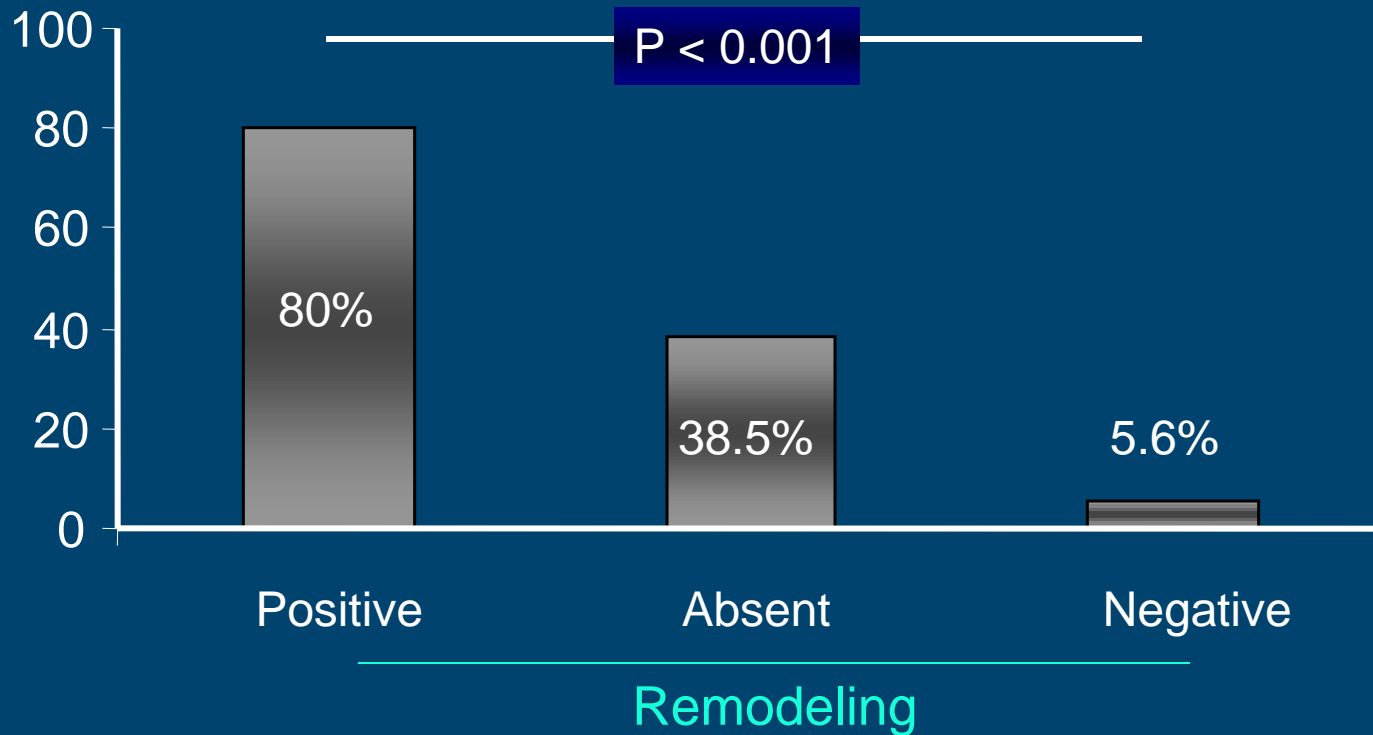
# Association Between Remodeling and Underlying Plaque Fibrous Cap thickness

Fibrous Cap Thickness (Median,  $\mu\text{m}$ )

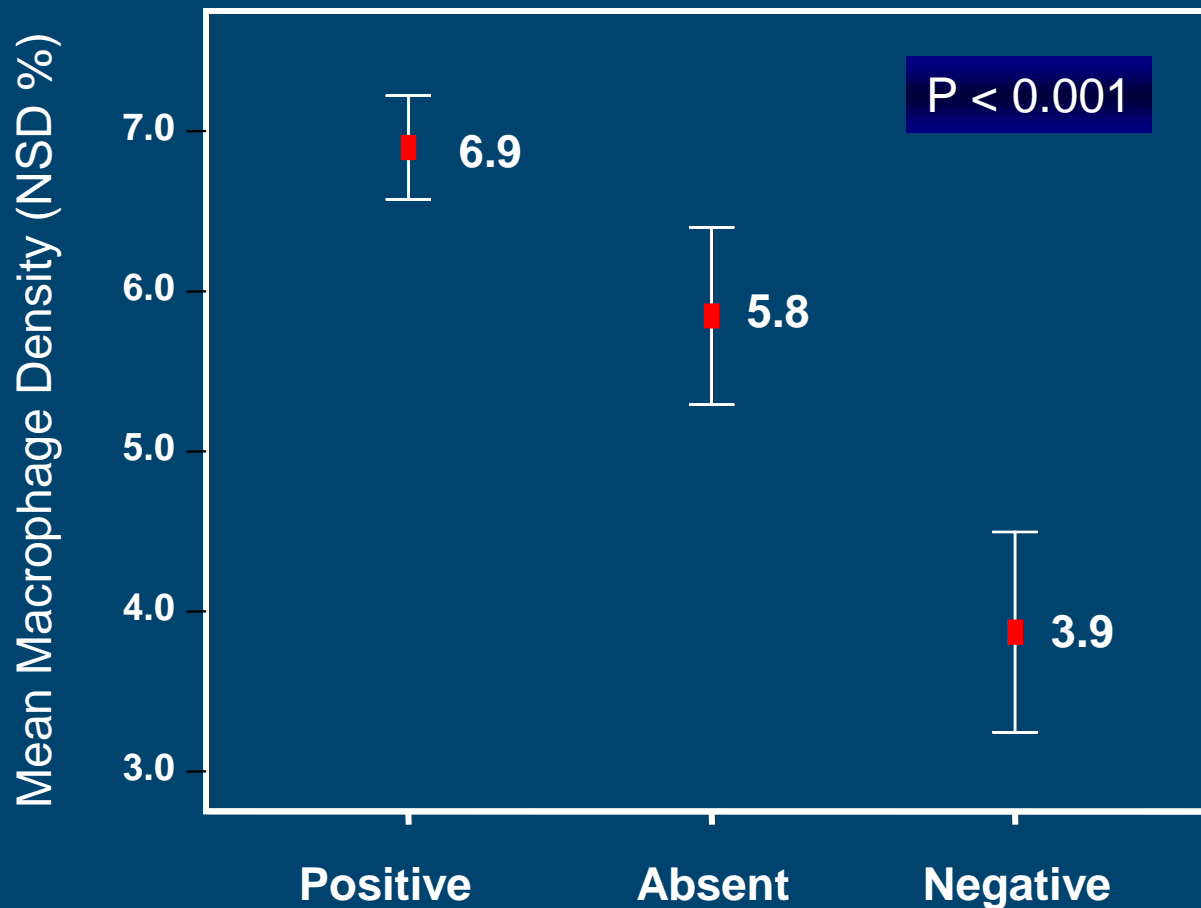


# Remodeling and TCFA: Association between type of remodeling and frequency of TCFA

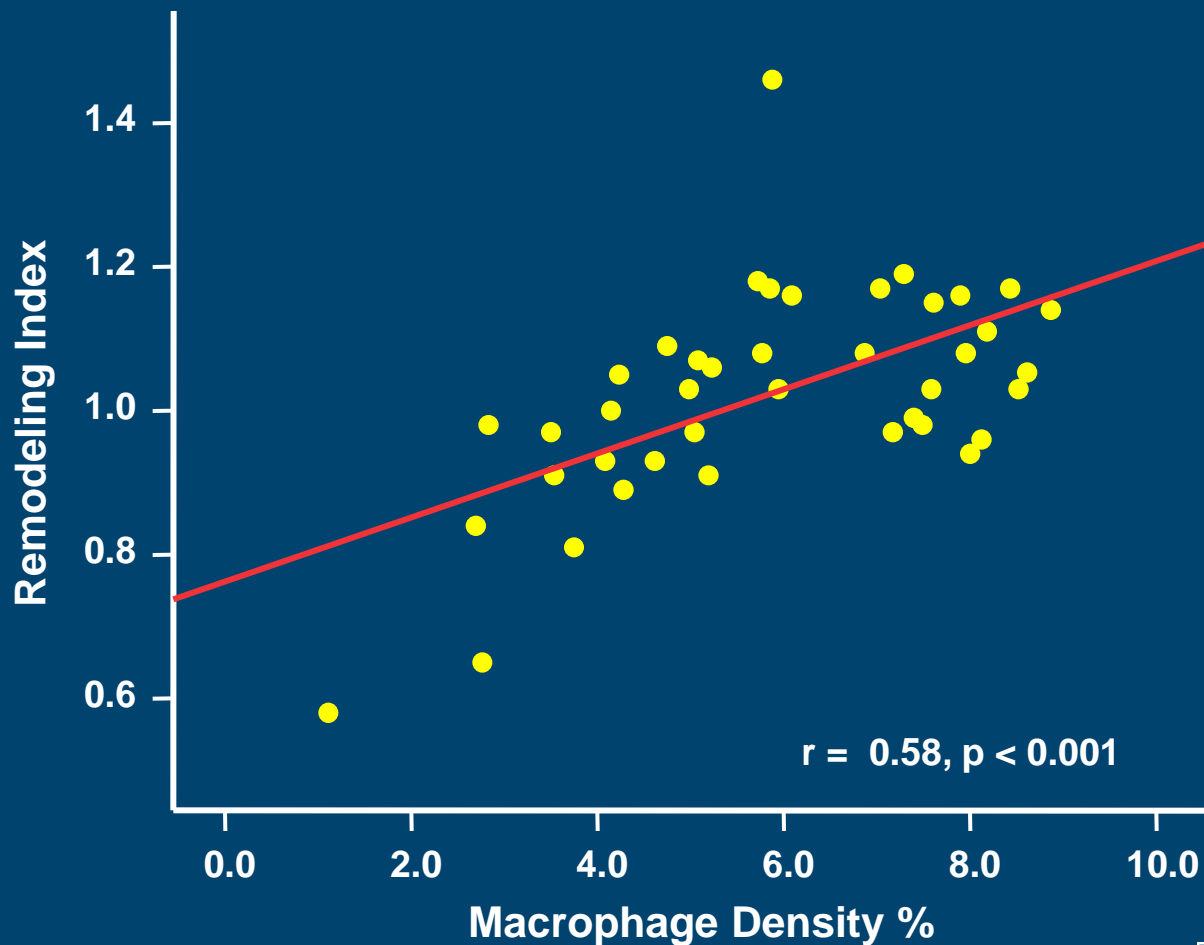
% of TCFA within each group



# Association Between Remodeling and Underlying Plaque Macrophage Density



# Correlation Between Remodeling Index and Macrophage Density



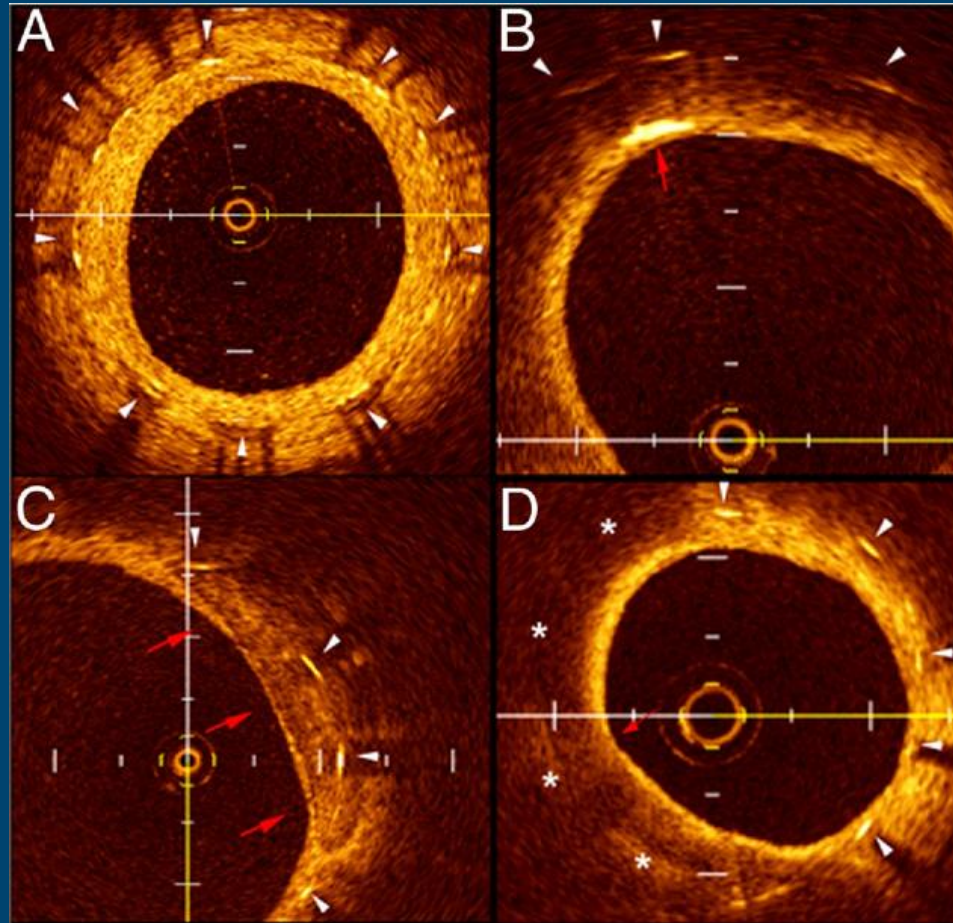


# OCT

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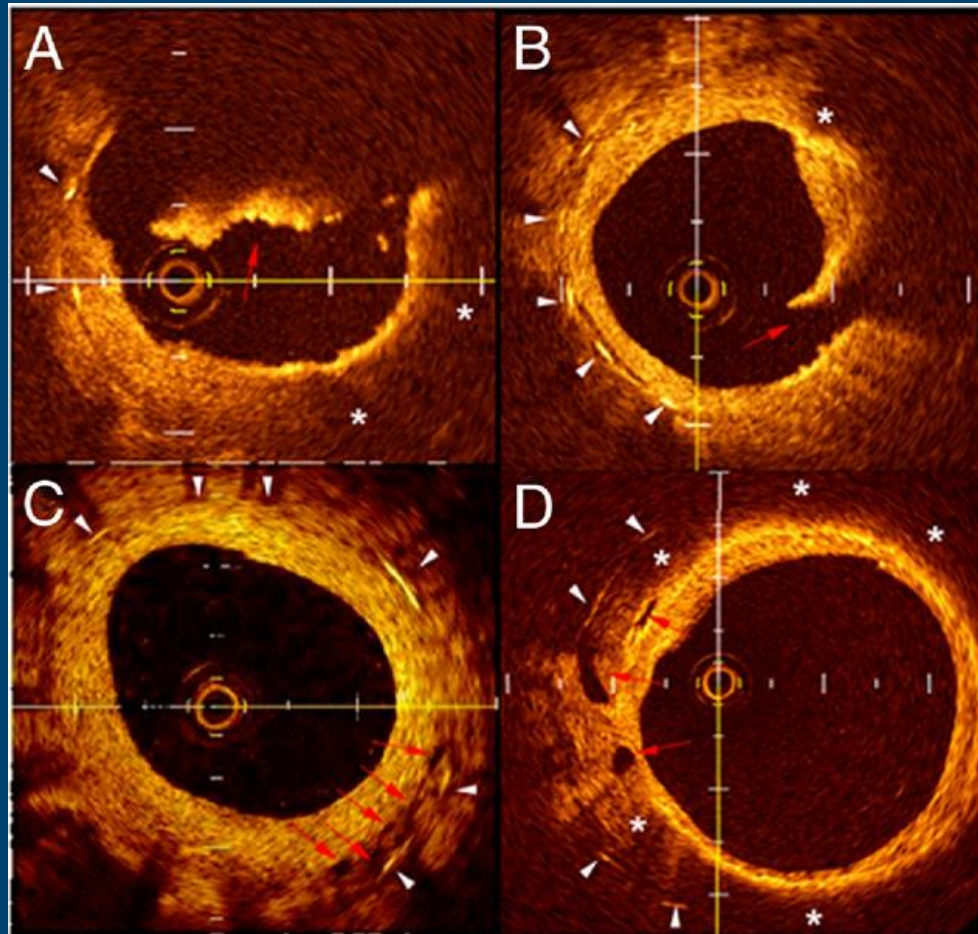
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# Late changes of Neointima: BMS



Takano, Mizuno. JACC 2010

# Late changes of Neointima: BMS



# OCT for Neointima inside BMS

	< 6 mo (n=20)	> 5 yrs (n=21)	
Lipid laden intima	0	67%	< 0.05
Intimal disruption	0	38%	< 0.05
Thrombus	5%	25%	< 0.05
Intraintimal neovascularization	0	62%	0.01

# Development of LRP inside BMS

- 20/60 stents (33%), 16/39 patients (41%)
- Fibrous cap thickness:  $56.7 \pm 5.8 \mu\text{m}$
- Lipid arc:  $173 \pm 57.7^\circ$
- Plaque disruption: 6/20 (30%)
- Thrombus: 1/20 (5%)
- Macrophage: 7/20 (35%)
- Hypertension and smoking were associated with development of lipid-rich plaque.



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# Characterization of Neointima inside SES using Quantitative Tissue Property Analysis Program

Collaboration between  
Harbin Medical University and  
Massachusetts General Hospital



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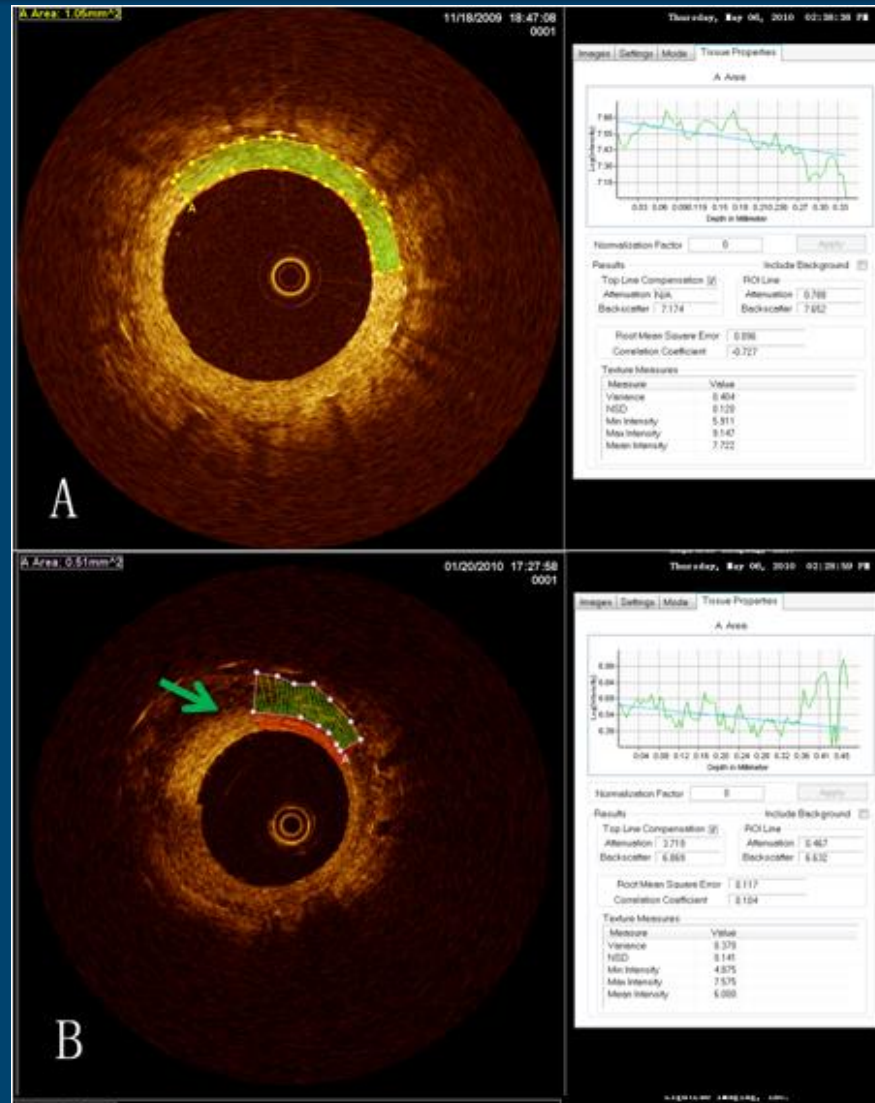
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# Aims of the study

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- To evaluate the nature of neointima tissue inside SES
- To compare the evolution of tissue property over time
- To identify associated vascular changes

# Tissue Property Analysis



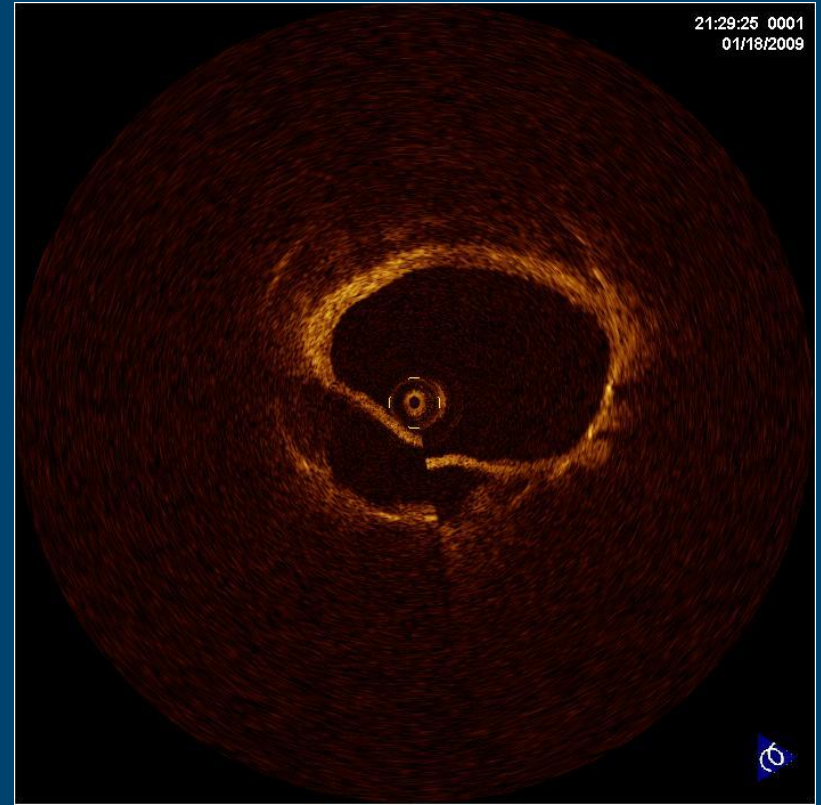
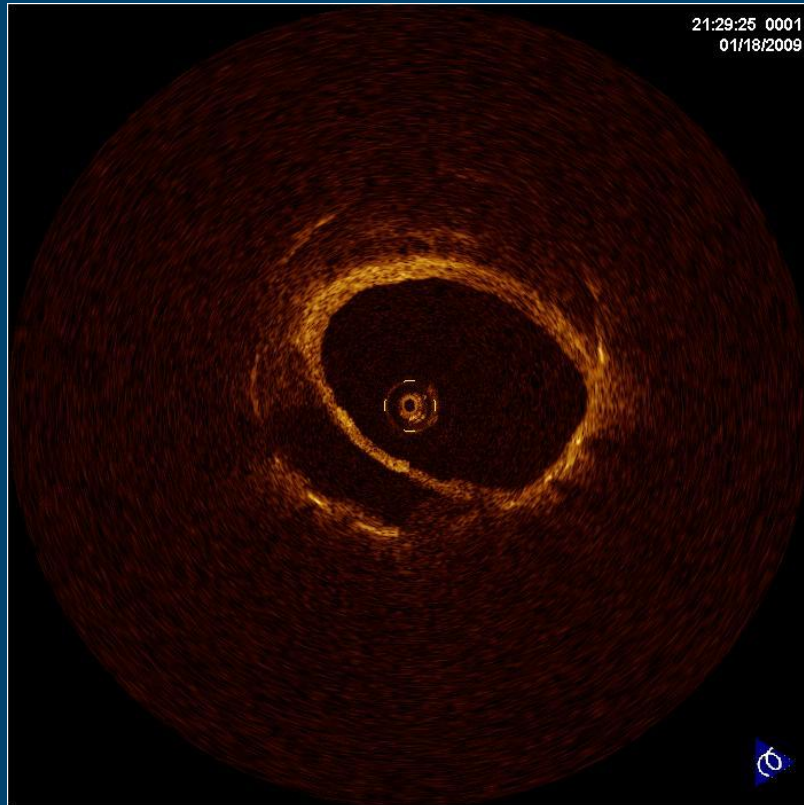


# Results

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- 136 SES in 96 patients:
  - Group 1: < 24 mo (98 stents in 71 pts)
  - Group 2: > 24 mo (35 stents in 25 pts)
- Group 2 had higher incidence of
  - Lipid plaque
  - Microchannels
  - Heterogenous neointima

# VP inside SES



# Conclusion

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- Neointima characteristics change over time after SES.
- The incidence of heterogenous neointima was higher in the longer f/u group.
- The heterogenous group had higher incidence of angiogenesis and lipid-rich plaque.
- LRP inside SES can rupture resulting in ACS.

# Conclusion

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**OCT is a powerful tool to understand vascular biology.**



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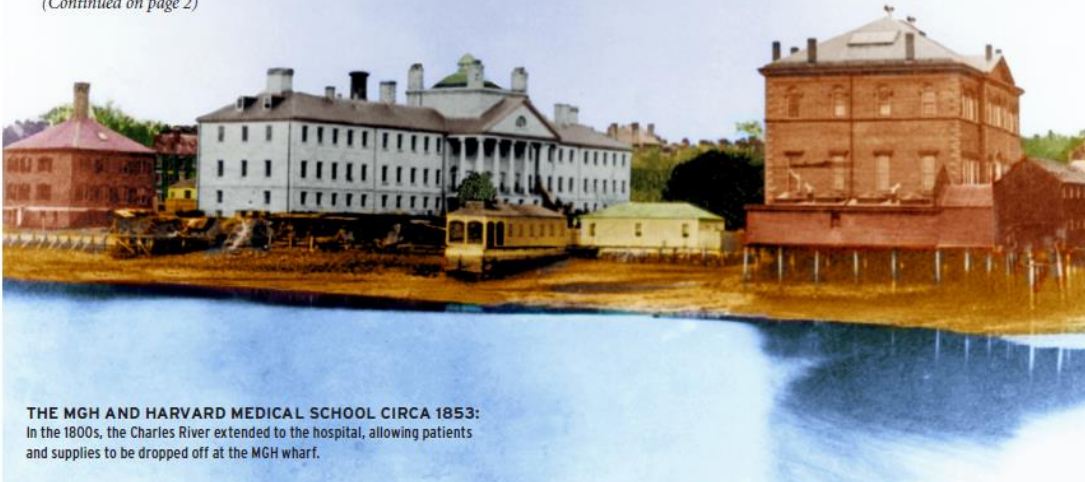
# Thank You



## *MGH history book to commemorate bicentennial*

**AS PART OF** the MGH's bicentennial celebrations, a commemorative book covering the hospital's unique beginnings and illustrious history will be published in 2011. "Something in the Ether, A Bicentennial History of Massachusetts General Hospital, 1811 to 2011," was written by author and publisher Webster Bull. Much of the content was drawn from interviews with longtime MGH staff and countless hours of research of historical records and archival material. The book is scheduled to be released in March and will be available at the MGH General Store and select booksellers.

*(Continued on page 2)*



**THE MGH AND HARVARD MEDICAL SCHOOL CIRCA 1853:**  
In the 1800s, the Charles River extended to the hospital, allowing patients and supplies to be dropped off at the MGH wharf.



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