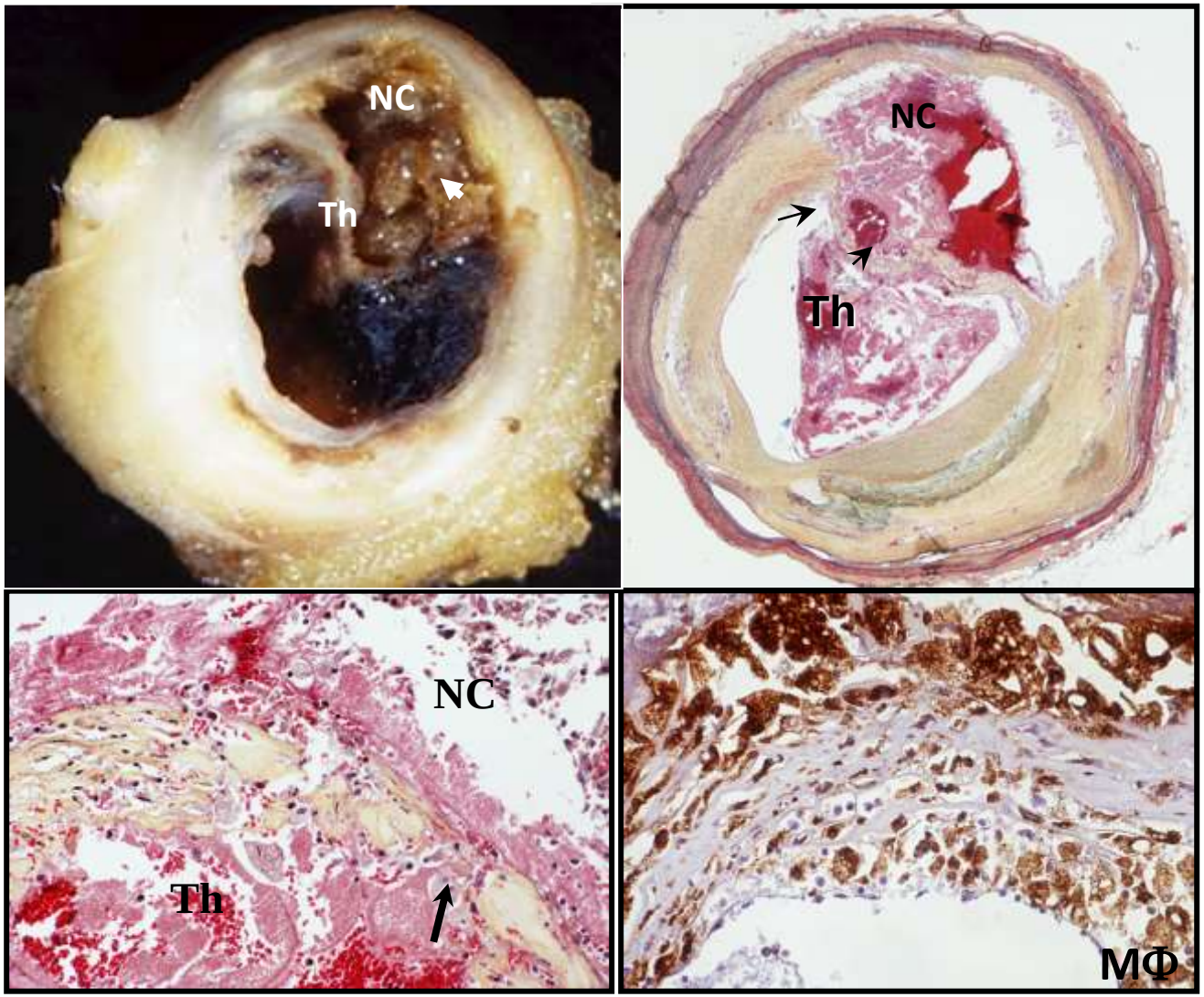
Determinants of Plaque Progression, Regression and Rupture

NAKAZAWA, G
TOKAI Univ.

Plaque Rupture



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Progression of Atherosclerosis

non-progressive → progressive

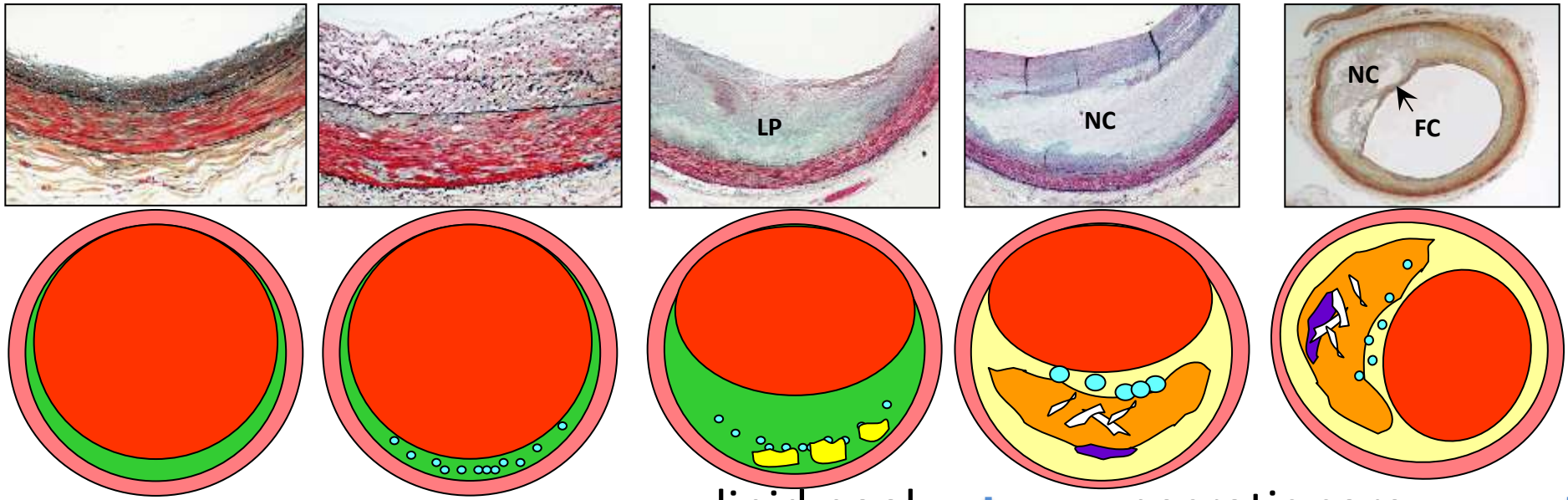
Adaptive Intimal thickening

Intimal xanthoma

Pathologic intimal thickening

Fibrous cap atheroma

Thin-cap Fibroatheroma



lipid pool

necrotic core

early → late necrosis

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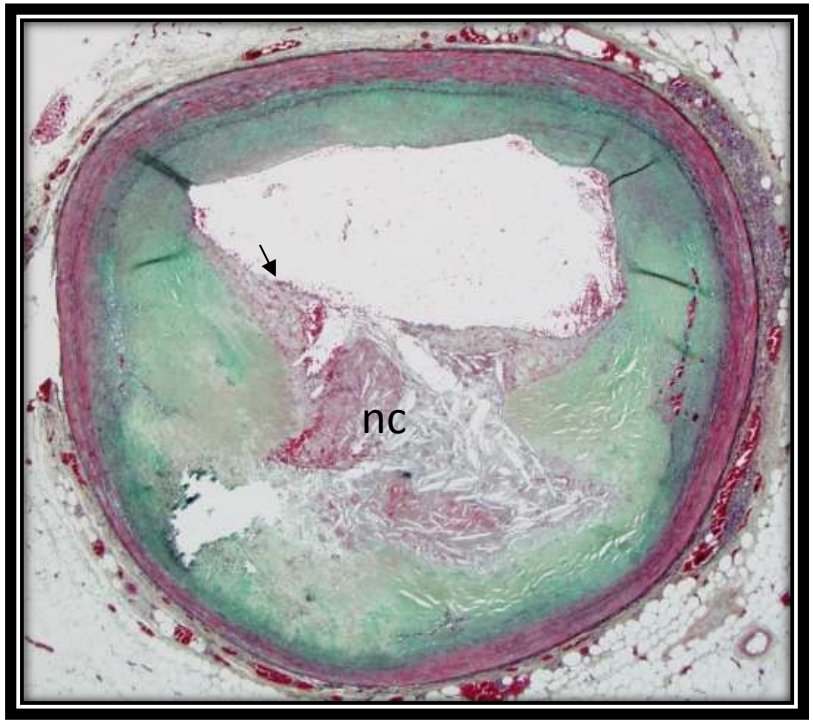
Do TCFA Go on Plaque Rupture？



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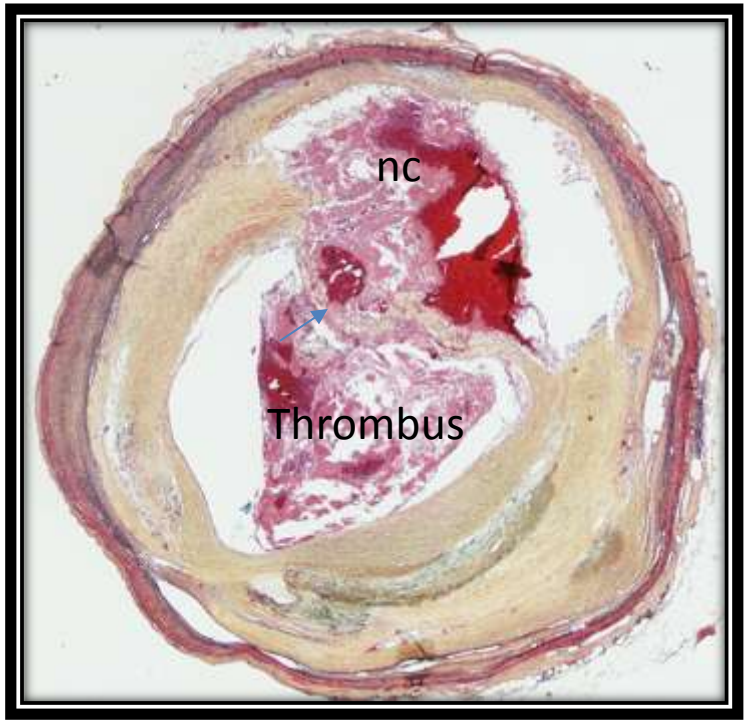


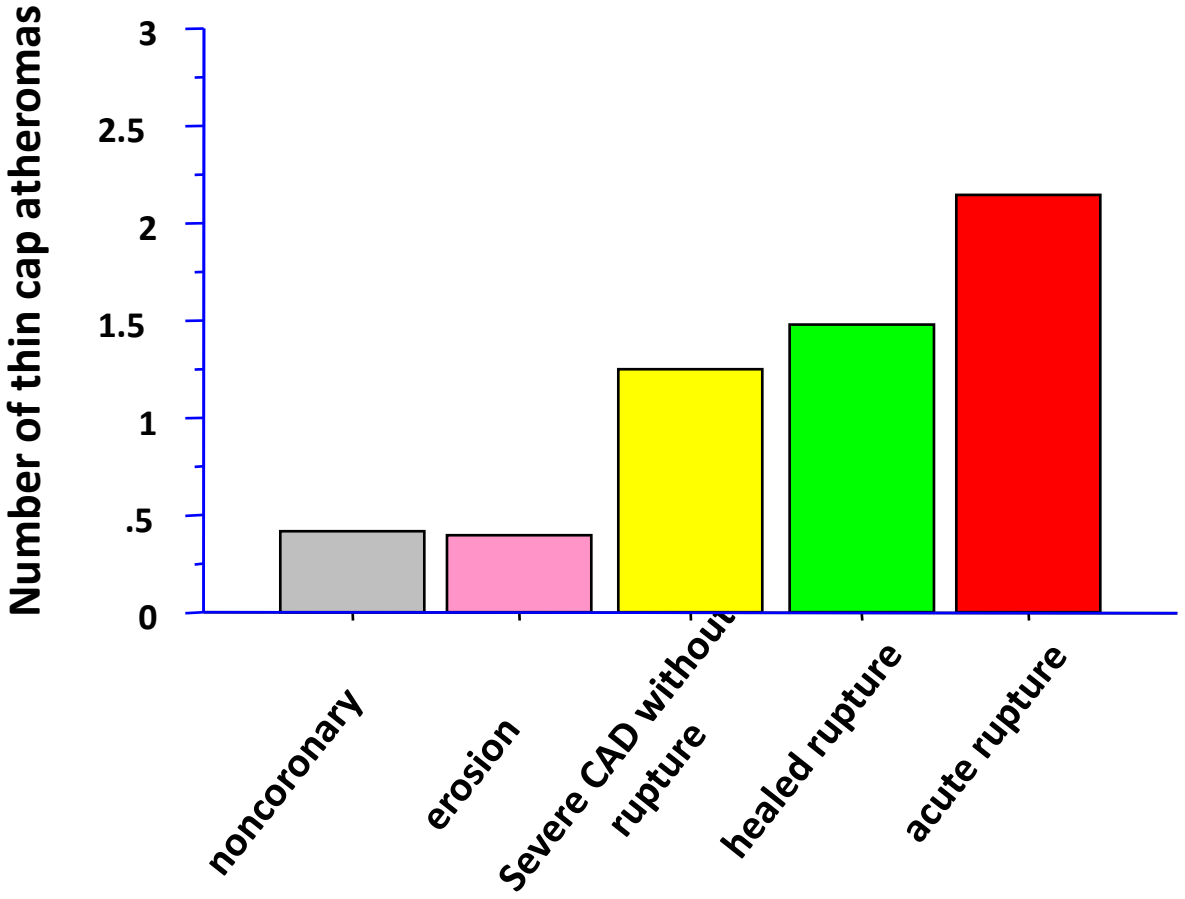
Thin cap fibroatheroma

- Necrotic core
- Thin fibrous cap (< 65 mm)
- Cap infiltrated by macrophages &lymphocytes
- Cap composition – type 1 collagen with few or absent smooth muscle cells

Plaque Rupture

- Discontinuous fibrous cap
- Underlying necrotic core
- Luminal thrombus

Number of TCFA / Heart at autopsy



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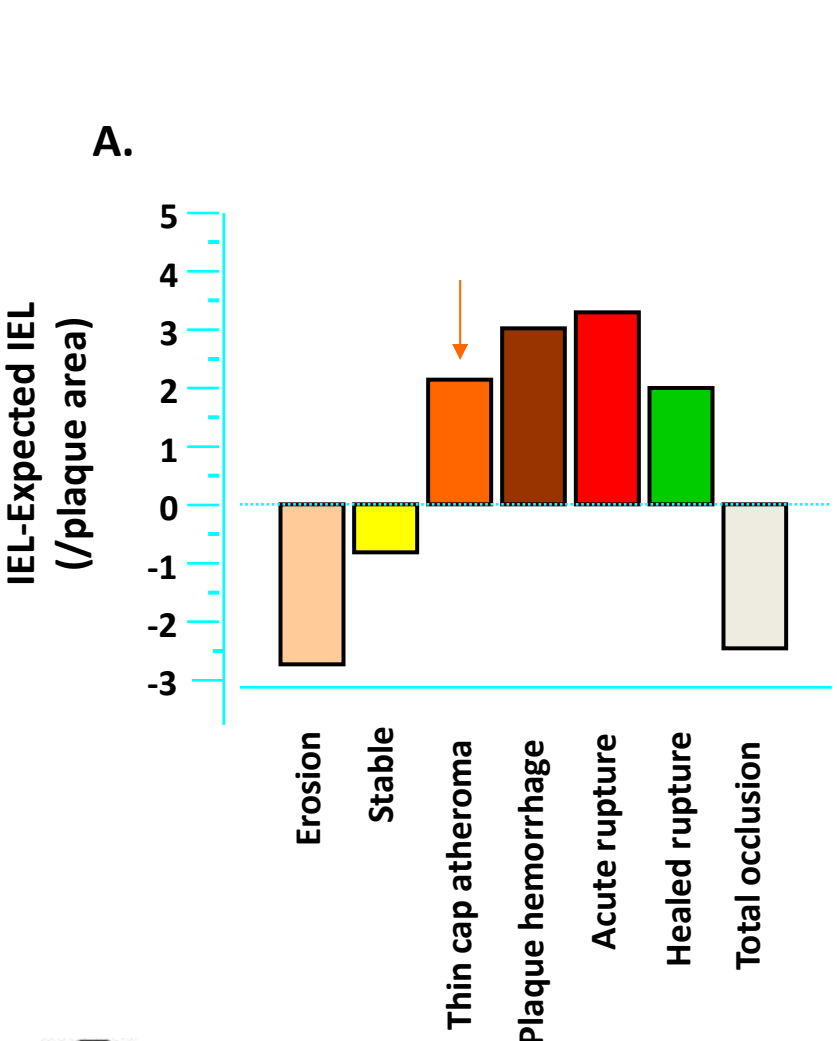
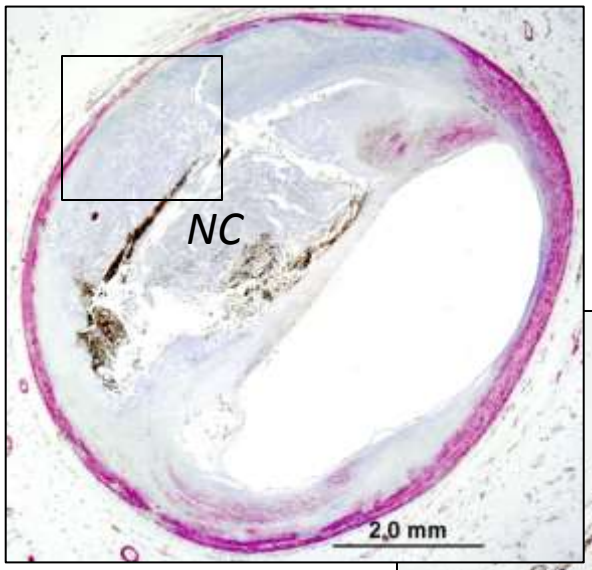
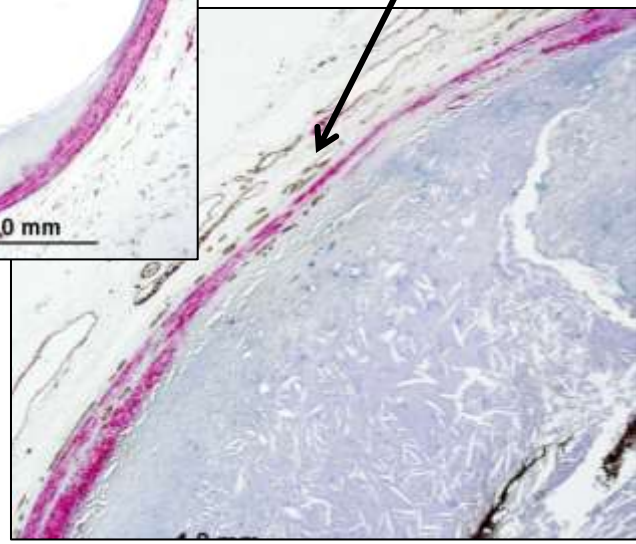
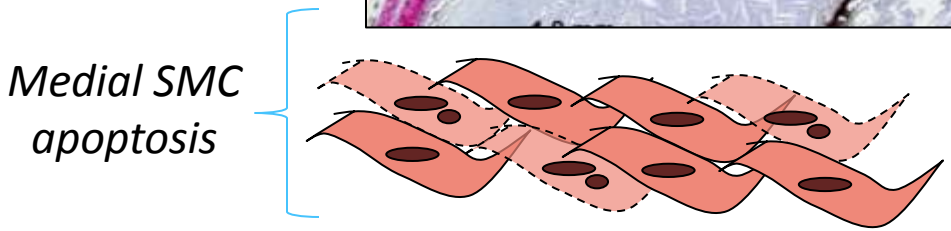
Remodeling in Varying Coronary Lesion Morphologies



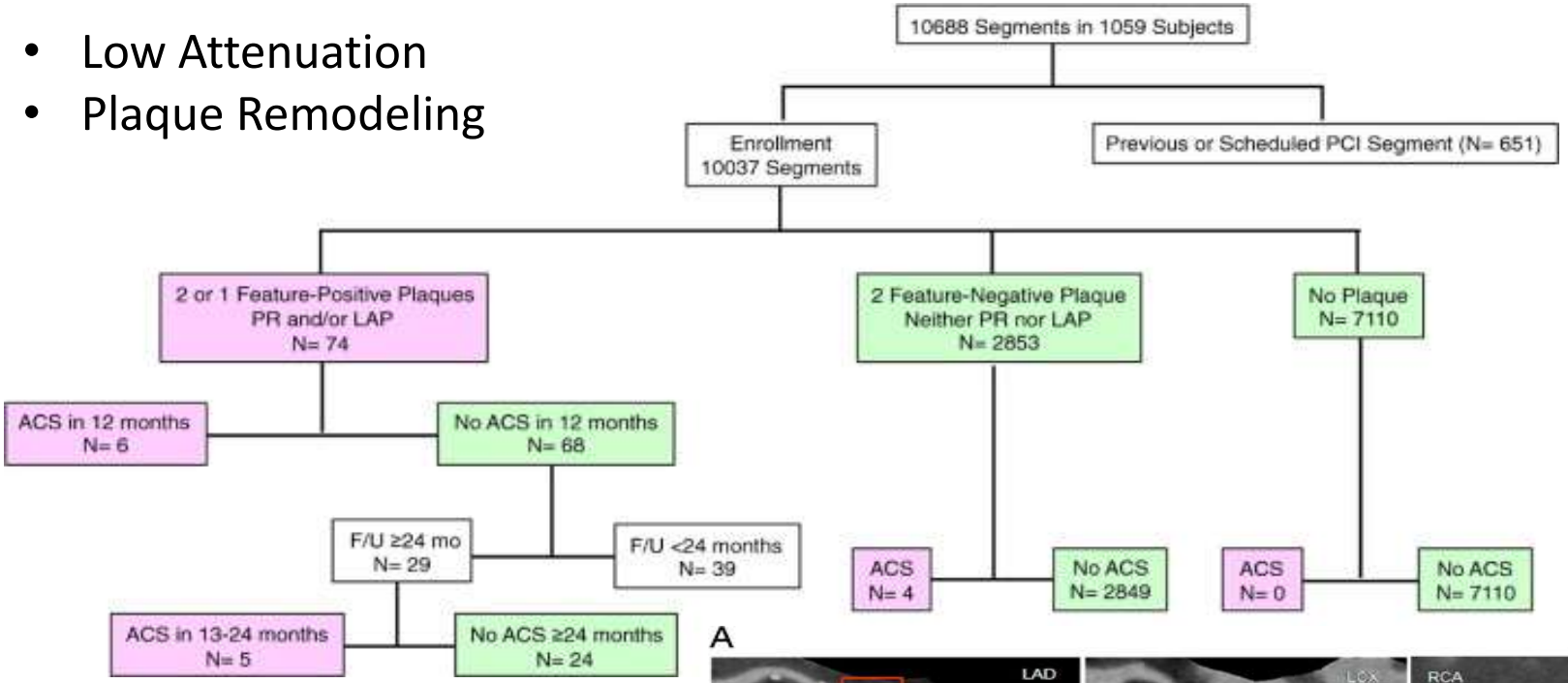


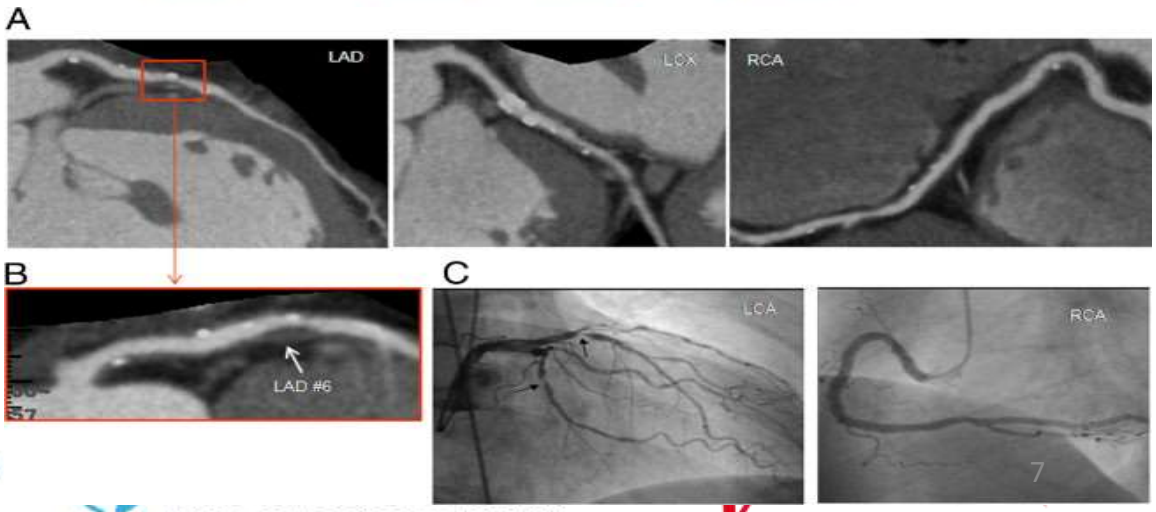




Computed Tomographic Angiography Characteristics of Atherosclerotic Plaques Subsequently Resulting in ACS

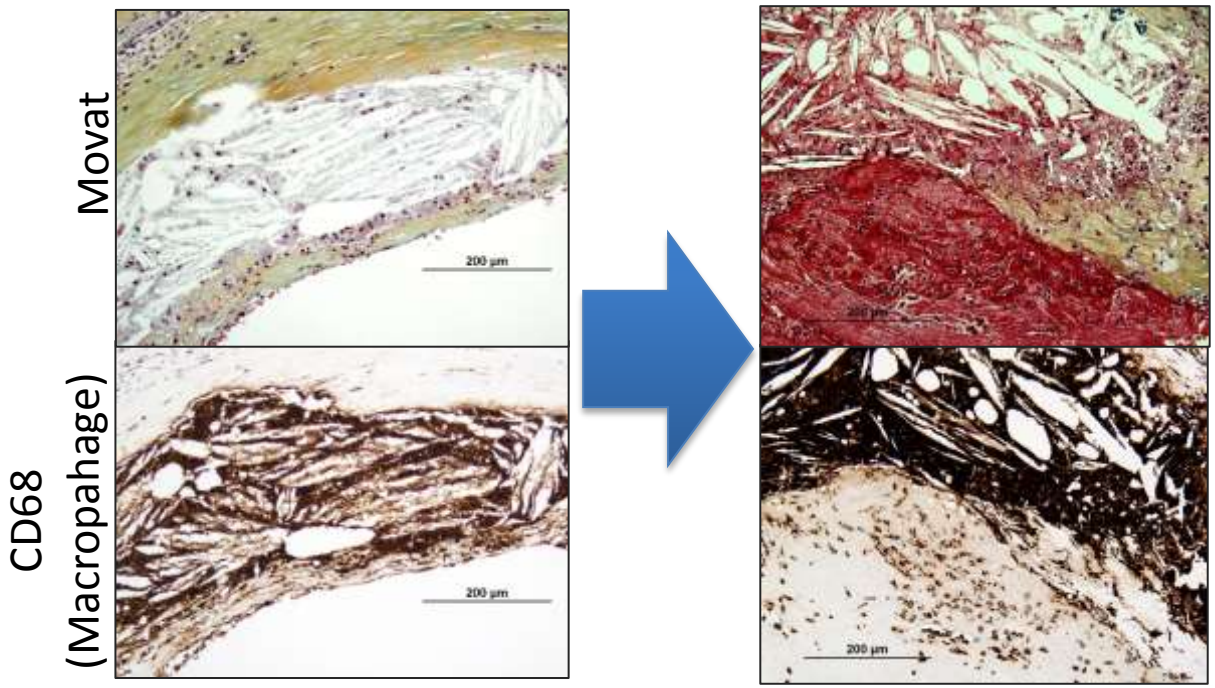
- Low Attenuation
- Plaque Remodeling





Motoyama S et al. J Am Coll Cardiol 54, (1) 2009 49 - 57

Independent risk factors for “rupture”



	P Value	Odds Ratio	95% CI
Cap thickness	0.005	0.35	0.16 – 0.69
%NC	0.02	2.0	1.1 – 3.7
%Macrophage	0.052	1.8	0.99 – 3.2

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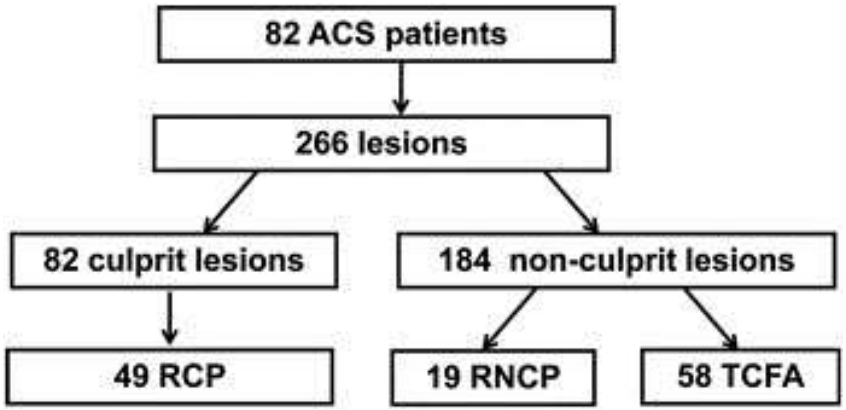
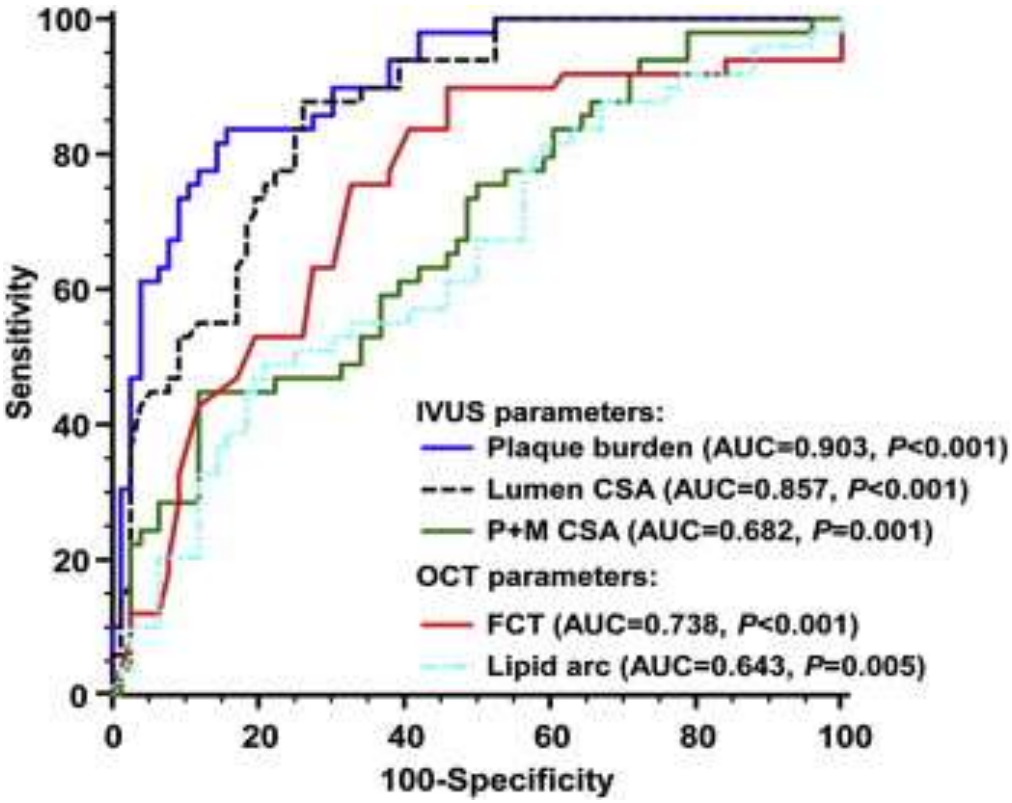
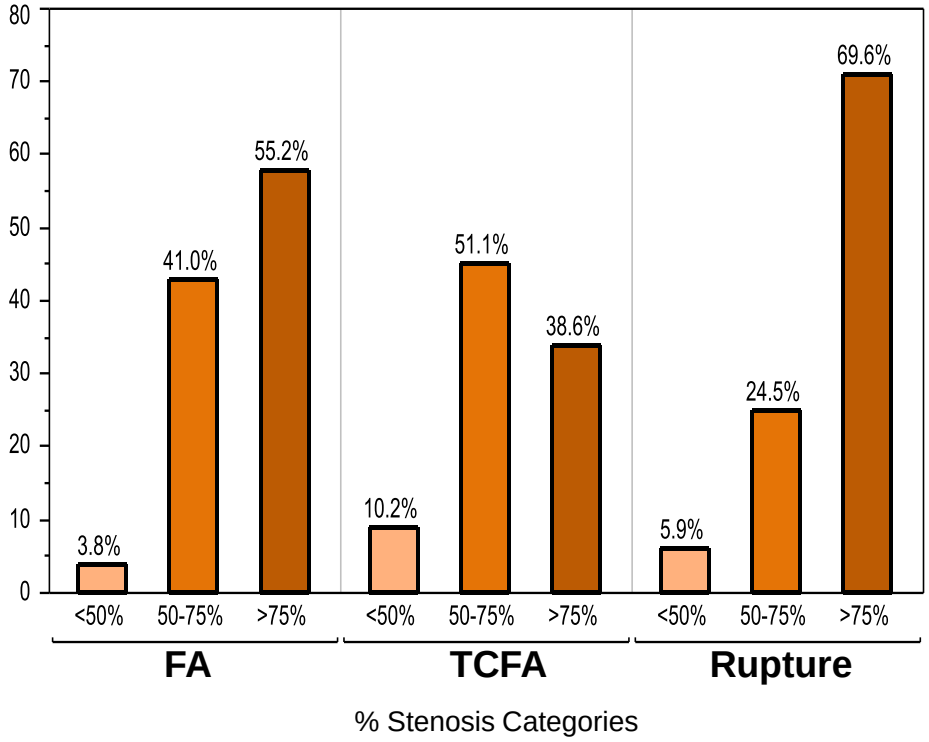
Difference between Culprit vs. Non-Culprit VP

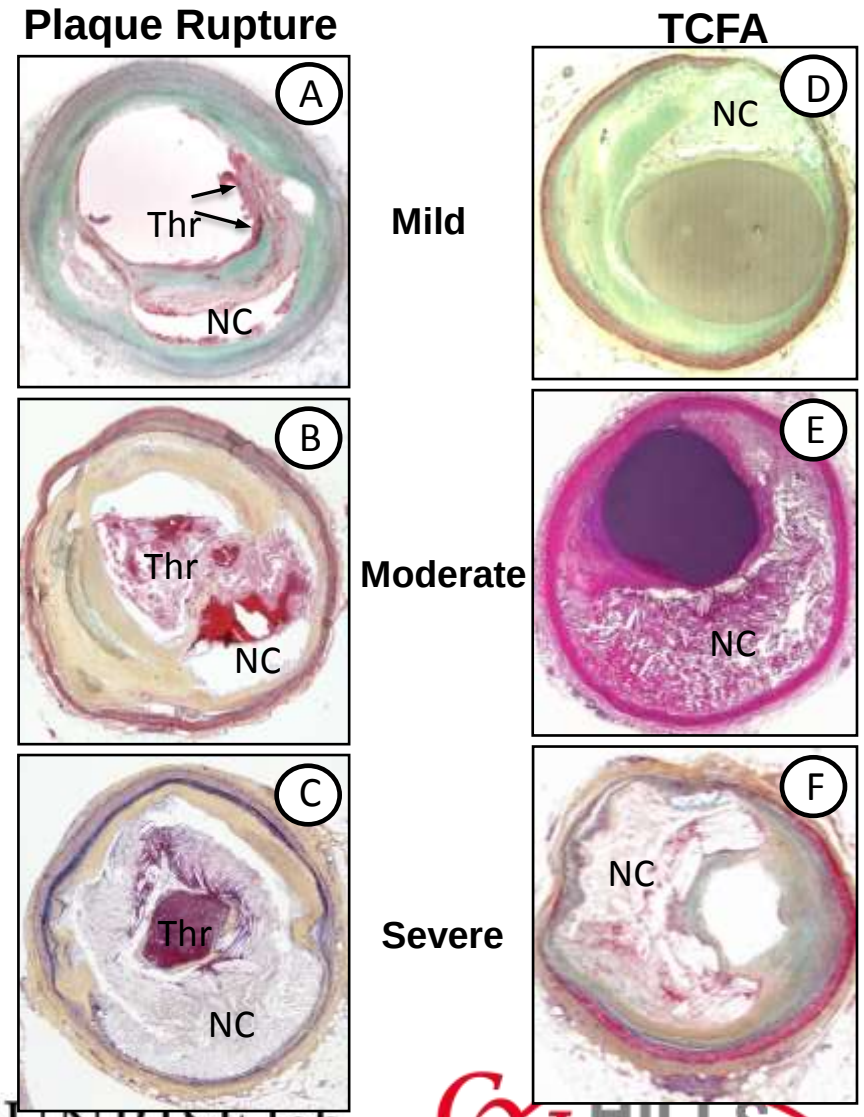




Jinwei Tian et al. JACC, Volume 63, Issue 21, 2014, 2209 - 2216

Plaque Rupture and TCFA with Varying Luminal Stenosis





Narula J, Nakano M, et al.
J Am Coll Cardiol 2013;61:1041-51.

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Rapid Necrotic expansion is definitely one of the important factors for plaque rupture!

Intraplaque Hemorrhage

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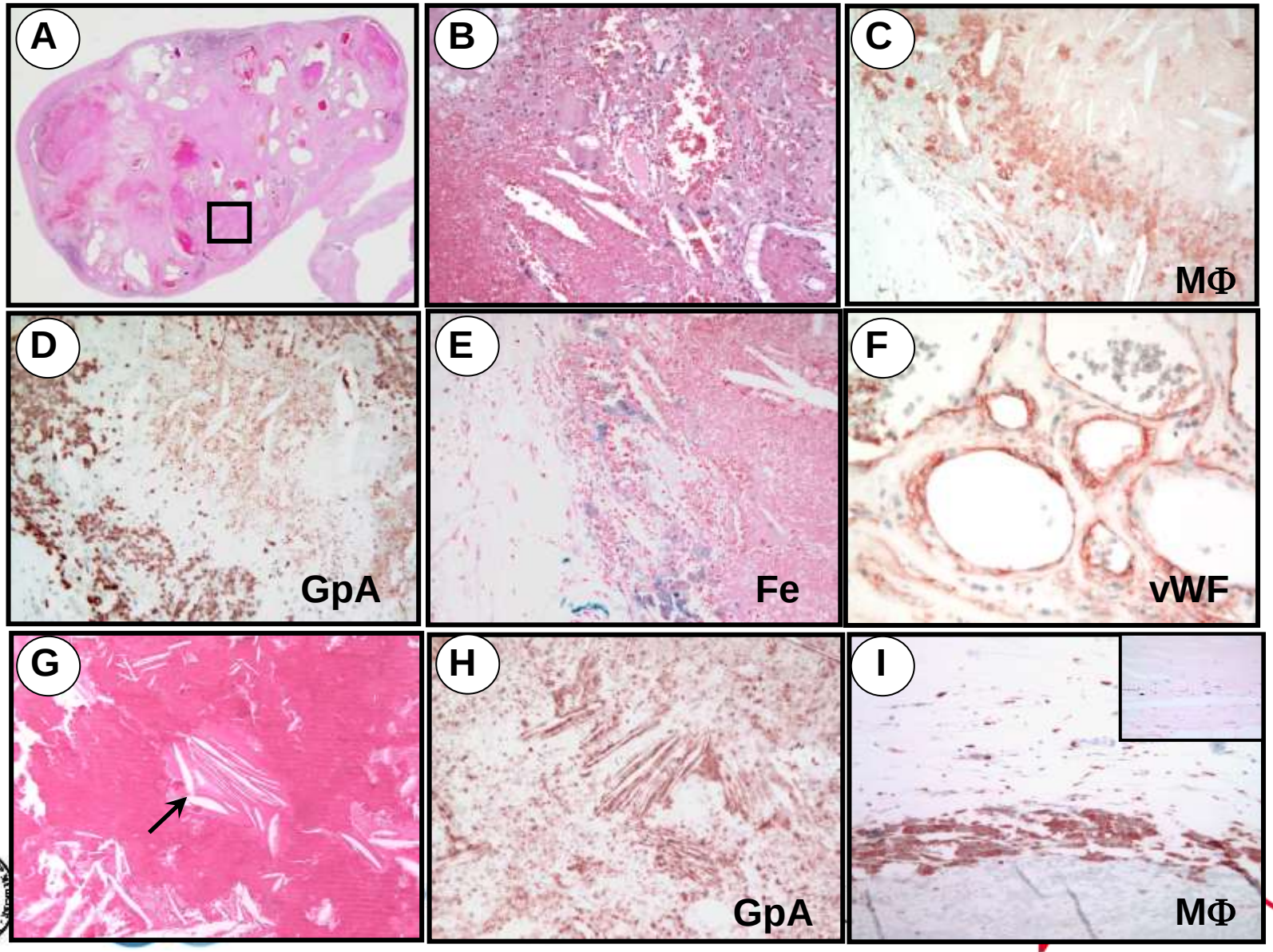
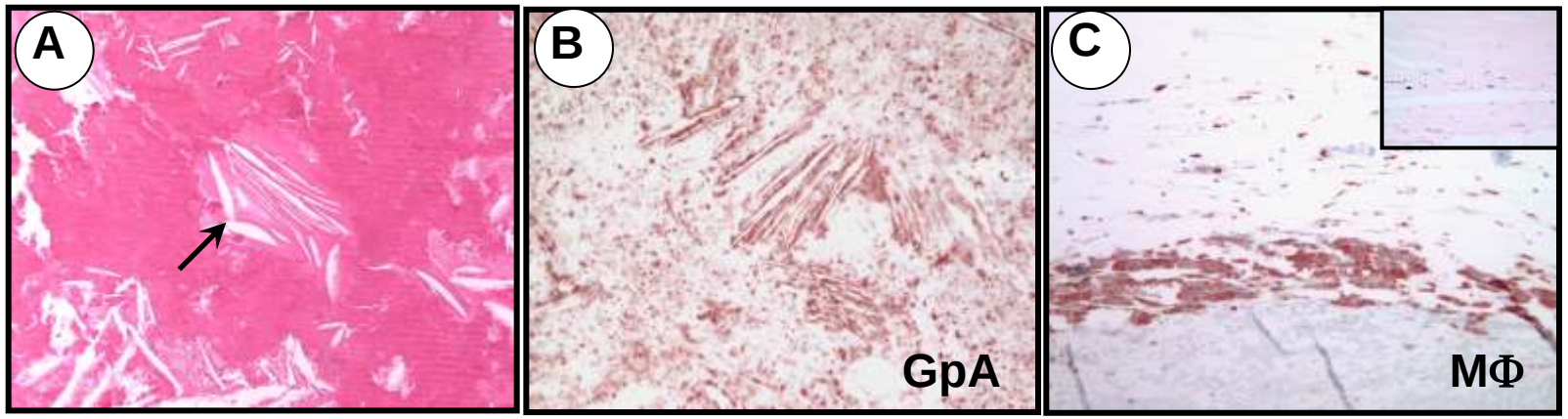
Intracardiac Hemangioma (A-F) and Hemorrhagic Pericarditis (G-I)



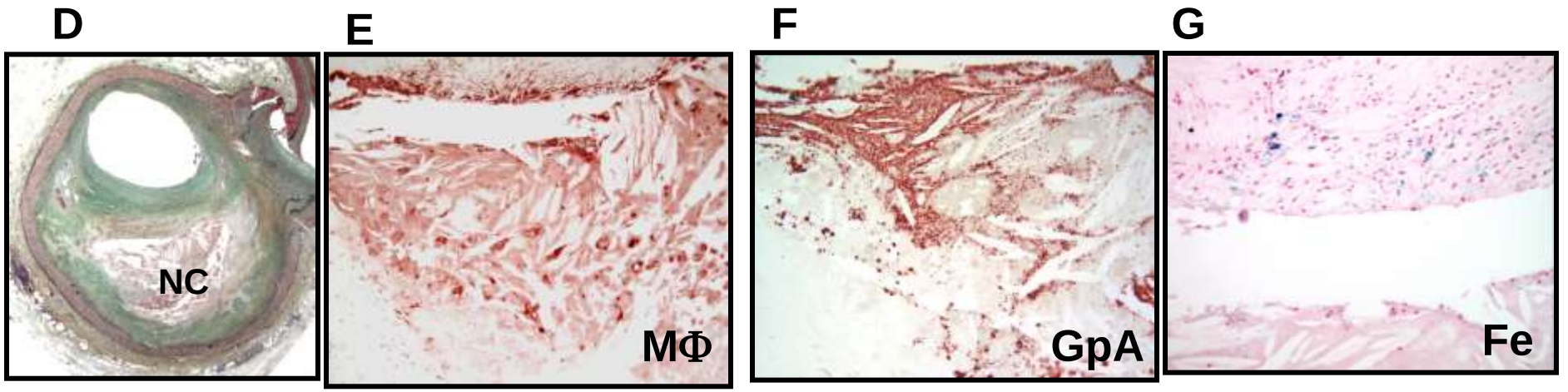
Kolodgie FD, et al. New Engl J Med 2003

Similarities between hemorrhagic pericarditis and Fibroatheroma

Hemorrhagic pericarditis



Late Fibroatheroma



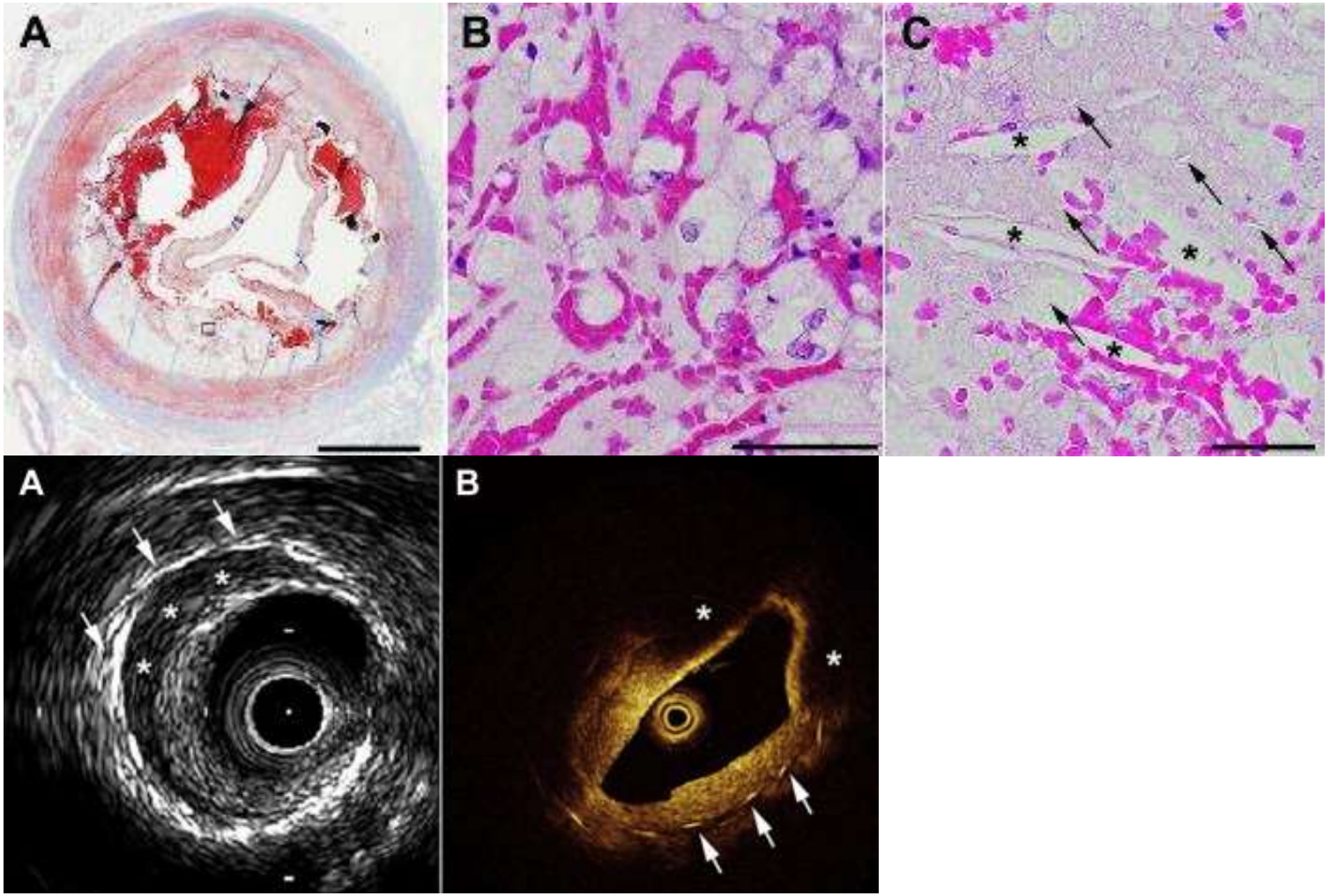
Morphometric Analysis of Hemorrhagic Events in Human Coronary Plaques from Sudden Death Victims

Plaque Type	GpA Score	Iron	Necrotic Core (mm^2)	MΦ (mm^2)
PIT *no* core *(n=129)*	0.09±0.04	0.07±0.05	0.0	0.002±0.001
FA *early* core *(n=79)*	0.23±0.07	0.17±0.08	0.06±0.02	0.018±0.004
FA *late* core *(n=105)*	*0.94±0.11	*0.41±0.09	*0.84±0.08	*0.059±0.007
TCFA *(n=52)*	*1.60±0.20	*1.24±0.24	*1.95±0.30	*0.142±0.016

Values are reported as the means±SE, *p<0.001 versus early core. The number in parenthesis represent the number of lesions examined;the total number= 365. MΦ = macrophages

Kolpdgie FD, et al. New Engl J Med 2003

Neointimal Hemorrhage After Drug-Eluting Stent Implantation : Possible Role for Development of Neoatherosclerosis



Hiroyuki Hao , Kenichi Fujii , et al. JACC: Cardiovascular Interventions, Volume 7, Issue 10, 2014, 1196 - 1197

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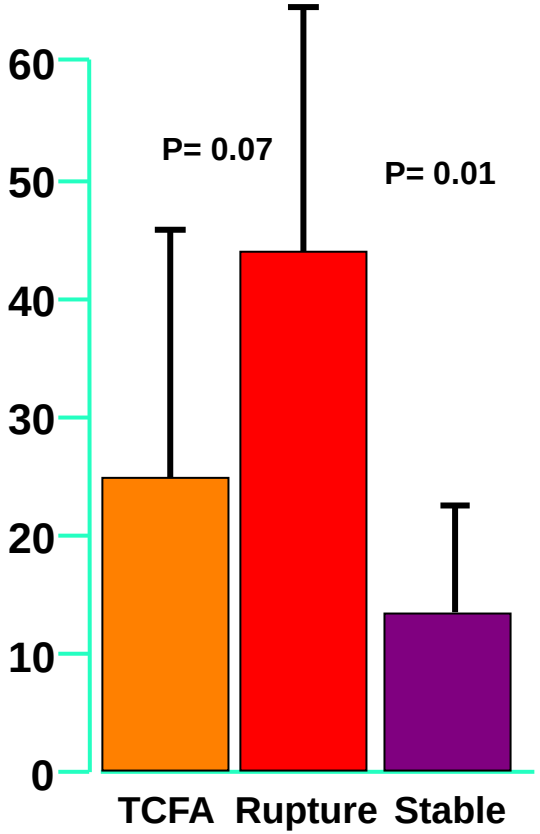
Plaque Vasa Vasorum

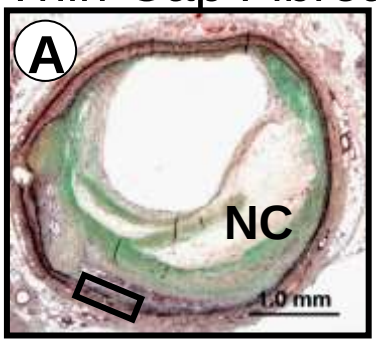
- Atherosclerotic monkey model showed 5x increase of Vasa Vasorum (Ateriosclerosis 1986)
- (Increase of) Vasa Vasorum is often observed in atherosclerotic lesion which is considered to be related to ischemia of coronary plaque

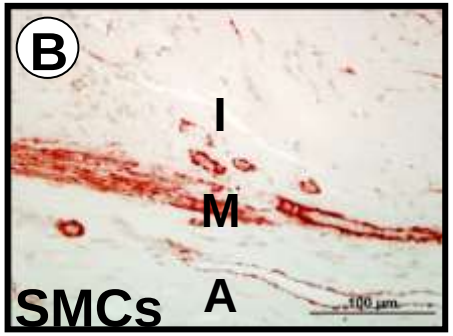
Frequency Vasa Vasorum by Plaque Type

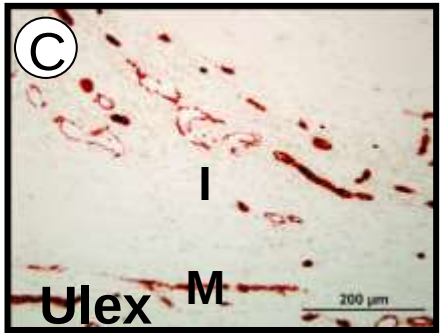


Mean No. of Vasa Vasorum by Plaque Type

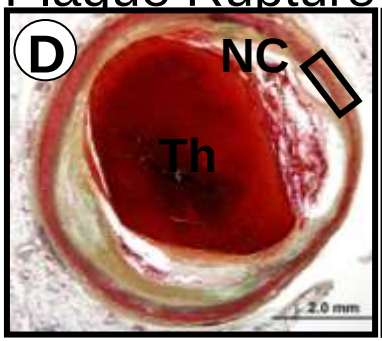
Thin-Cap Fibroatheroma

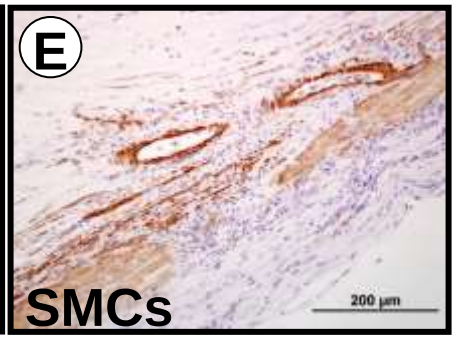


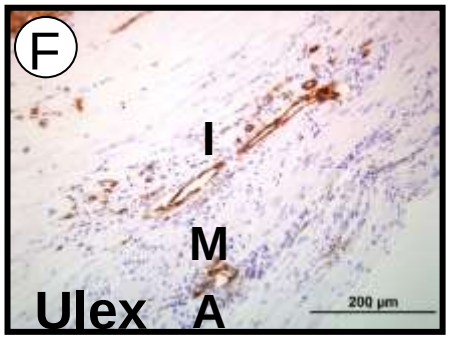




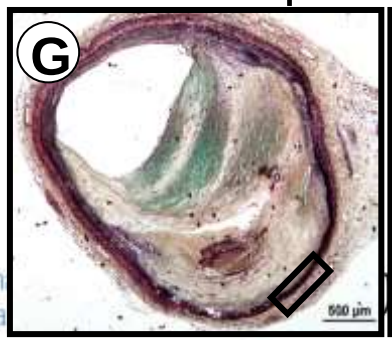
Plaque Rupture

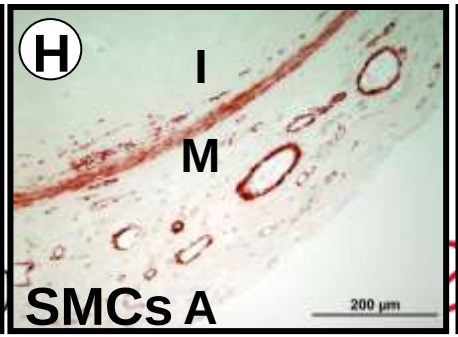


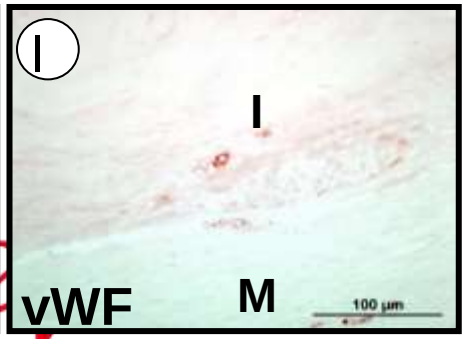




Stable Plaque

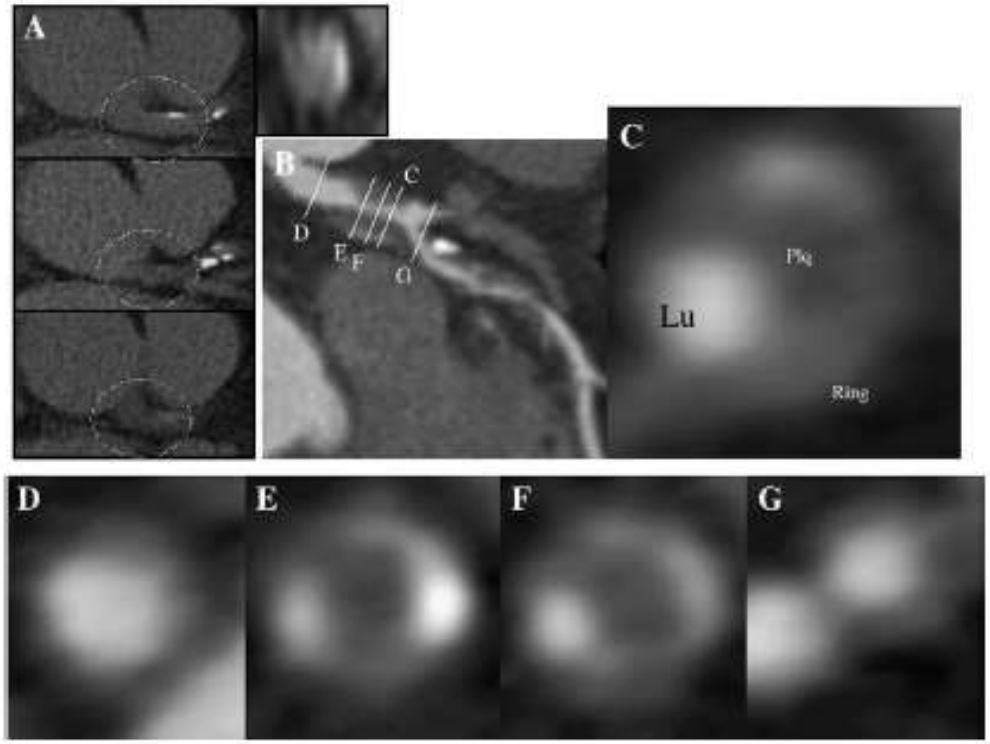






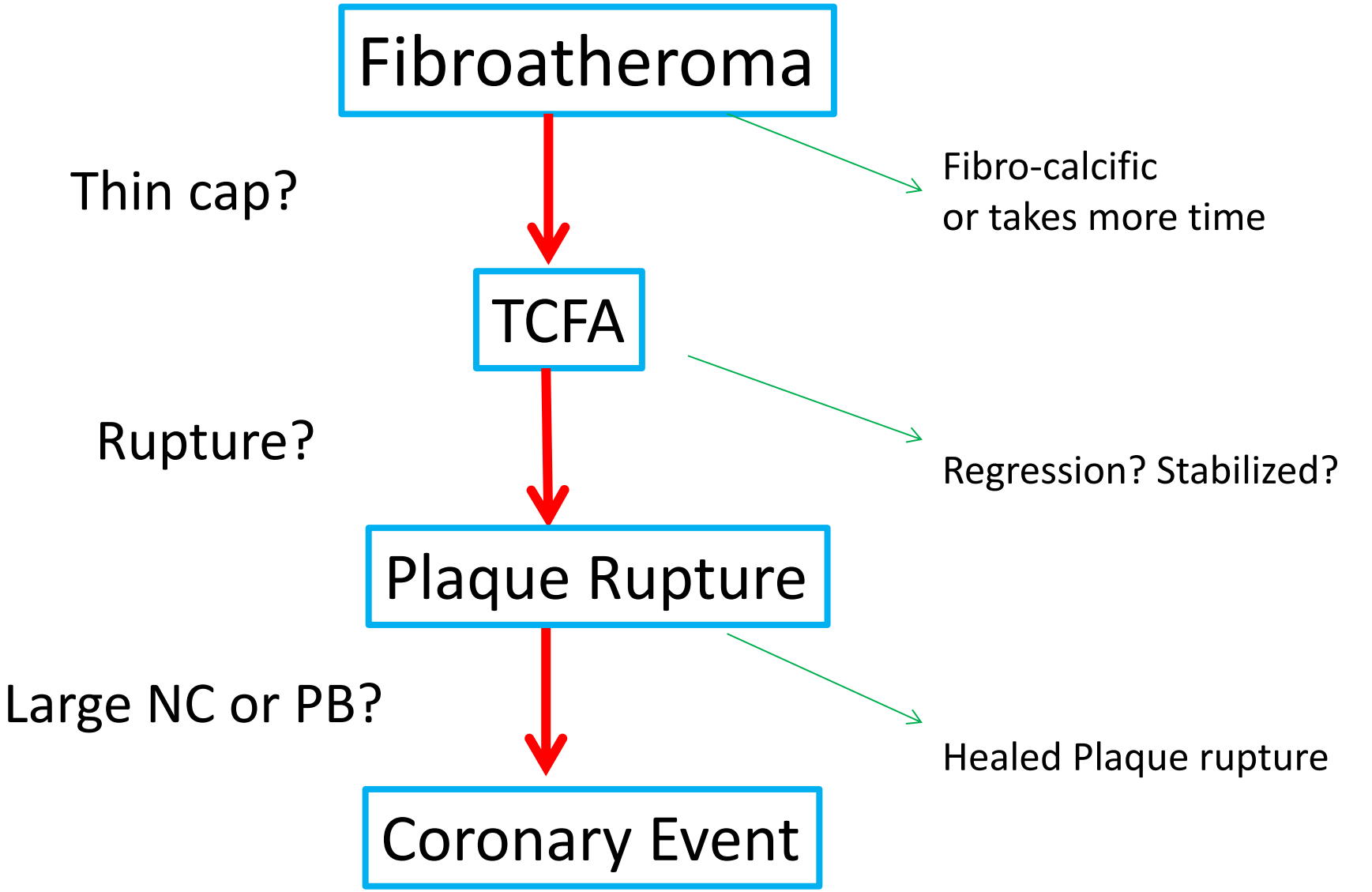
Efficacy of culprit plaque assessment by 64-slice multidetector computed tomography to predict transient no-reflow phenomenon during percutaneous coronary intervention

Gaku Nakazawa, MD, Kengo Tanabe, MD, PhD, Yoshinobu Onuma, MD, Sen Yachi, MD, Jiro Aoki, MD, PhD, Hirosada Yamamoto, MD, Yasutomi Higashikuni, MD, Atsuhiko Yagishita, MD, Hiroyoshi Nakajima, MD, PhD, and Kazuhiro Hara, MD, FACC *Tokyo, Japan*



Conversion of Vulnerable plaque

- Vulnerable plaques have moderate stenosis
- However, plaque rupture frequently show severe stenosis
- Rapid Progression might be a key and intra-plaque hemorrhage from Vaso Vasorum might be associated with this phenomenon



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