

Anatomy and Pathology of Left main coronary artery

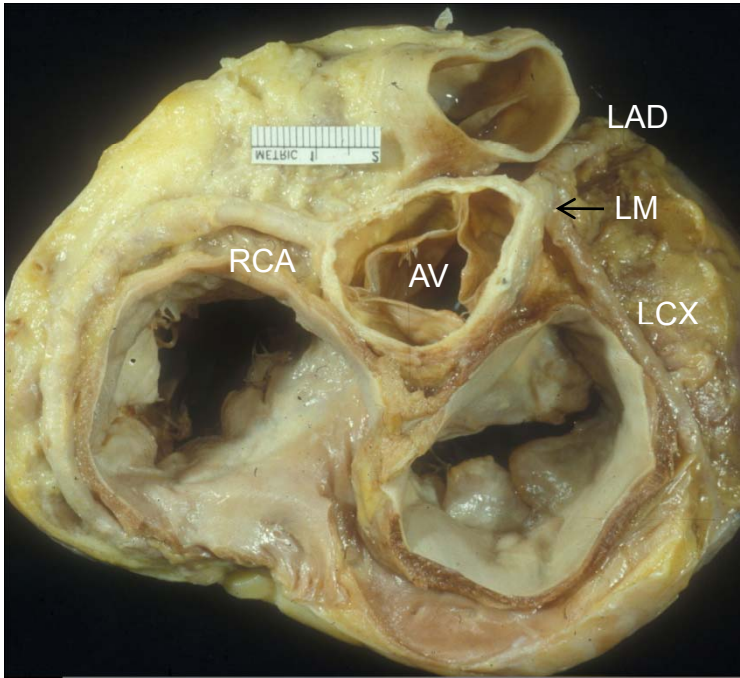
*G Nakazawa
Tokai Univ.
Kanagawa, Japan*

Anatomy – Definition



✓ Left main coronary artery

(LMCA): The proximal segment of the left coronary artery that arises from the left aortic sinus just below the sinotubular junction to its bifurcation into the LAD and LCX



- ✓ LMCA is responsible for supplying approximately 75% of the left ventricular cardiac mass

Anatomy



- ✓ LMCA is generally divided into 3 anatomic regions
 1. Ostium (Origin of LMCA from aorta)
 2. Middle portion
 3. Distal (Bifurcation) portion
- ✓ Approximately one-third of cases have **trifurcation**
- ✓ The Average length of LMCA: 10.8 ± 5.2 mm (2–23 mm)
- ✓ The Average angle of terminal brunches: $87 \pm 29^\circ$ (40–165°)
- ✓ **Positive correlation**: length and angle

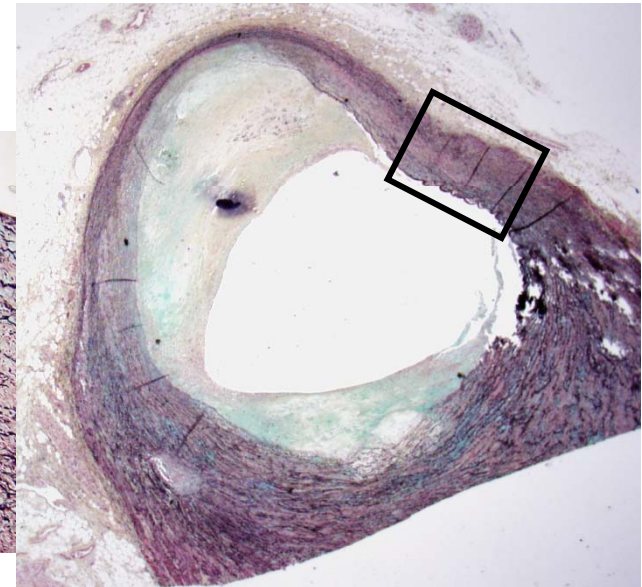
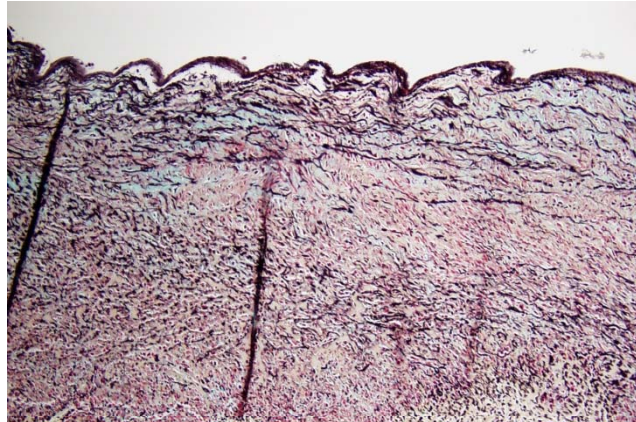
Reig J et al. Clin Anat 2004

Anatomy Specific Features...



- ✓ Ostium portion of LMCA is rich in **aortic smooth muscle cells and elastic fibers**

⇒ **Elastic recoil**



- ✓ Bifurcation at the distal portion

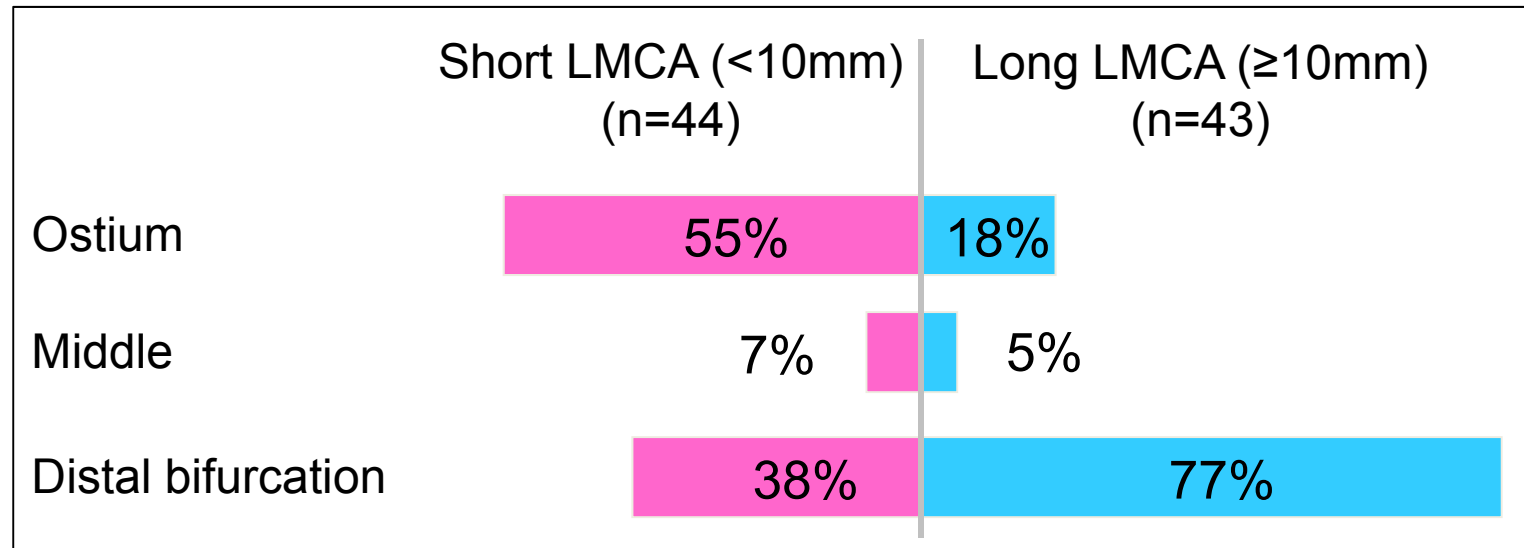
⇒ **Flow disturbance** (Susceptible to develop the plaque)

⇒ **Procedural Complexity**

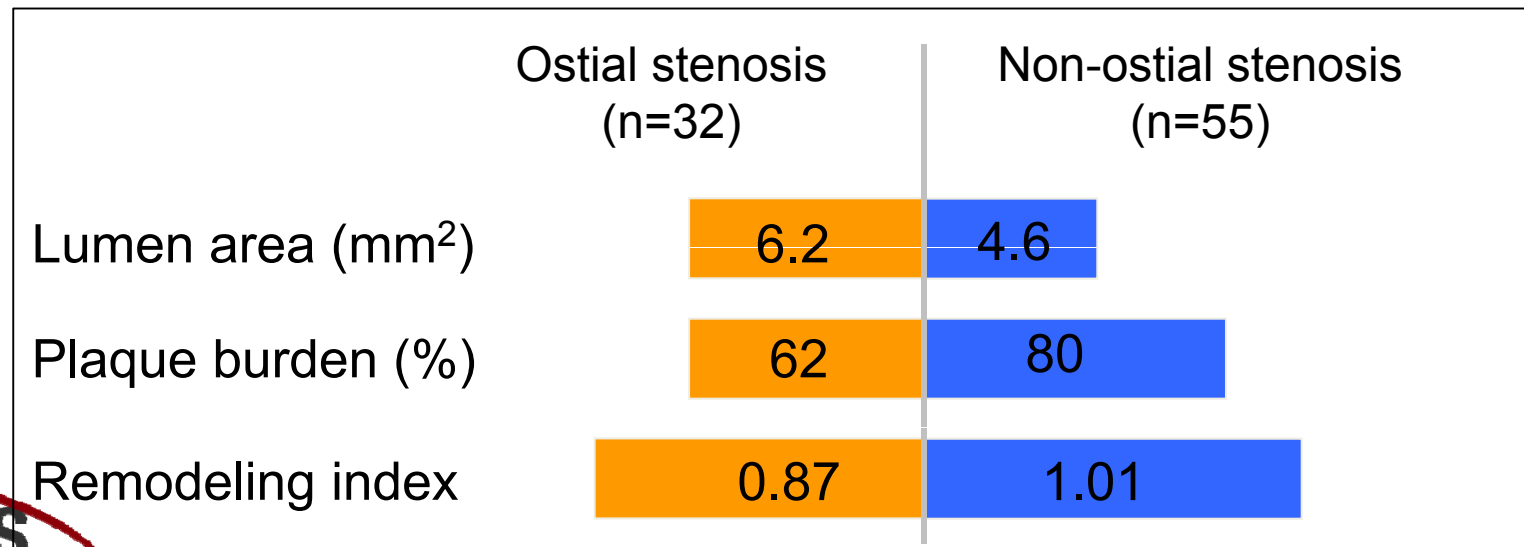
Anatomic features and the development of atherosclerotic plaque in left main coronary artery: IVUS data



Stenosis Location



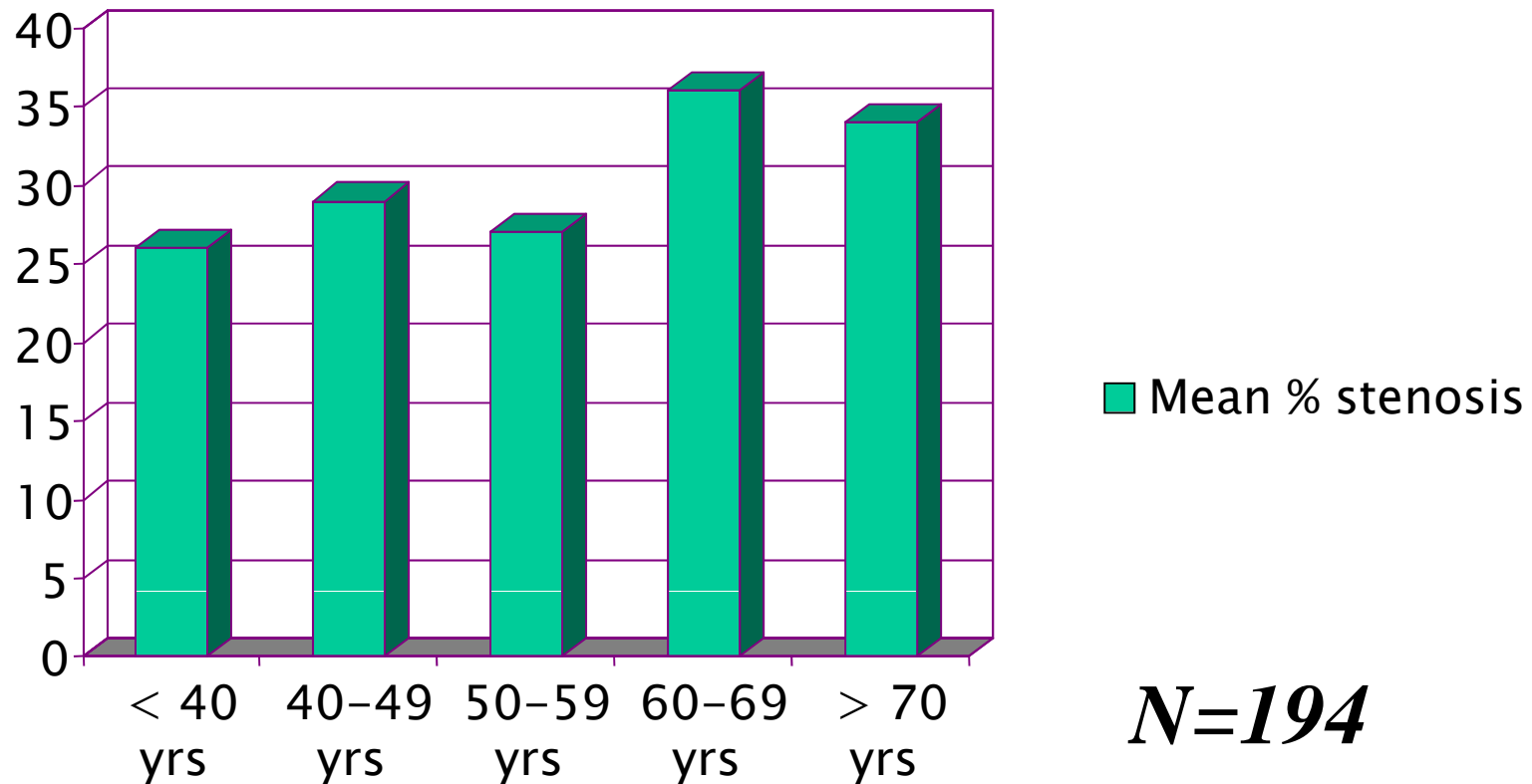
Morphologic Findings



Plaque Formation – Luminal Narrowing



Mean cross sectional luminal narrowing, left main, by age, sudden coronary death

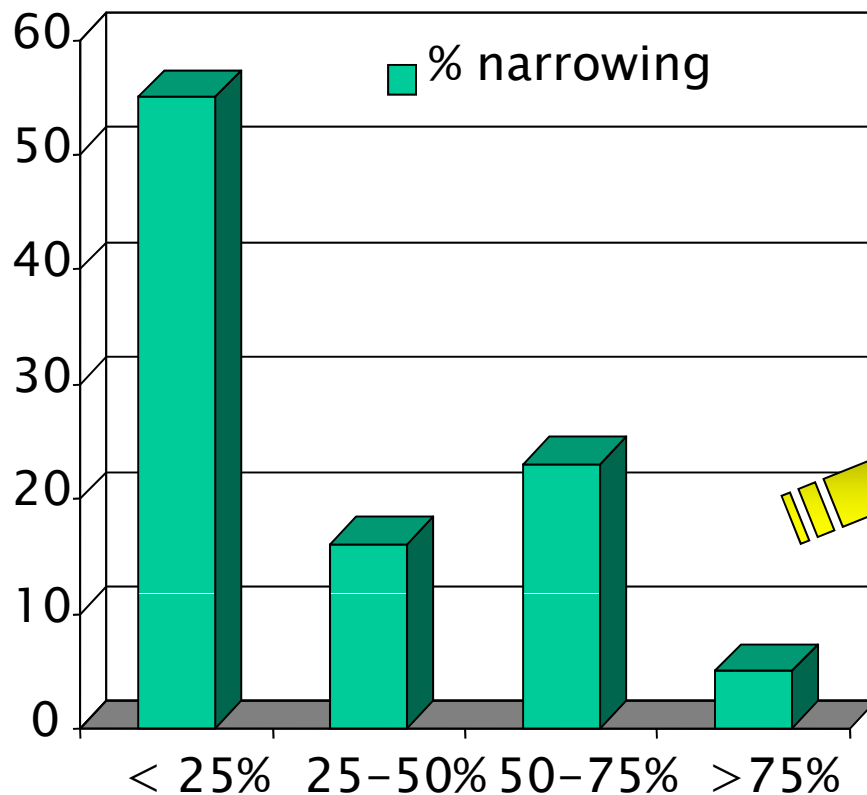


Data from CVPath sudden cardiac death registry

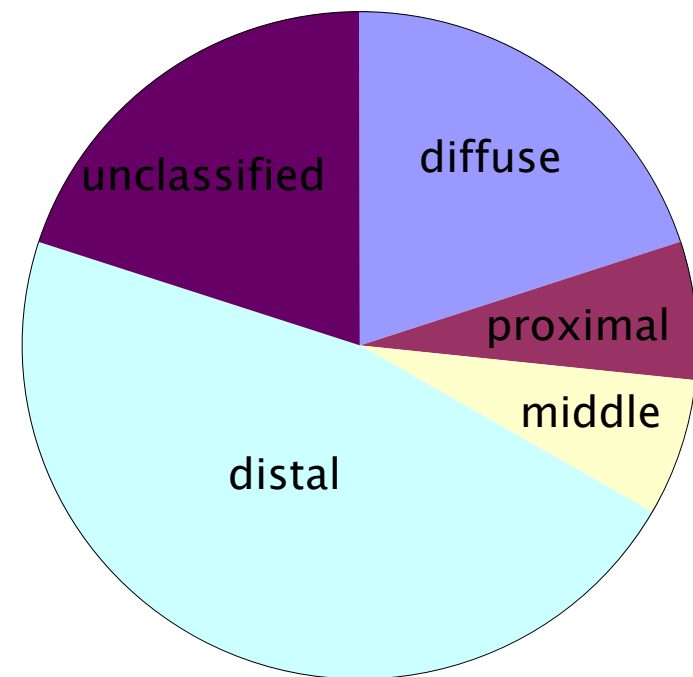
Plaque Formation in LMCA



Maximal cross sectional luminal narrowing,
194 cases of sudden coronary death



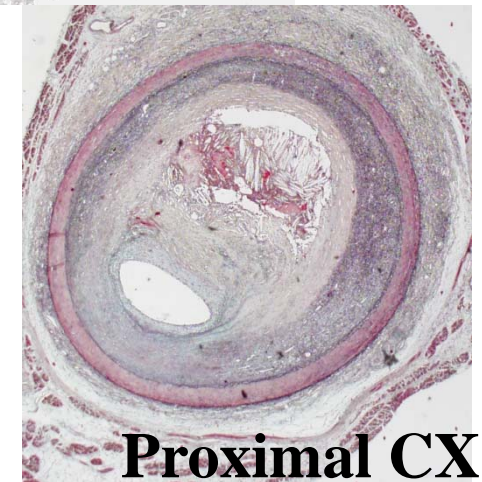
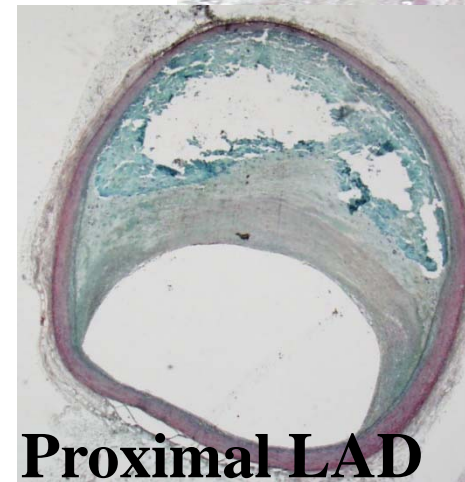
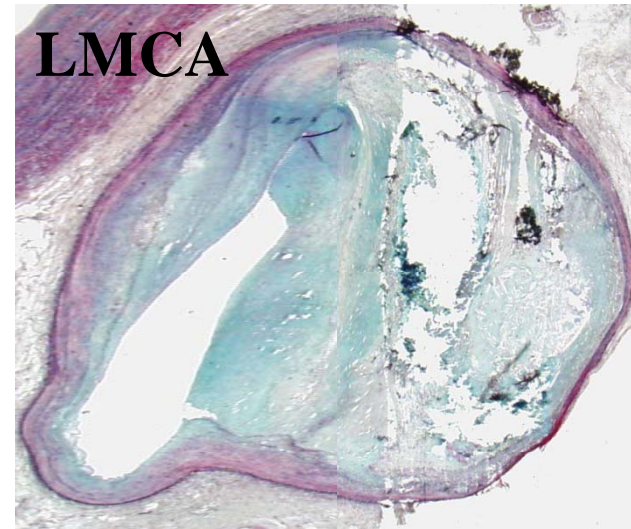
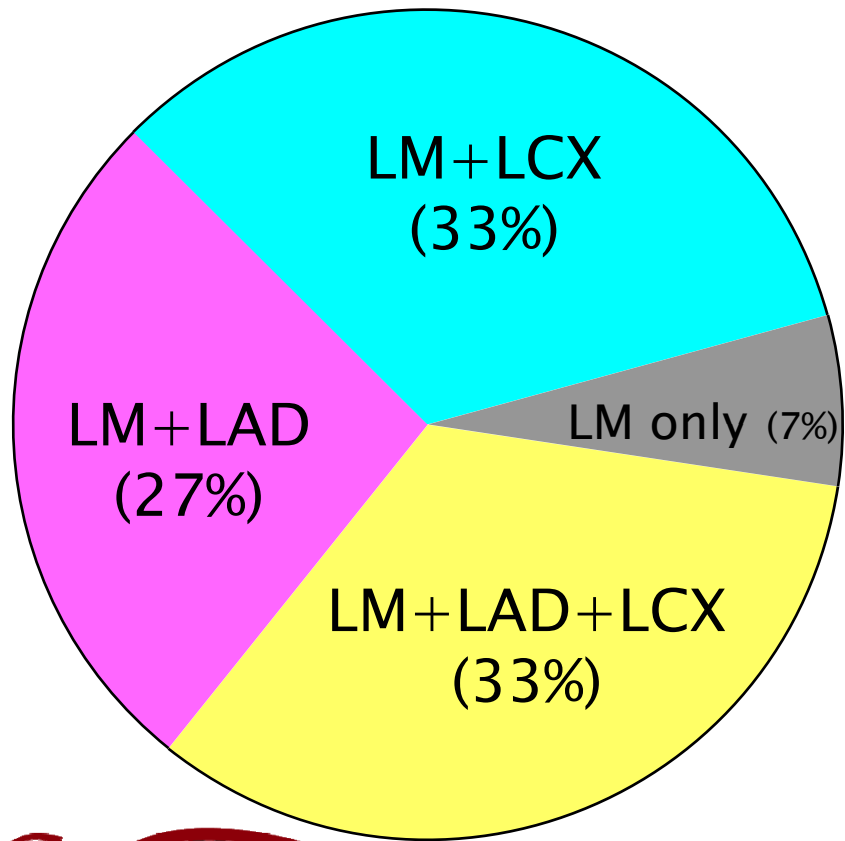
Location of stenosis (>75%)



Patients with $>75\%$ LM stenosis



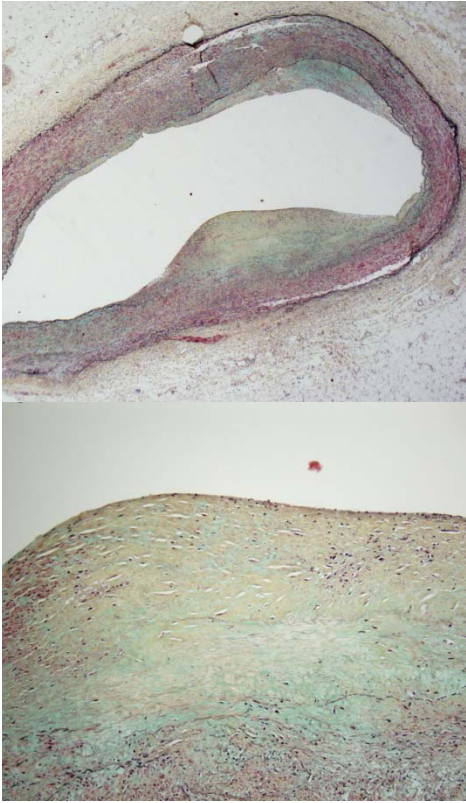
Proximal LAD and/or
LCX involvement



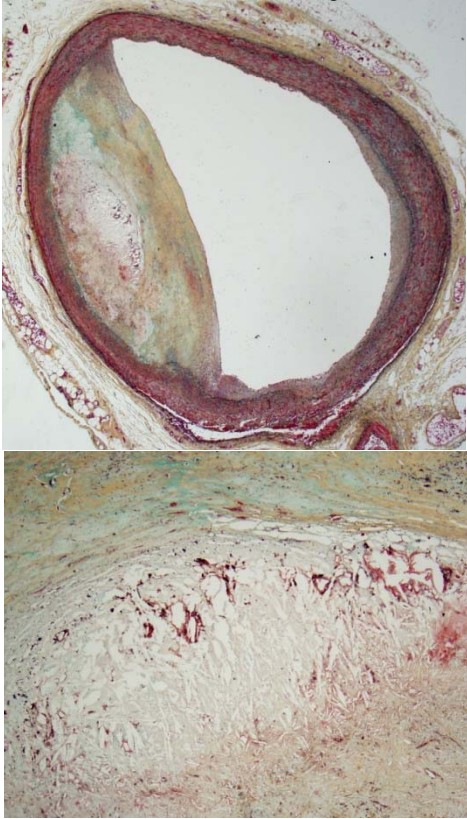
Plaque Progression in LMCA



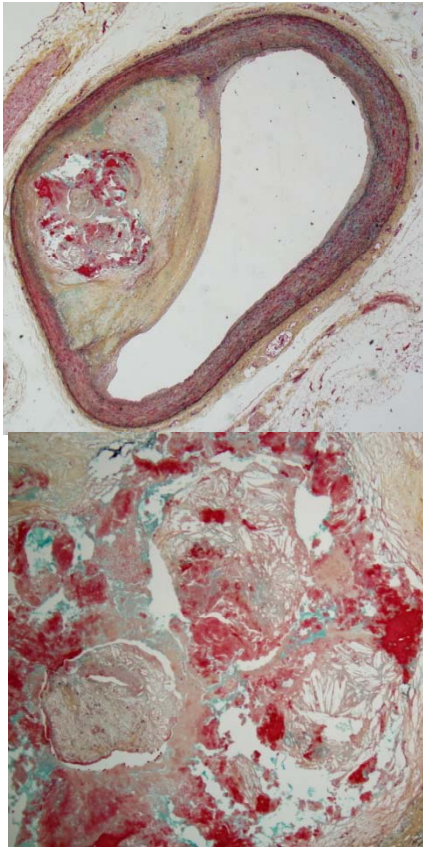
PIT



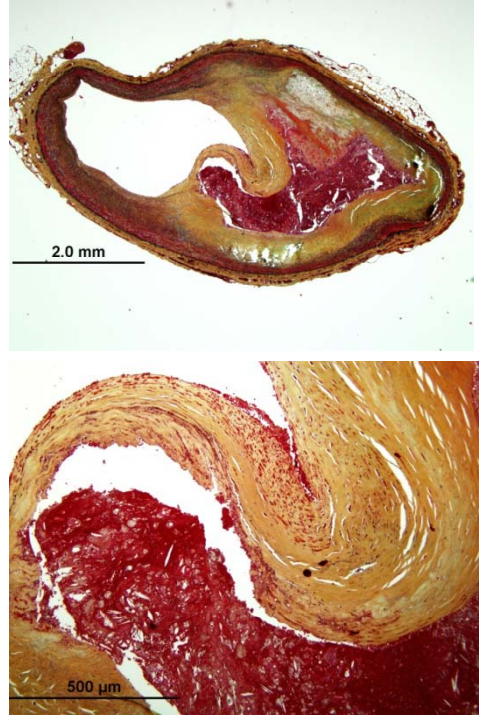
Early NC



Late NC



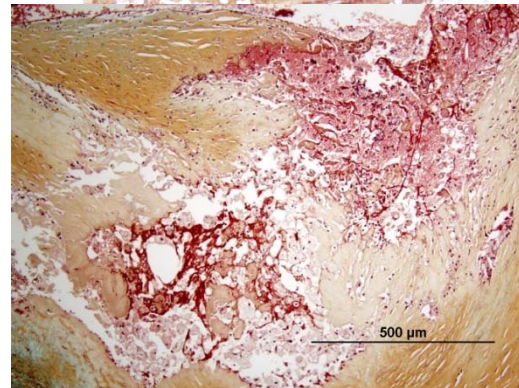
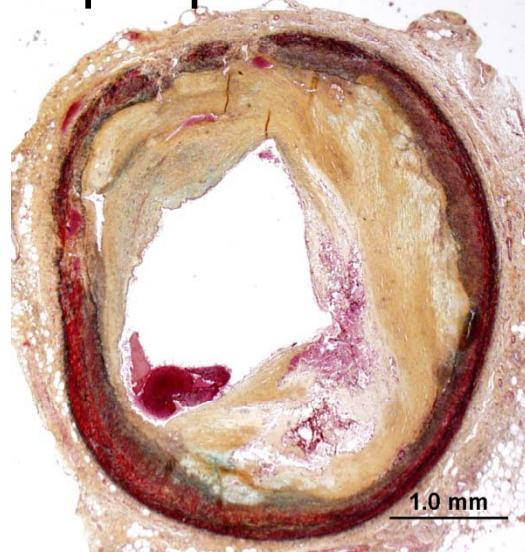
TCFA



Advanced plaque in LMCA

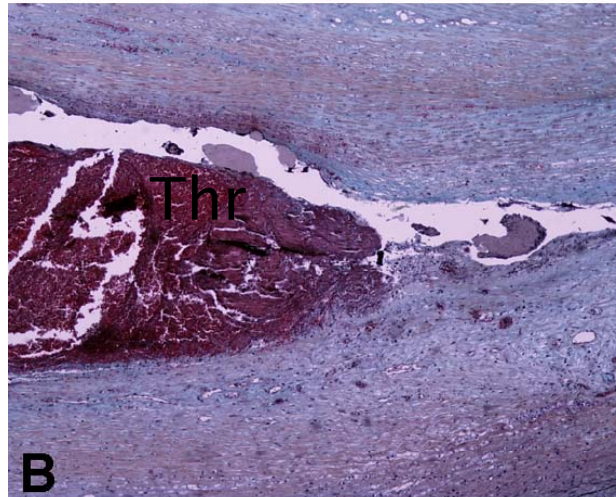
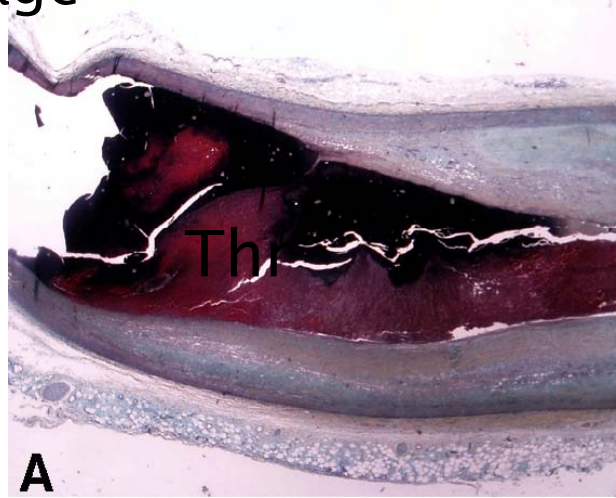


Intraplaque hemorrhage

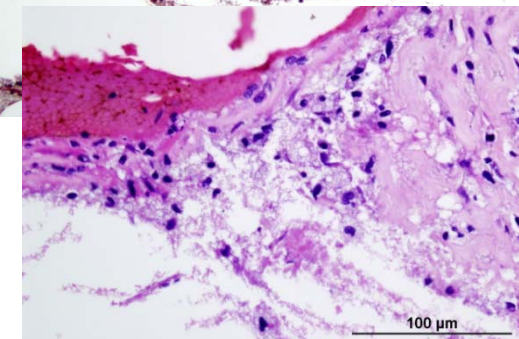
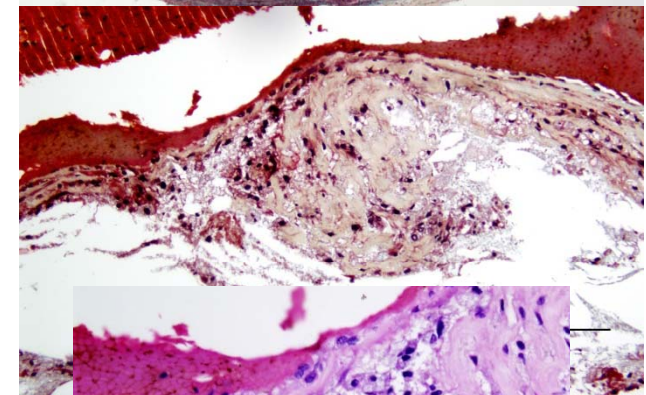
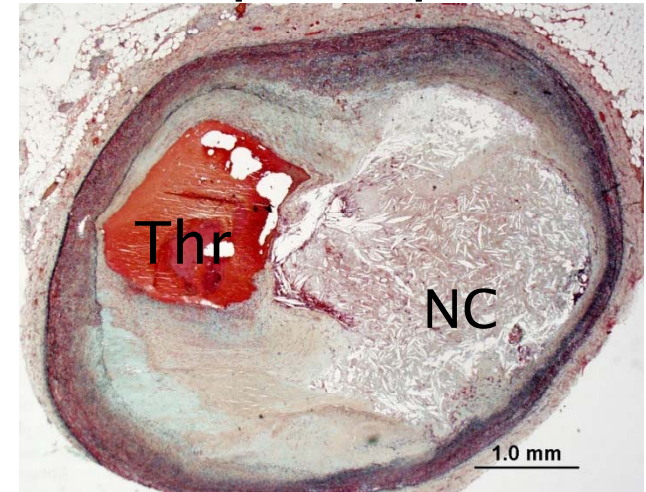


Hemorrhage

Erosion



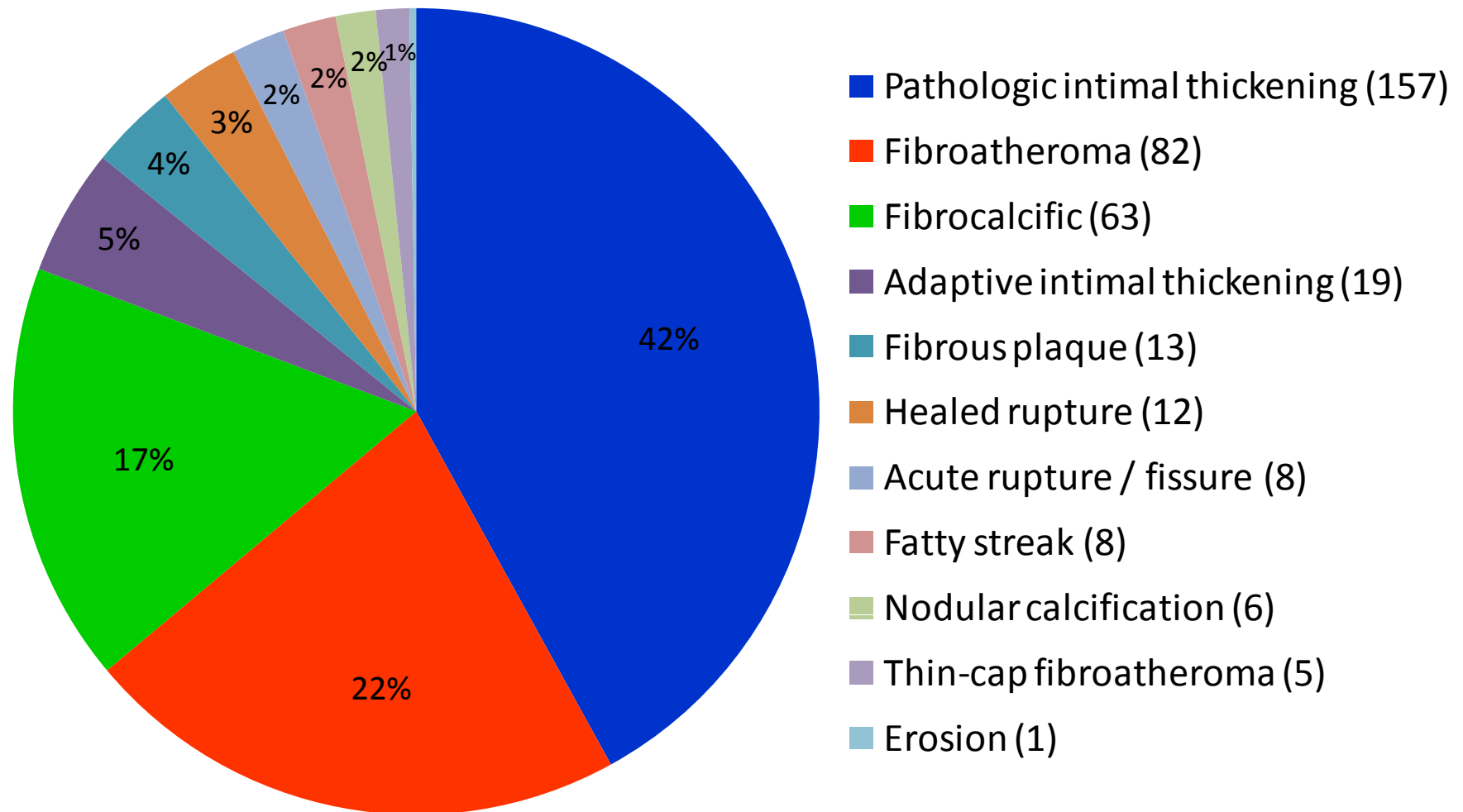
Plaque rupture



Types of plaque in LMCA in sudden coronary death cases



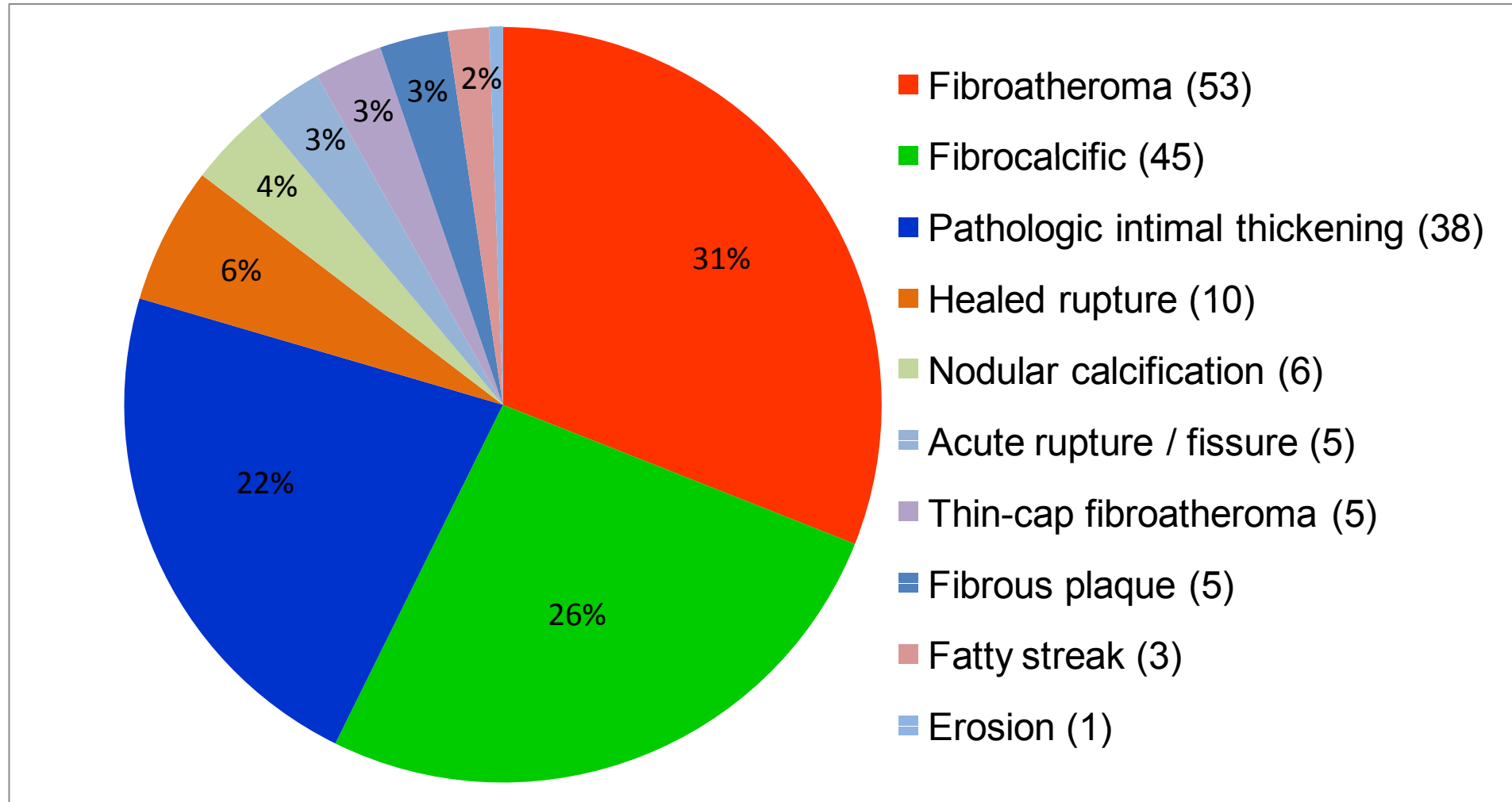
All sudden coronary death cases (n=374)



Types of plaque in LMCA in sudden coronary death cases with stenosis $\geq 50\%$

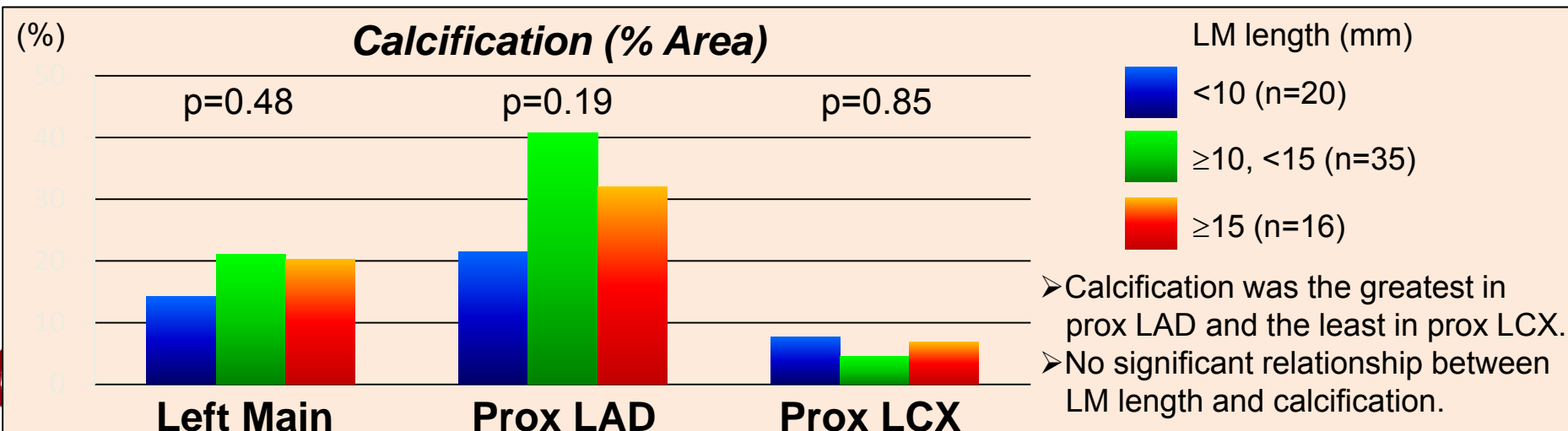
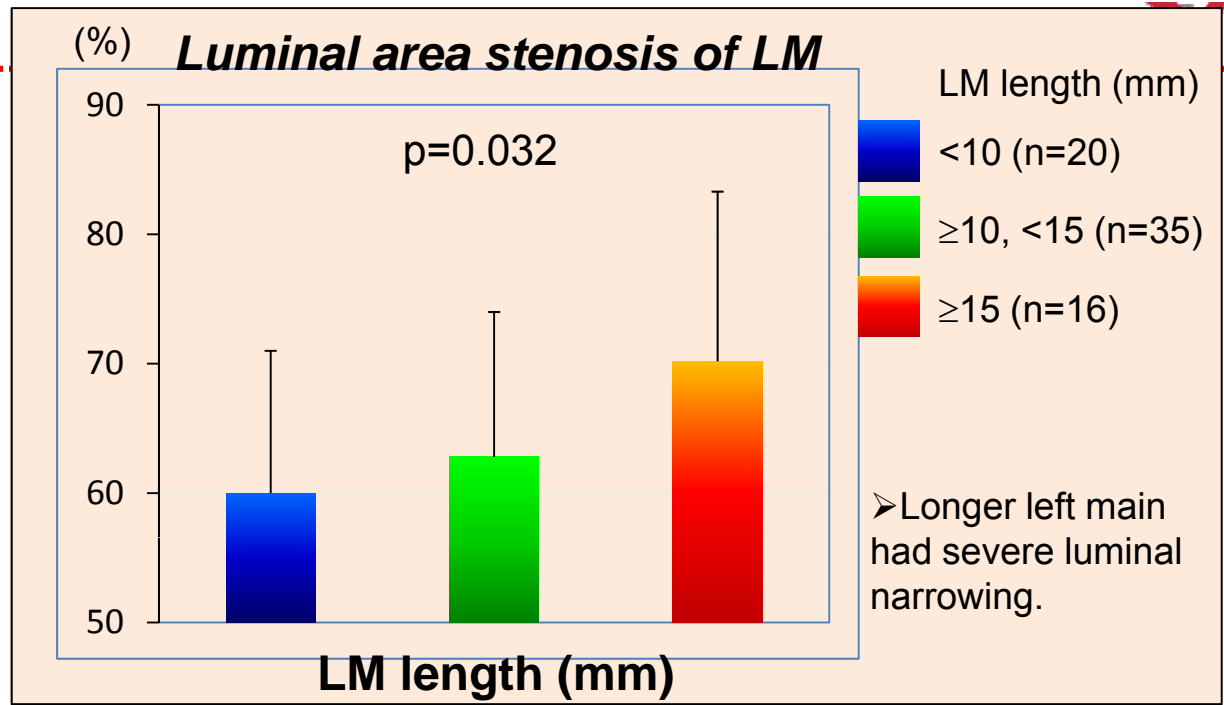
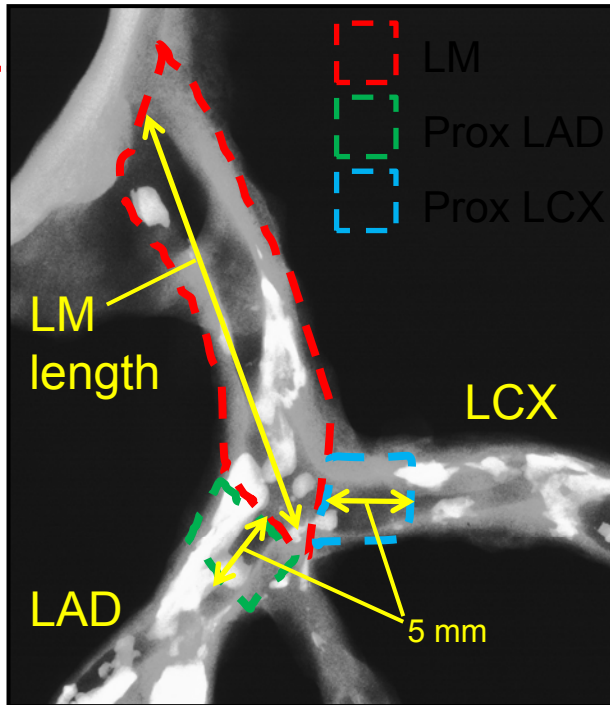


Cases with stenosis $\geq 50\%$ in sudden coronary death (n=171)

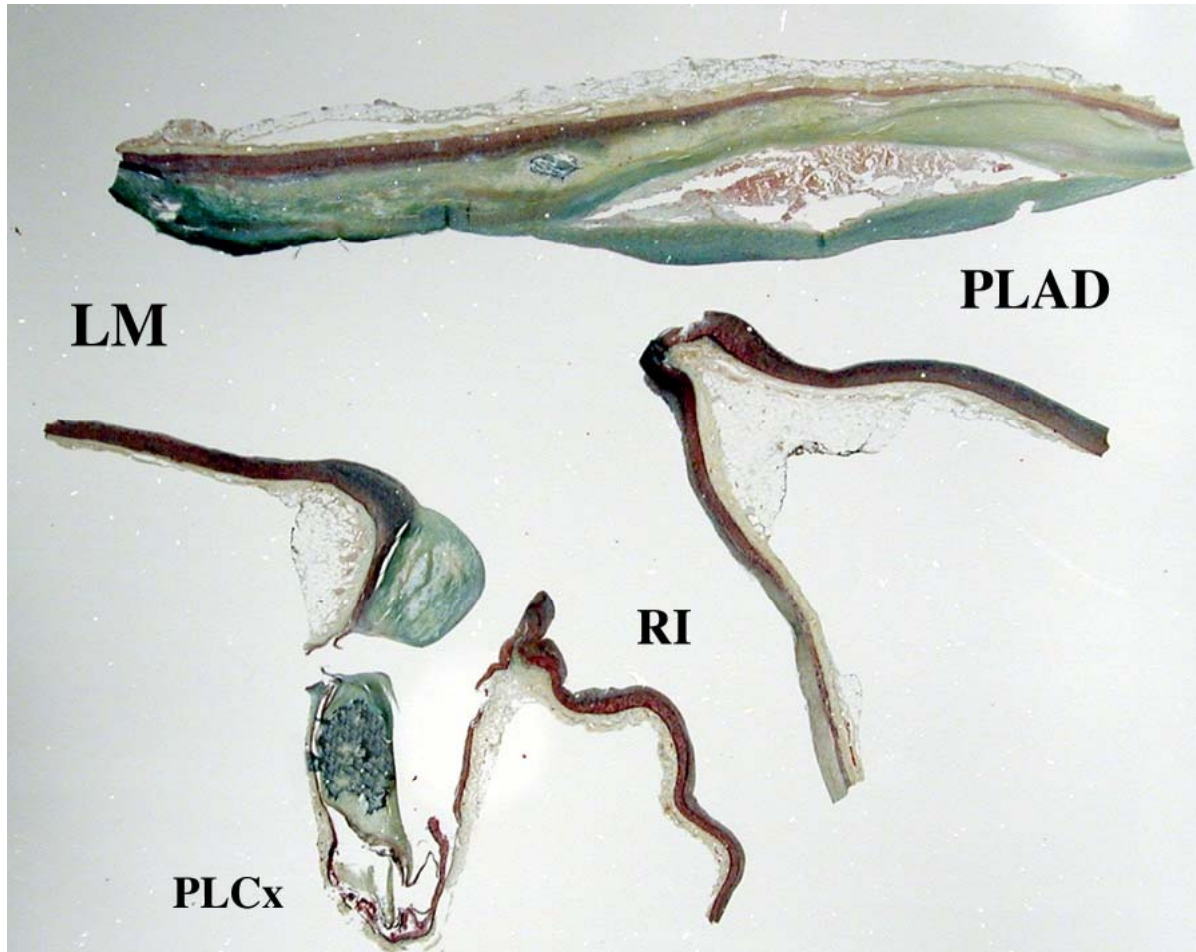


LM Length and Luminal Narrowing, Calcification

Sudden coronary death victims with LM luminal narrowing $\geq 50\%$ (n=71)



Plaque distribution in bifurcation lesion

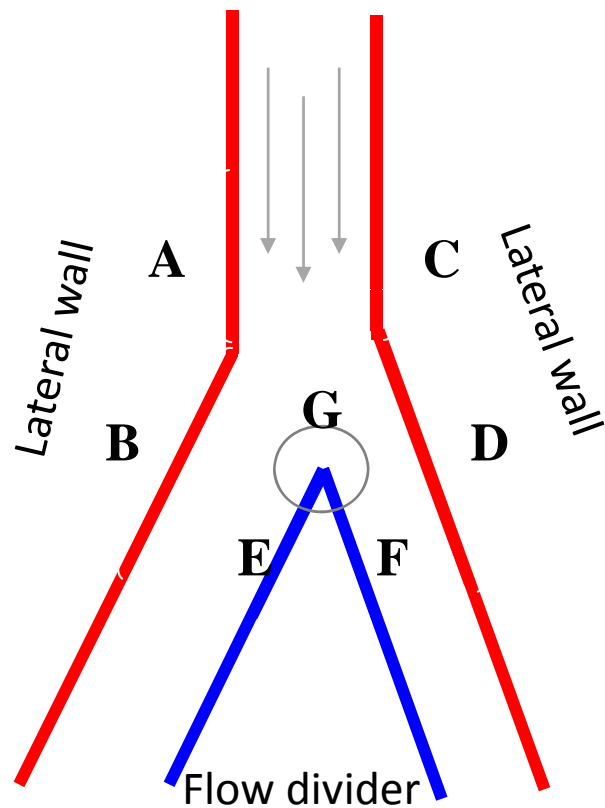


Plaque Formation in Bifurcation

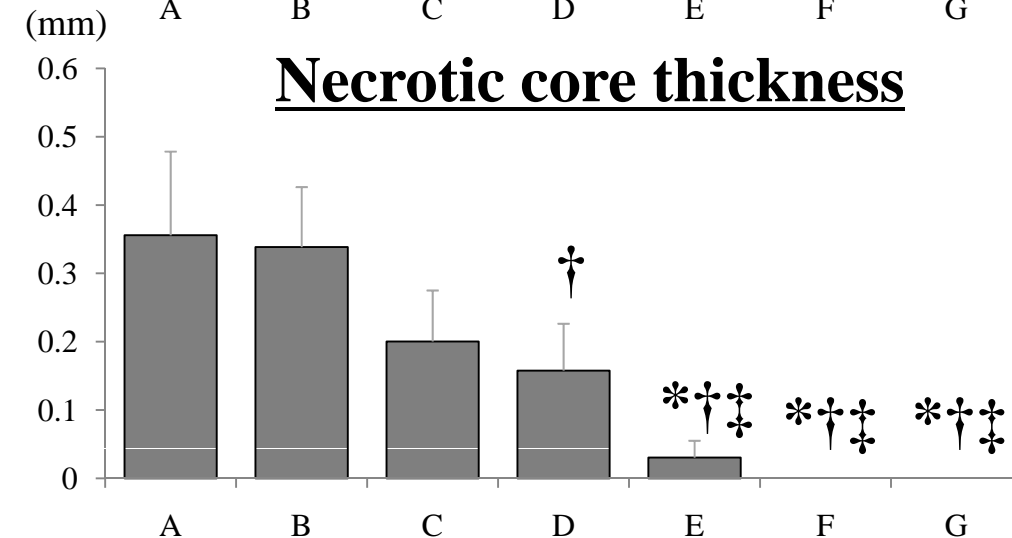
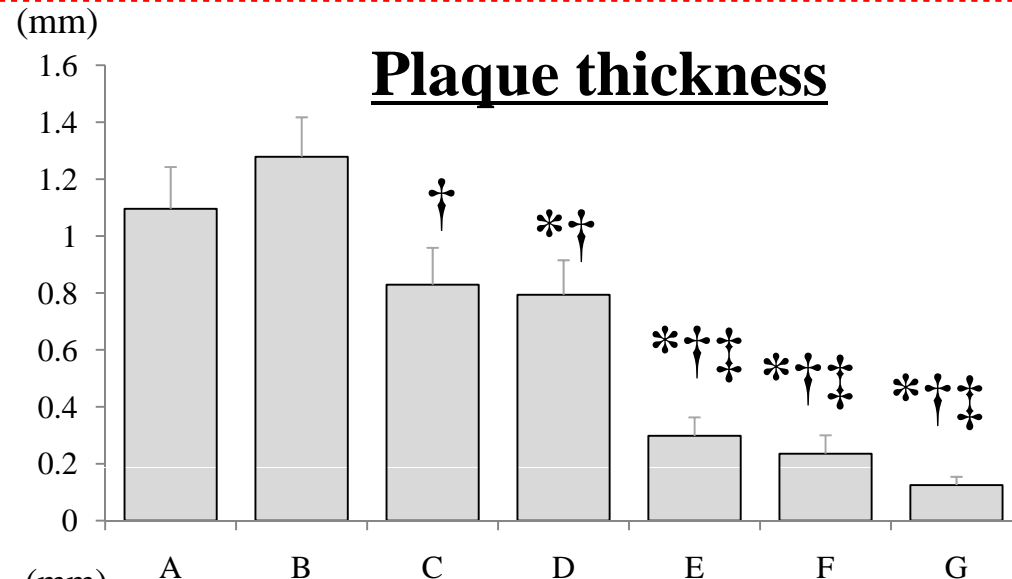


— High shear — Low shear

Main Vessel proximal



Main Vessel distal Side Branch

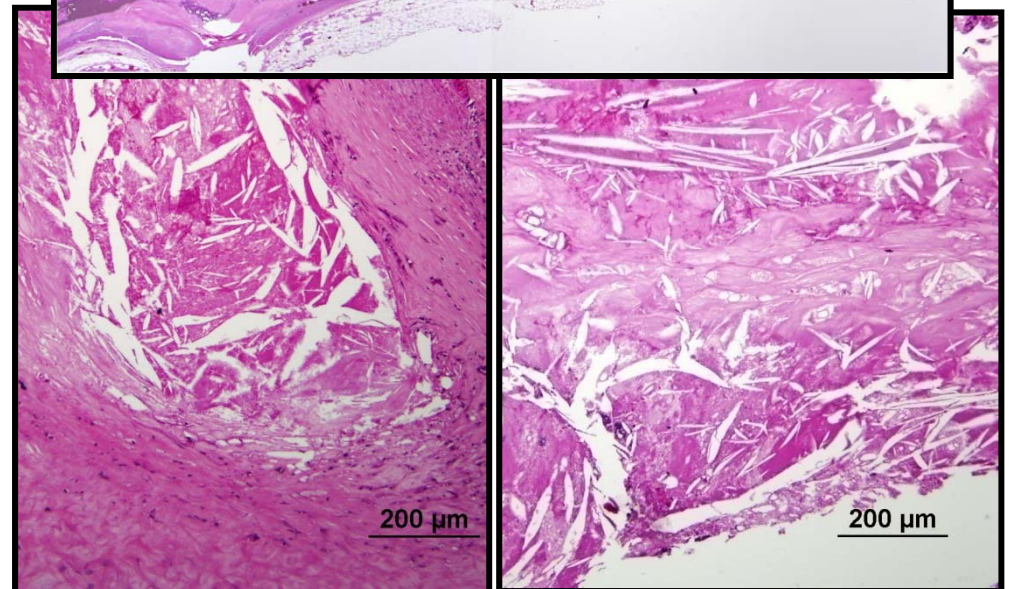
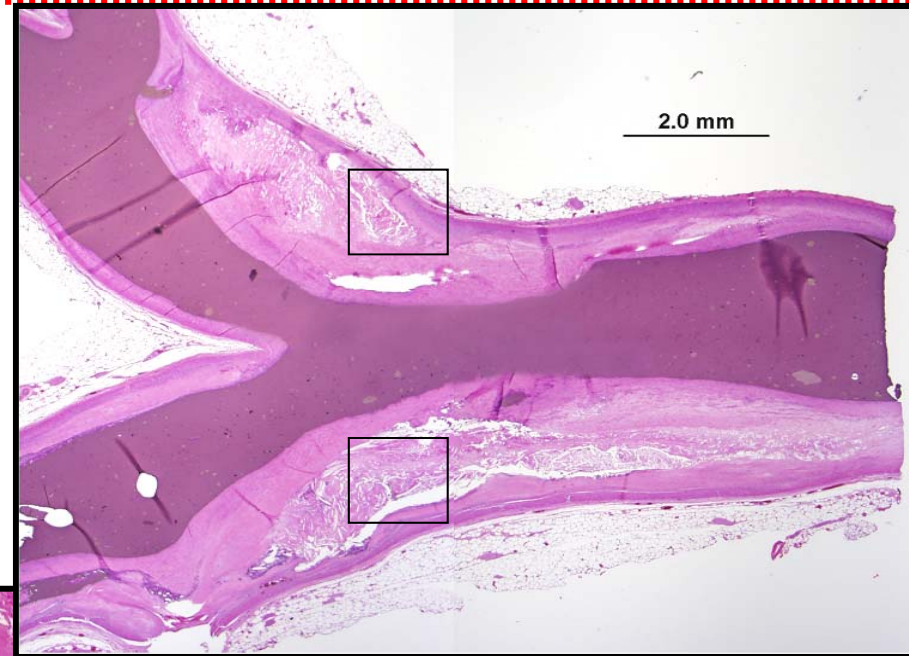
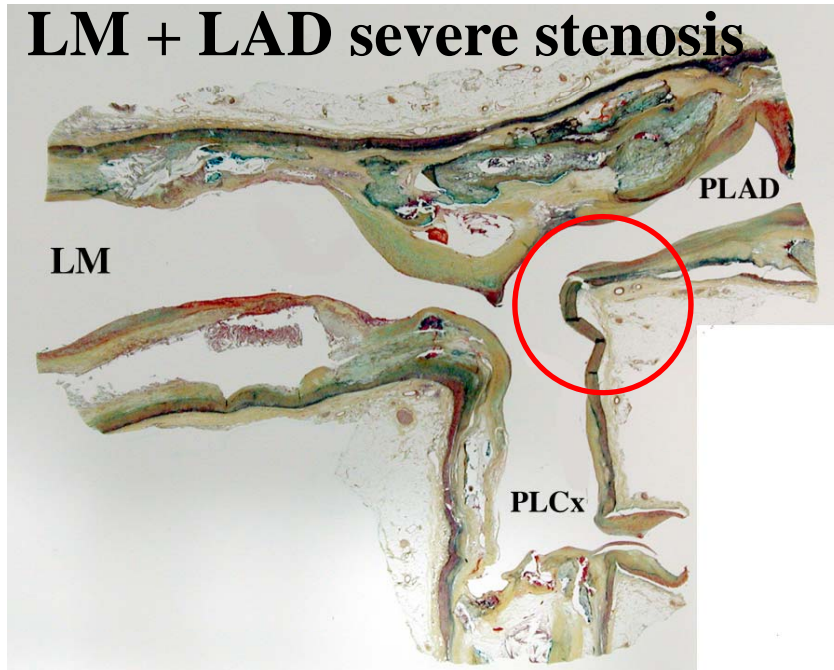


P < 0.05, vs. A (*), vs. B (†), vs. C & D (‡)

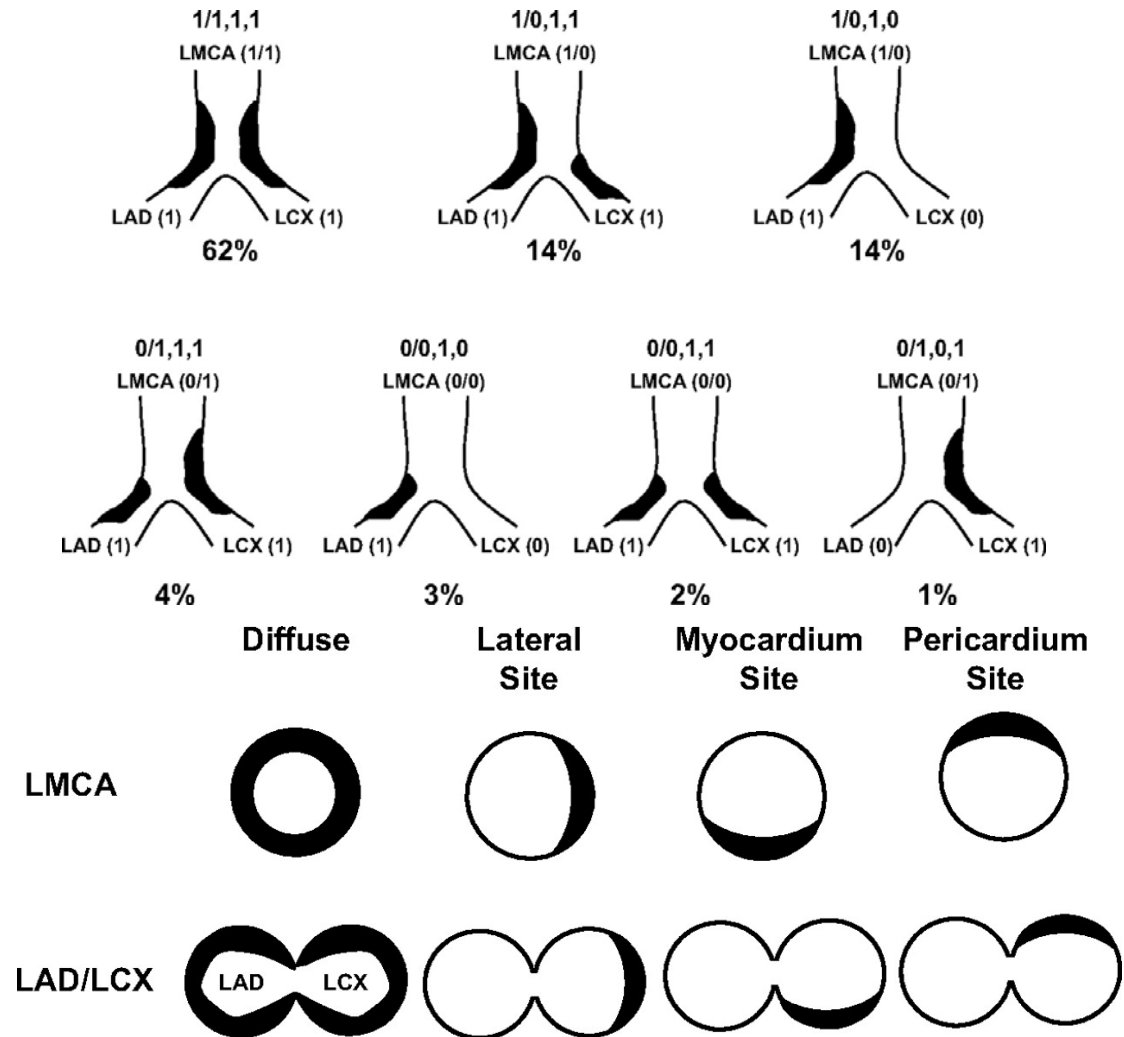
Plaque Formation



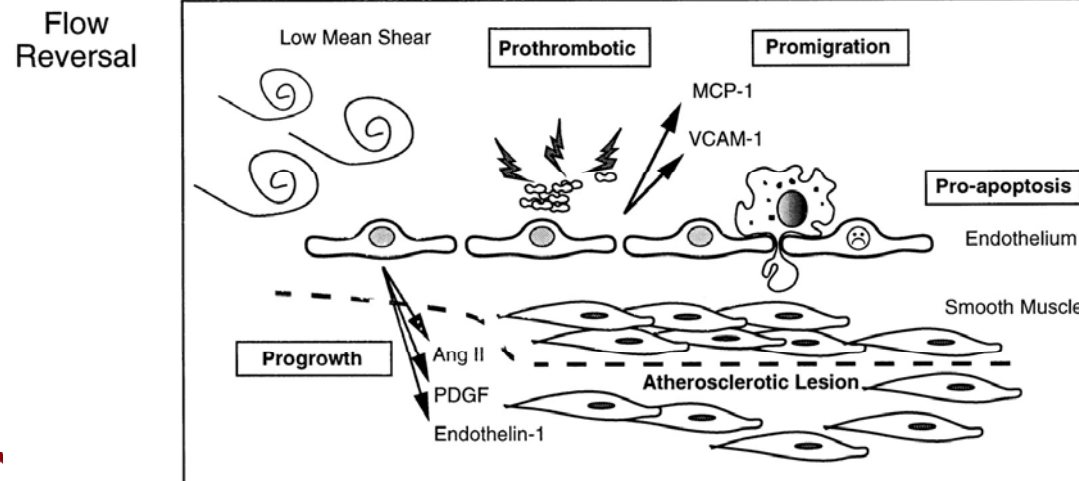
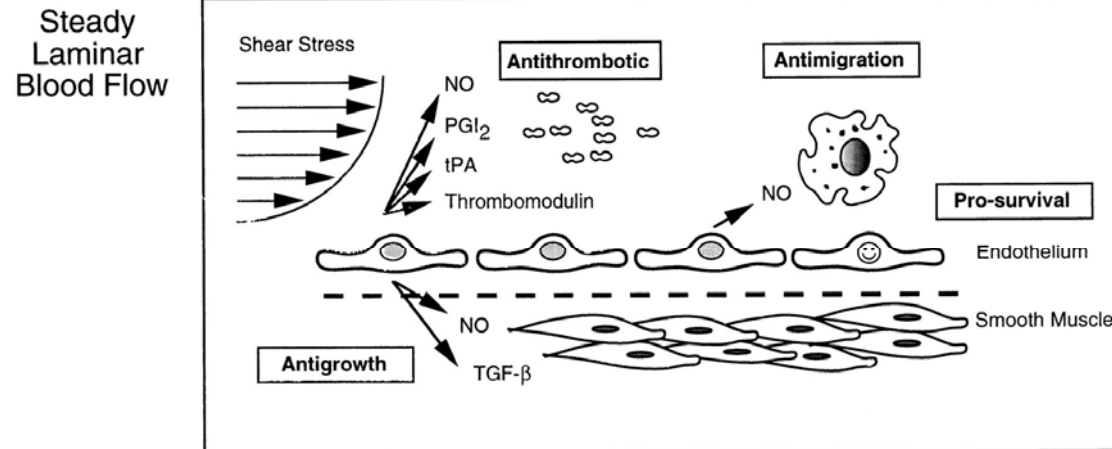
LM + LAD severe stenosis



IVUS classification for LMCA bifurcation plaque distribution



Why so susceptible to get diseased?





Pathology of Left Main Coronary Artery Stenting

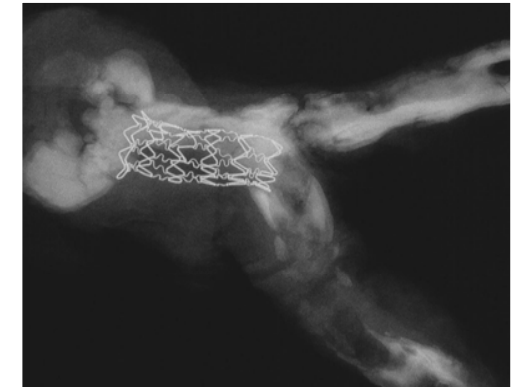
Data from CVPath Autopsy Registry

BMS vs DES in LMCA @ Autopsy

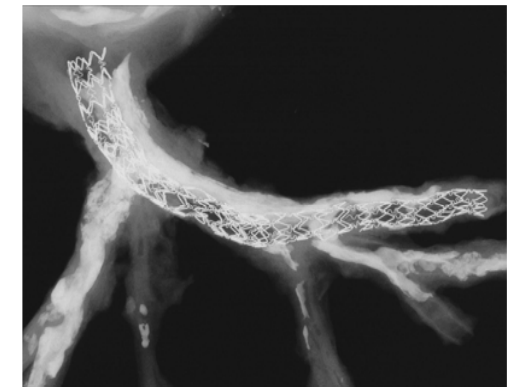


Vorpahl M et al. ACC2010

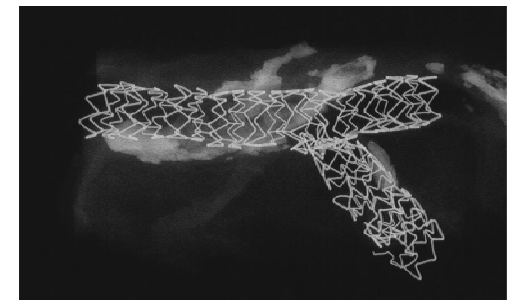
Patient Characteristics	BMS (n=15)	DES (n=12)	
Age	56.0 ± 12.8	73.2 ± 8.8	p=0.001
Gender (f/m)	4/11	3/9	p=0.53
Duration of Survival (days)	189 ± 206	212 ± 324	p=0.98
CABG	5	6	



Lesion Characteristics	BMS (n=15)	DES (n=12)	
Stent lesion length (mm)	16.2 ± 5.5	29.6 ± 18.0	p= 0.02
Isolated Left Main	2	3	
Bifurcation (single vessel)	11	6	
Bifurcation (>2 vessels)	1	3	



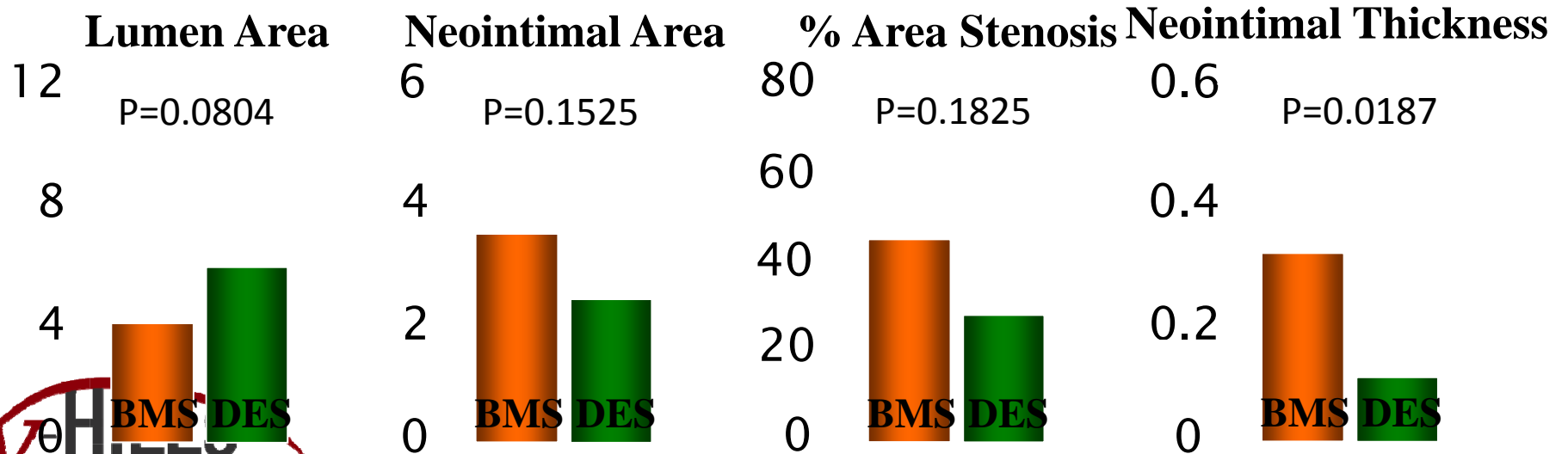
Indication	BMS (n=15)	DES (n=12)	
ACS/AMI	2	3	
Stable Angina	13	9	



BMS vs DES in LMCA @ Autopsy



Pathology	BMS > 30 days (n=11)	DES >30 days (n=10)	
Duration	288 ± 189	340 ± 374	P=0.7019
Stent diameter	3.73±0.67	3.95±0.57	P=0.4437
Vessel Diameter	5.73 ±1.00	5.93±0.93	P=0.6532
Vessel Area	19.47±4.67	20.25±4.61	P=0.7037
Stent Area	7.6±1.93	8.51±2.52	P=0.3725
Plaque Area	11.84±3.85	11.73±3.46	P=0.9476



Cause of Death at Autopsy with LMCA stenting



Cause of Death	BMS (n=15)	DES (n=12)	
SRD	6 (40)	7 (58)	p=0.26
NSRD	4 (26)	4 (33)	
NCD	5 (33)	1 (8)	

SRD: Stent Thrombosis/ Restenosis

NSRCD: SCD and patent stent

NCD: other

LM

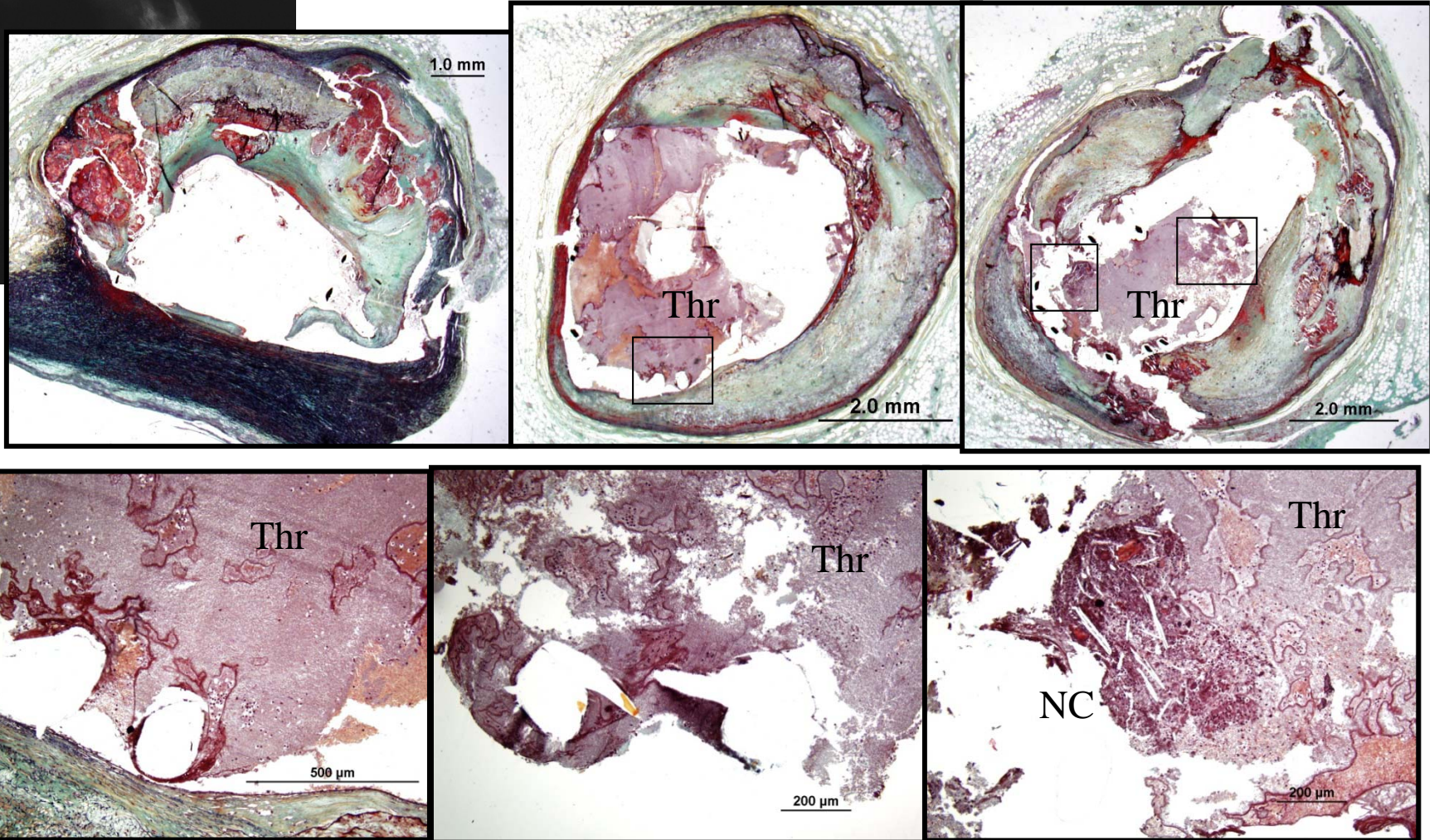
CX

LAD

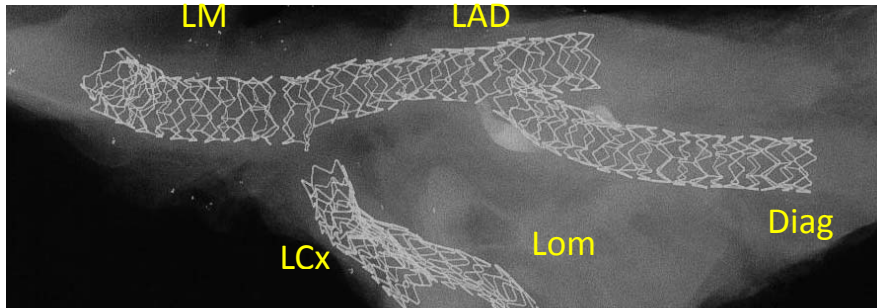
Early Stent thrombosis

73F, Cypher stent implantation in LMCA

Sudden death 2 days after implantation

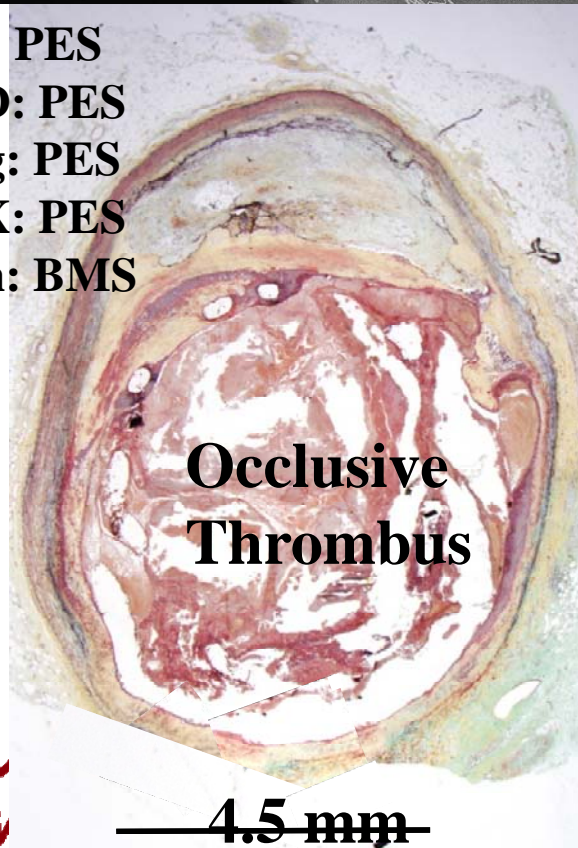


Very Late Stent Thrombosis in LM stent (PES2.5 years)

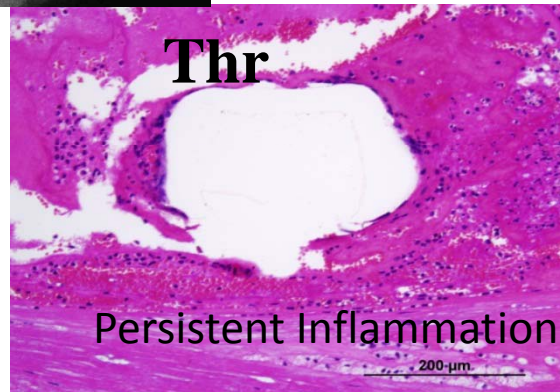


SCD seven days after discontinuation of Clopidogrel and ASS for lung biopsy.

- LM: PES
- LAD: PES
- Diag: PES
- LCX: PES
- Lom: BMS

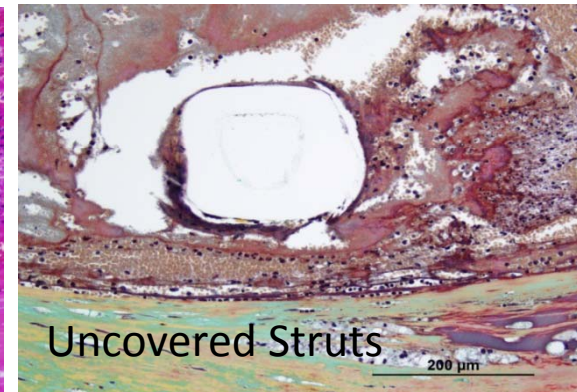


**Occlusive
Thrombus**

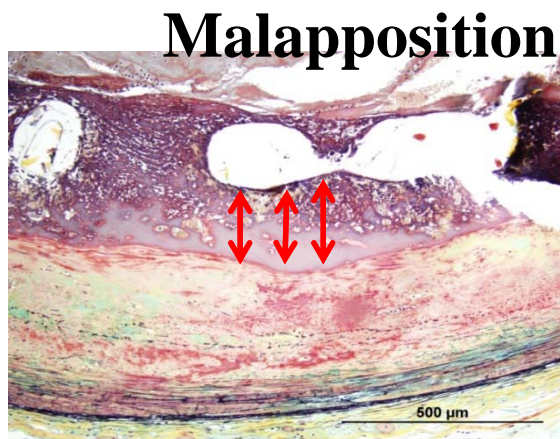


Thr

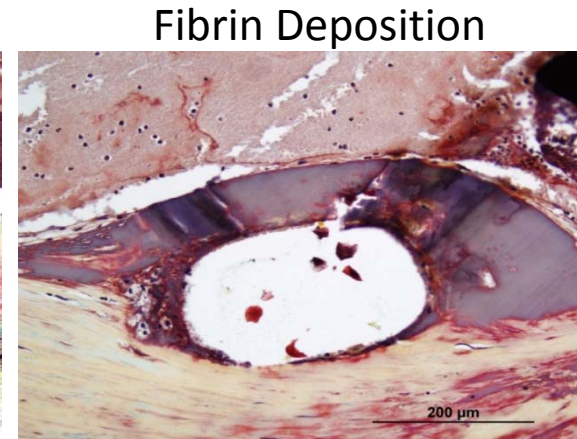
Persistent Inflammation



Uncovered Struts



Malapposition



Fibrin Deposition



Analysis of Bifurcation Stenting

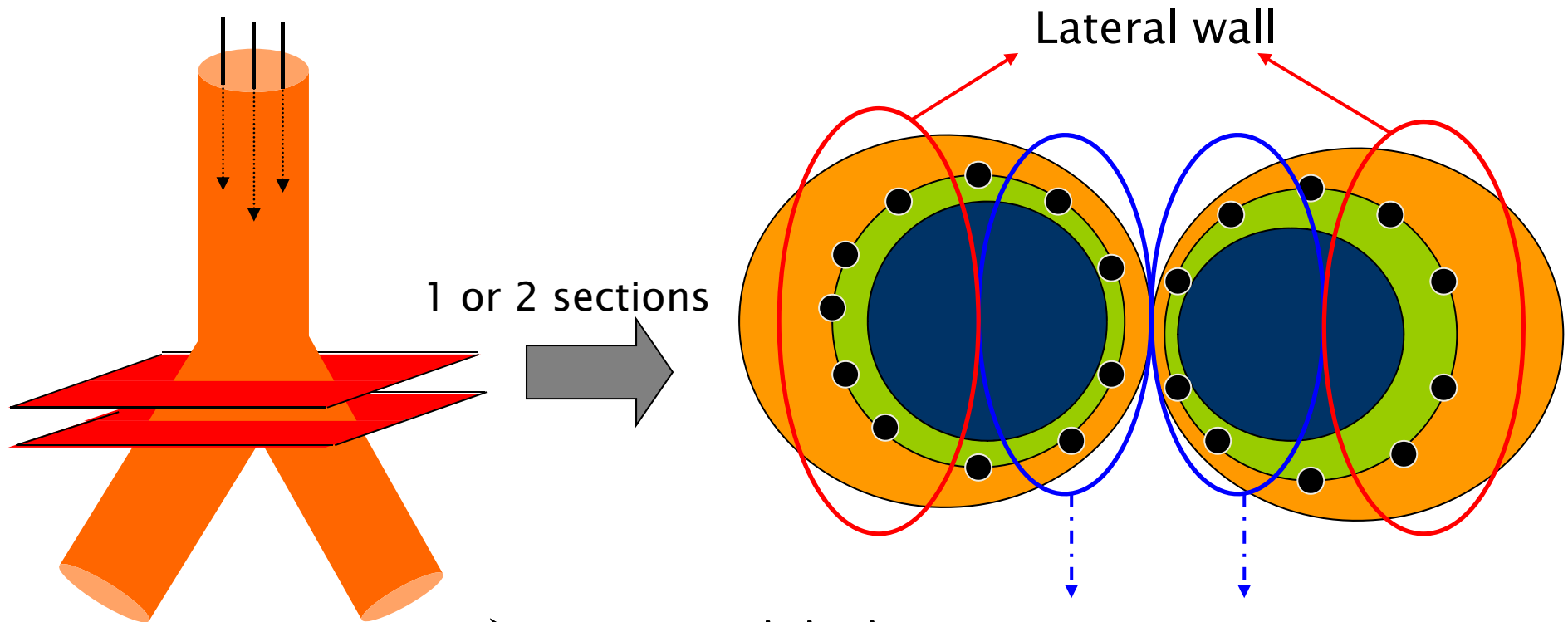
From CVPath Autopsy Cases



DES implantation in Bifurcation Lesion

	DES (n=19)	BMS (n=21)	p value
Age (yrs)	61 ± 16	58 ± 17	0.61
Male Gender (%)	15 (79)	13 (62)	0.41
Mean duration (day)	330 [188, 680]	150 [54, 540]	0.14
>30 days (%)	12 (63)	14 (67)	0.81
<u>Technique</u>			
1 stent	10	9	0.38
2 stent, T/ V/ Crush	5/ 2/ 2	9/ 3/ 0	
<u>Number of stents</u>	1.9 ± 0.8	1.8 ± 0.8	0.58
<u>Restenosis</u>			
MV (%)	1 (6)	7 (33)	0.03
SB (%)	3 (16)	6 (29)	0.7
<u>Thrombosis</u>			
< 30 days <			
MV (%)	3 (43)	3 (43)	0.33
SB (%)	3 (43)	4 (57)	0.73
> 30 days <			
MV (%)	9 (75)	5 (36)	0.04
SB (%)	5 (42)	2 (14)	0.35
<u>Timing of thrombus</u>	270 [195, 585]	60 [35, 105]	0.003

Morphometric Analysis



1 or 2 sections

- Neointimal thickness
 - Fibrin deposition
 - Uncovered struts
- Flow divider



Morphometric Analysis

BMS



BMS	Flow divider	Lateral wall	p value
Neointimal thickness (mm)	0.42 ± 0.35	0.50 ± 0.34	0.15
Struts with fibrin (%)	24 ± 30	20 ± 30	0.31
Uncovered Strut (%)	17 ± 31	5 ± 10	0.08

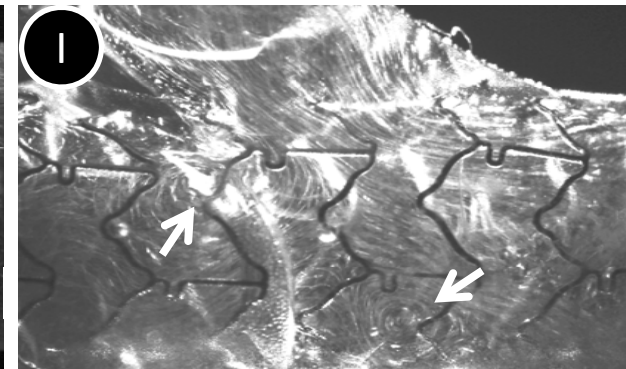
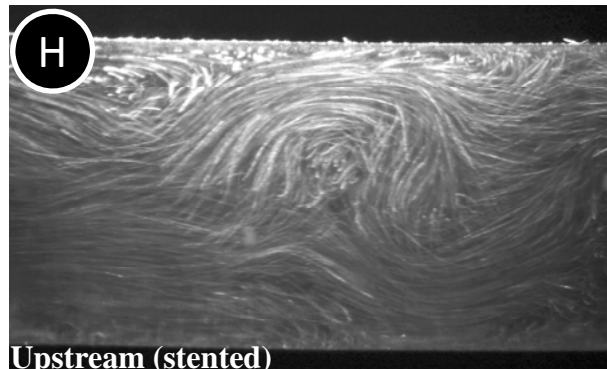
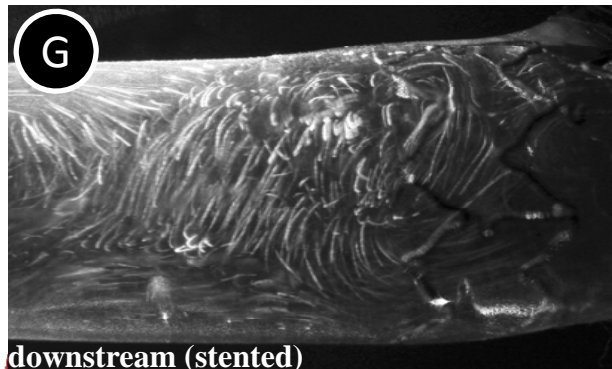
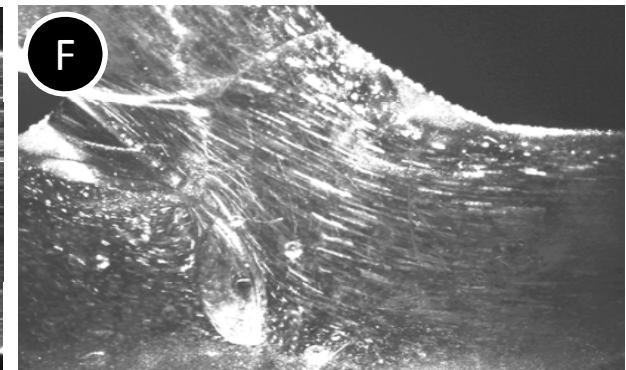
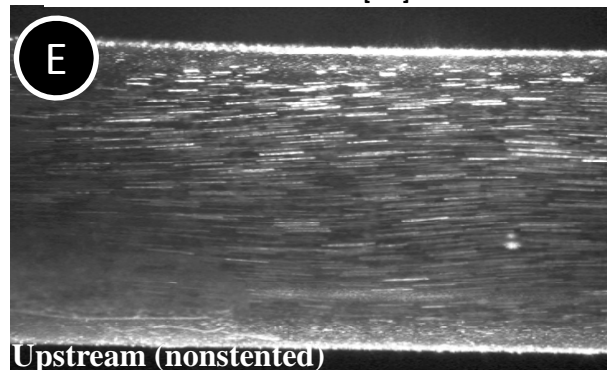
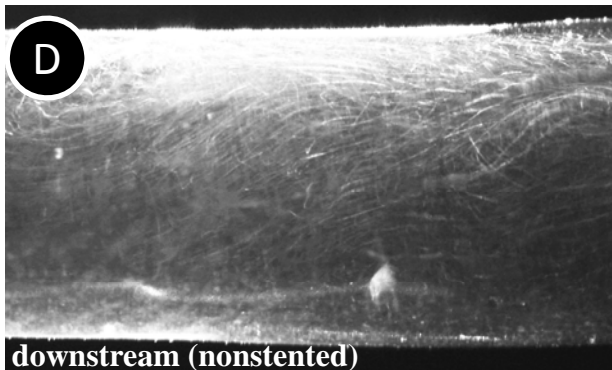
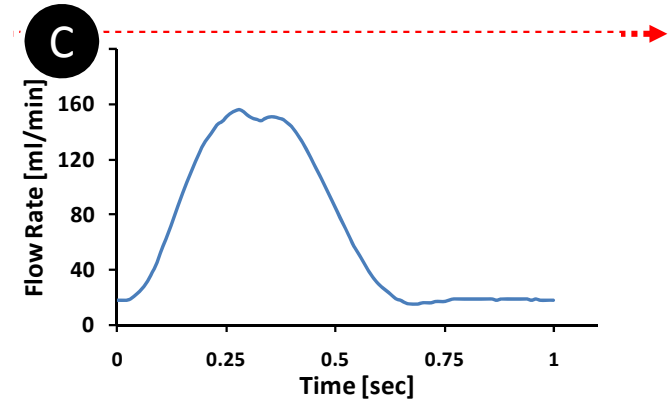
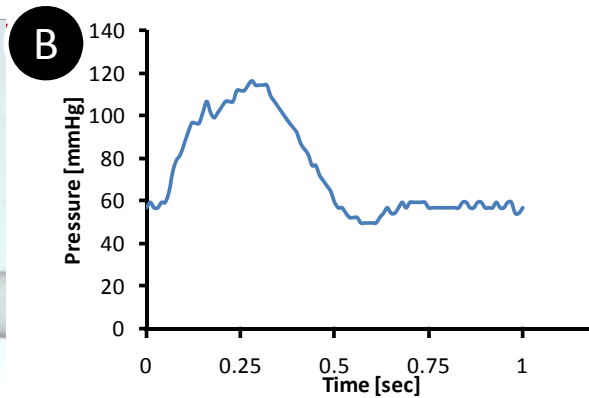
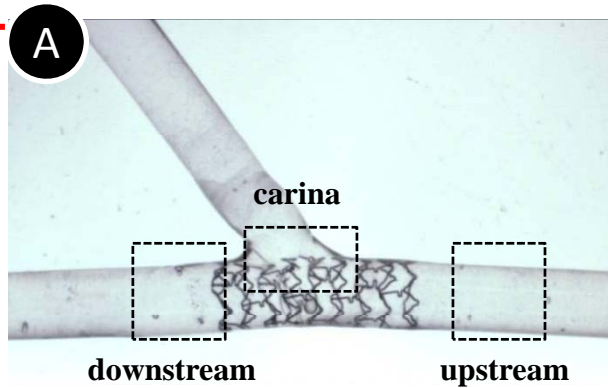
Morphometric Analysis

DES



	Flow divider	Lateral wall	p value
Neointimal thickness (mm)	0.08 ± 0.07	0.16 ± 0.09	0.003
Struts with fibrin (%)	52 ± 27	36 ± 33	0.03
Uncovered Strut (%)	48 ± 33	13 ± 24	<0.0001

Flow disturbance induced by stenting



Conclusions



- LMCA show complex plaque especially when significantly narrowed
- LAD and/or LCX involvement was common in patients with LMCA stenosis
- Atherosclerotic plaque was predominantly seen in lateral wall rather than flow divider
- Because of the plaque complexity, the deployment is important in LMCA stenting
- Flow disturbance is the primary cause of delayed arterial healing in bifurcation lesion following DES implantation