Does intravascular imaging save lives?

John A Ambrose, MD, FACC
Emeritus Chief of Cardiology, UCSF Fresno
Professor of Medicine UCSF

NOTHING TO DECLARE


NO

MAYBE !!!

3 areas to consider where imaging has been used

- Pathophysiology in CAD
- PCI
- Vulnerable plaque detection

Pathophysiology in CAD

Intravascular imaging in general useful in determining the following parameters:

- **Plaque burden, area stenosis, vessel remodeling, calcification, plaque type based on cap thickness, lipid and fibrous components**
- **Optimum stent deployment/causes of stent failure**
- **Pathophysiology of ACS-identification of plaque rupture/erosion/calcified nodule**

Pathophysiology in ACS

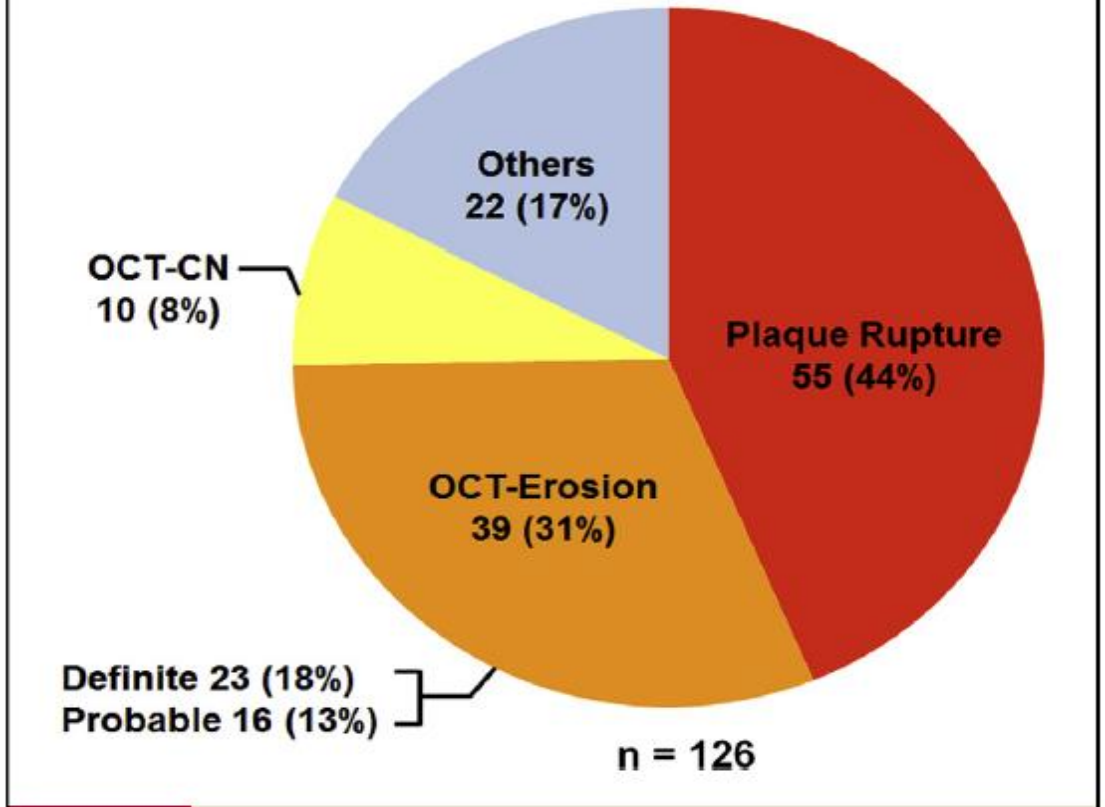


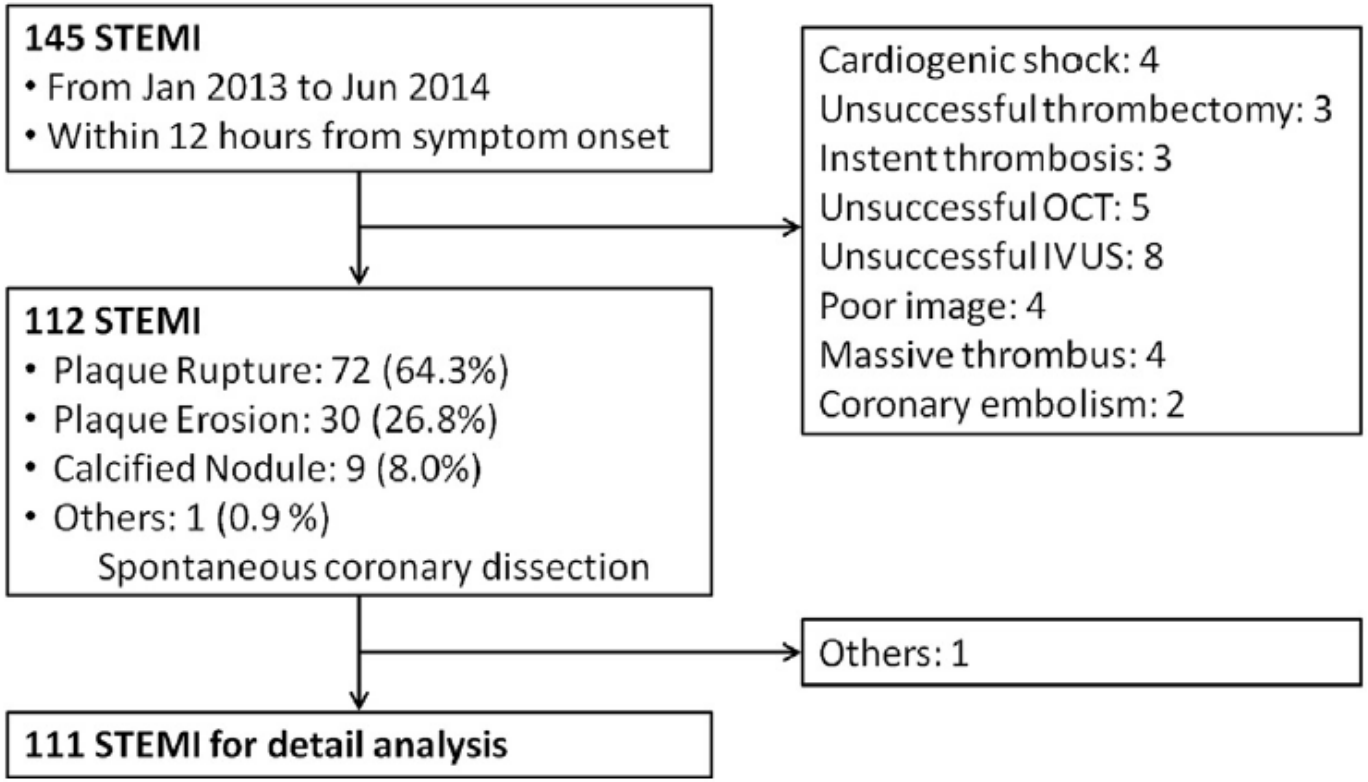
Figure 6 Incidence of Plaque Rupture, OCT-Erosion, and OCT-CN in Patients With ACS

Among the 126 culprit lesions, 55 (44%) lesions were classified as plaque rupture, 39 (31%) lesions were classified as optical coherence tomography (OCT)-erosion, 10 (8%) lesions were classified as OCT-calcified nodule (CN), and 22 (17%) lesions were classified as others. ACS = acute coronary syndrome.

PR in 72% STEMI and 32% NSTEMI
Erosion in 28% STEMI, 48% NSTEMI
Ca++ Nod in 20% NSTEMI

Jia et al. JACC 2013;62:1748

FIGURE 1 Study Flow Chart

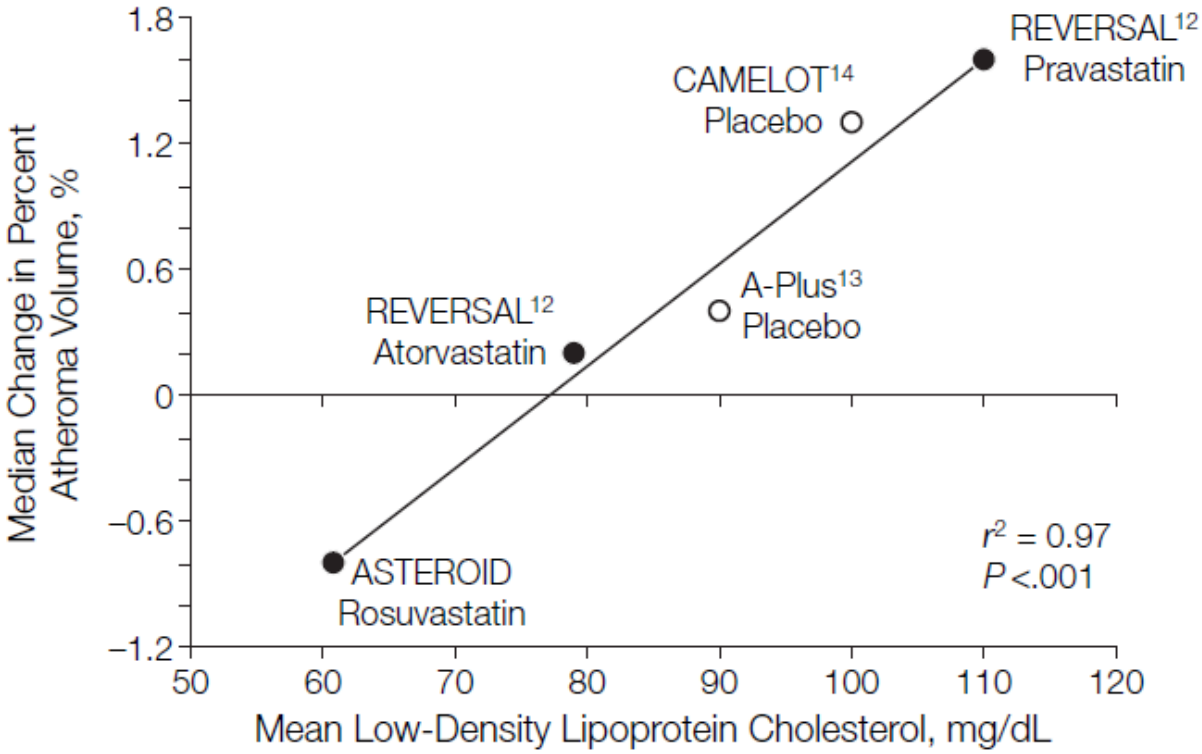


Of the 145 patients with acute onset STEMI, 112 patients were identified with the underlying mechanism of STEMI using OCT and IVUS. Finally, 111 STEMI patients were enrolled for detail analysis. IVUS = intravascular ultrasound; OCT = optical coherence tomography; STEMI = ST-segment elevation myocardial infarction.

Higuma et al. JACC Interv 2015

IVUS and plaque reversal with lipid lowering

Figure 3. Relationship Between Mean Low-Density Lipoprotein Cholesterol Levels and Median Change in Percent Atheroma Volume for Several Intravascular Ultrasound Trials



Nissen et al. JAMA 2006

Unless the intravascular technique can predict precisely which plaques are likely to cause plaque rupture or erosion and lead to a thrombotic event , knowing the pathophysiology/plaque burden alone is unlikely to save lives

3 areas to consider

- Pathophysiology in CAD
- PCI
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Intravascular imaging (IVUS) and PCI-advantages

- Informing the necessity of lesion preparation
- Choosing appropriate stent diameter and length
- Guiding optimal stent expansion
- Identifying acute complications
- Clarifying mechanisms of stent failure from neointimal hyperplasia, stent fracture, under expansion, thrombosis or neoatherosclerosis

after Maehara et al. JACC Imag 2017;10:1487

TABLE 3 Summary of Reports Showing an Effect of IVUS on Outcomes

	Steinvil (62)	Elgendy (61)	IVUS-XPL (60)	de la Torre Hernandez (64)	ADAPT-DES (4)
Uniqueness of study	Largest meta-analysis	Meta-analysis of randomized controlled trials	Largest randomized controlled trial, stent length ≥28 mm	Largest propensity matched pooled analysis of unprotected left main lesions	Largest all-comers registry
Percent IVUS guidance (N)	46.9 (31,283)	50 (3,192)	50 (1,400)	50 (1,010)	39 (8,582)
No. of studies included	25	7	1	4	1
Follow-up time, yrs	1 (in 56%)	1 (in 73%)	1	3	2
	Unadjusted OR or HR				
	OR (95% CI)	OR (95% CI)	HR (95% CI)	Prevalence	HR (95% CI)
Major adverse cardiac event	0.76 (0.70-0.82)	0.60 (0.46-0.77)	0.48 (0.28-0.83)	11.7%/16%*	0.65 (0.54-0.78)
Death	0.62 (0.54-0.72)	0.46 (0.21-1.00)	3/5*	3.3%/6.0%*	0.70 (0.51-0.96)
Myocardial infarction	0.67 (0.56-0.80)	0.52 (0.26-1.02)	0/1*	4.5%/6.5%*	0.62 (0.49-0.77)
Stent thrombosis	0.58 (0.47-0.73)	0.49 (0.24-0.99)	2/2*	0.6%/2.2%*	0.47 (0.28-0.80)
Target lesion revascularization	0.77 (0.67-0.89)	0.60 (0.43-0.84)	0.51 (0.28-0.91)	7.7%/6.0%*	0.79 (0.85-0.95)
Target vessel revascularization	0.85 (0.76-0.95)	Not reported	Not reported	Not reported	0.84 (0.73-0.97)

*IVUS guidance/angiography guidance.

CI = confidence interval; HR = hazard ratio; IVUS-XPL = Impact of Intravascular Ultrasound Guidance on Outcomes of Xience Prime Stents in Long Lesions; OR = odds ratio; other abbreviations as in Tables 1 and 2.

Maehara et al. JACC Imag 2017;10:1487

IVUS versus OCT- outcomes

While there are differences between the 2 techniques in their ability to visualize the vessel wall before and after stenting, in the 2 largest randomized trials (ILUMIEN III and OPINION), an OCT-guided PCI strategy was non-inferior compared to IVUS for both acute and long–term outcomes

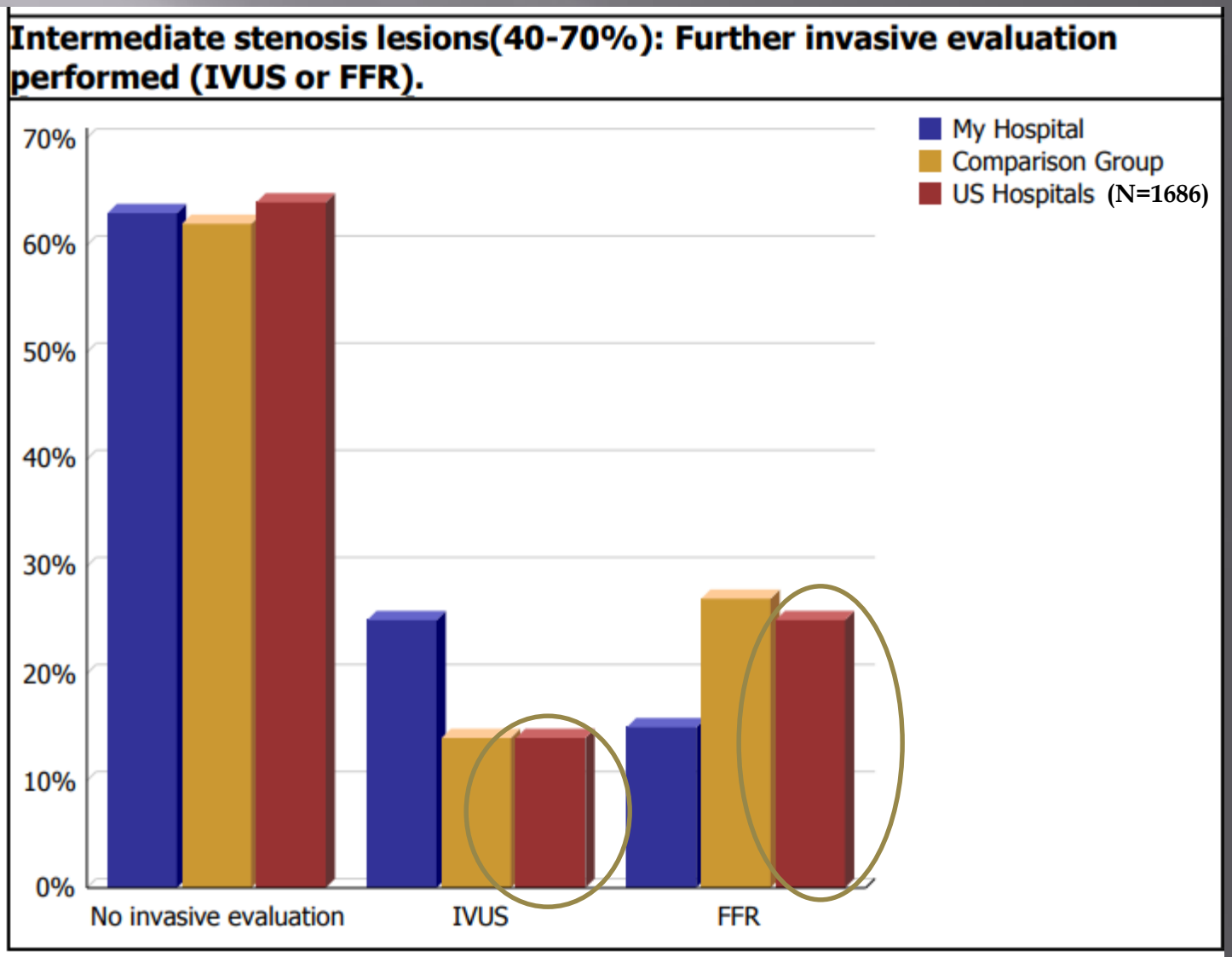
Ali ZA et al. Laccet 2016;388:2618
Kubo T et al. Eur Ht J 2017;18:467

2 caveats to the use of intravascular imaging in PCI

- **You must know what you are looking at- All of the previous trials carried out by operators with extensive expertise in the use of the analyses**
- **You must use the devices- According to the NCDR, in the USA**

- Between April, 2009 and Sept 2010, IVUS used in 20.3% of attempted PCI of intermediate lesions (n=61,784) and FFR used in 6.1% (Dattilo et al. JACC, 2012)

Quarter 3 2017- NCDR database



3 areas to consider

- Pathophysiology in CAD
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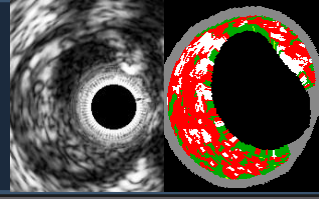
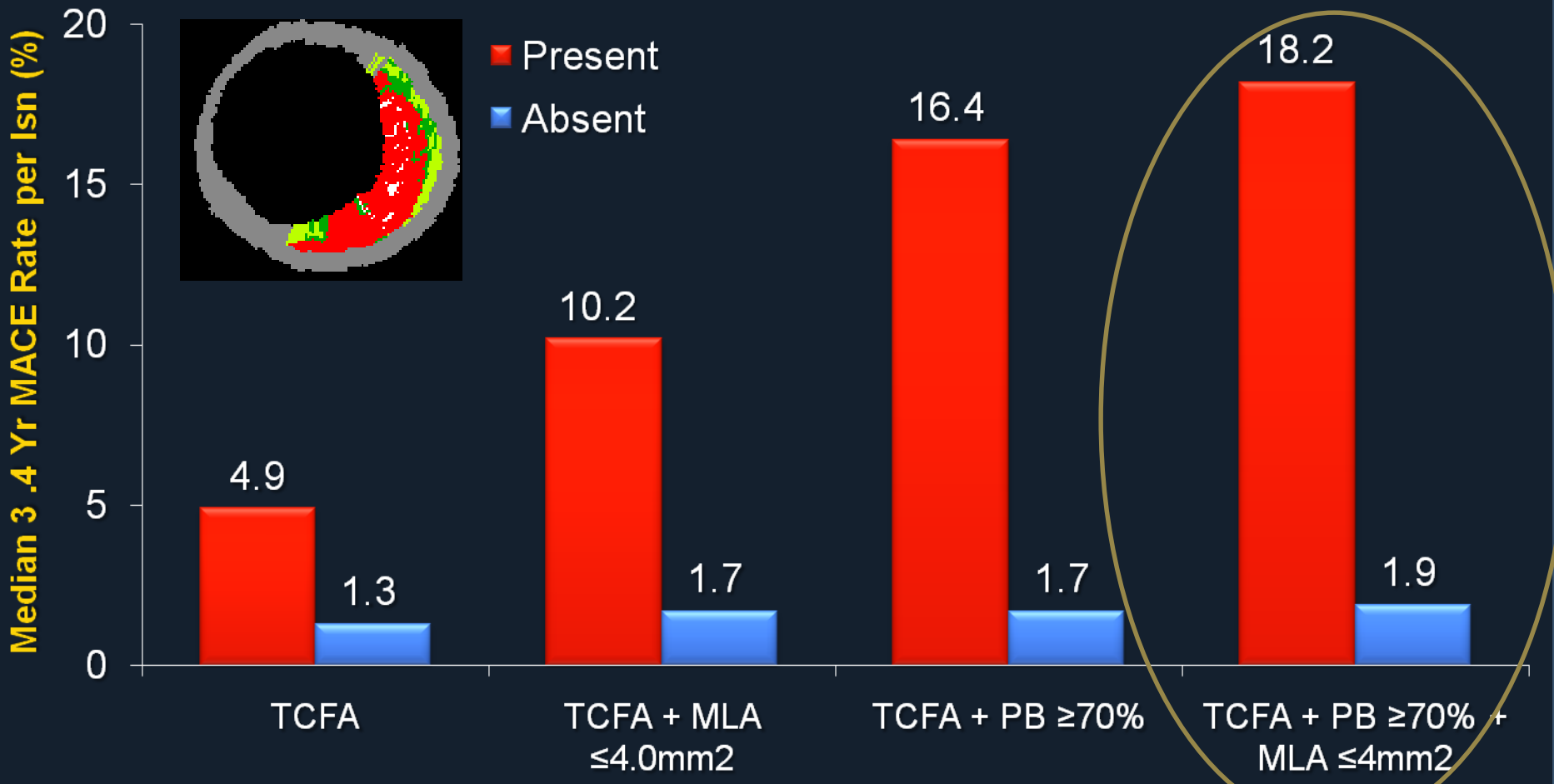
Vulnerable plaque detection

Can an intravascular device identify the specific lesion prior to it causing a thrombotic event, modify it through stenting or some other technique and thus prevent the event from occurring in the future better than optimal medical therapy alone?

PROSPECT: VH-TCFA and Non- Culprit Lesion Related Events

Stone G et al. N Eng J Med, 2011

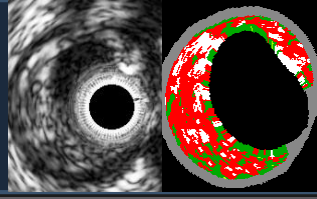




	TCFA	TCFA + MLA ≤4.0mm2	TCFA + PB ≥70%	TCFA + PB ≥70% + MLA ≤4mm2
Lesion HR	3.90 (2.25, 6.76)	6.55 (3.43, 12.51)	10.83 (5.55, 21.10)	11.05 (4.39, 27.82)
P value	<0.0001	<0.0001	<0.0001	<0.0001
Prevalence*	46.7%	15.9%	10.1%	4.2%

*Likelihood of one or more such lesions being present per patient. PB = plaque burden at the MLA

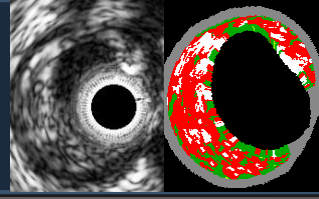
PROSPECT: MACE



3-year follow-up, non hierarchical

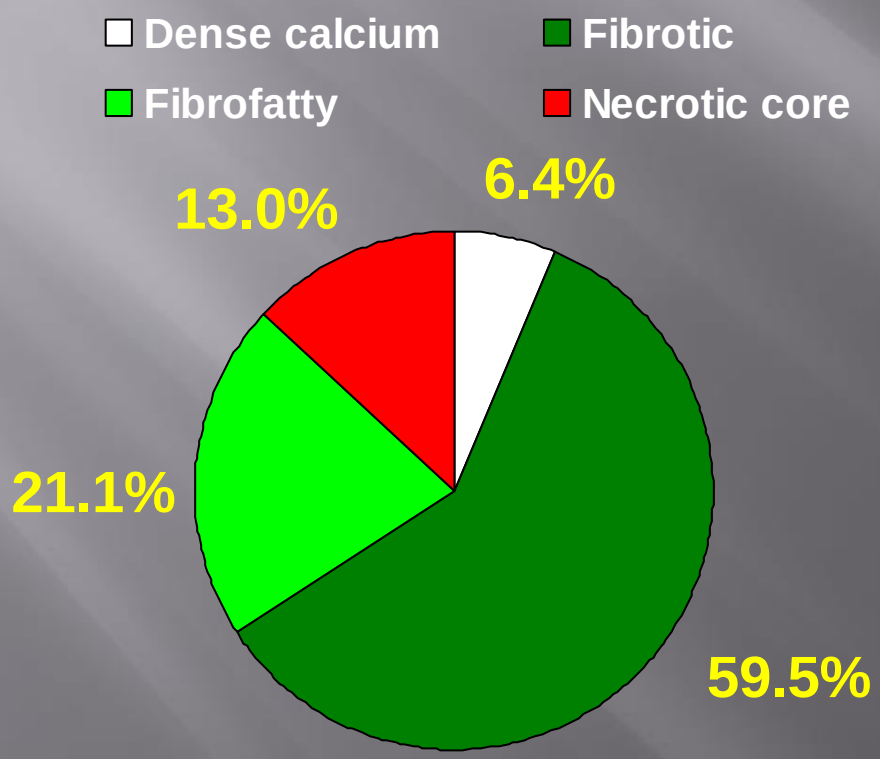
Rates are 3-yr Kaplan-Meier estimates (n of events)	All	Culprit lesion related	Non culprit lesion related	Indeter-minate
Cardiac death	1.9% (12)	0.2% (1)	0% (0)	1.8% (11)
Cardiac arrest	0.5% (3)	0.3% (2)	0% (0)	0.2% (1)
MI (STEMI or NSTEMI)	3.3% (21)	2.0% (13)	1.0% (6)	0.3% (2)
Unstable angina	8.0% (51)	4.5% (29)	**3.3% (21)**	0.5% (3)
Increasing angina	14.5% (93)	9.2% (59)	8.5% (54)	0.3% (2)
Composite MACE	20.4% (132)	12.9% (83)	11.6% (74)	2.7% (17)
Cardiac death, arrest or MI	4.9% (31)	2.2% (14)	1.0% (6)	1.9% (12)

PROSPECT: Imaging Summary



Virtual histology (N=2765 lesions in 615 pts)

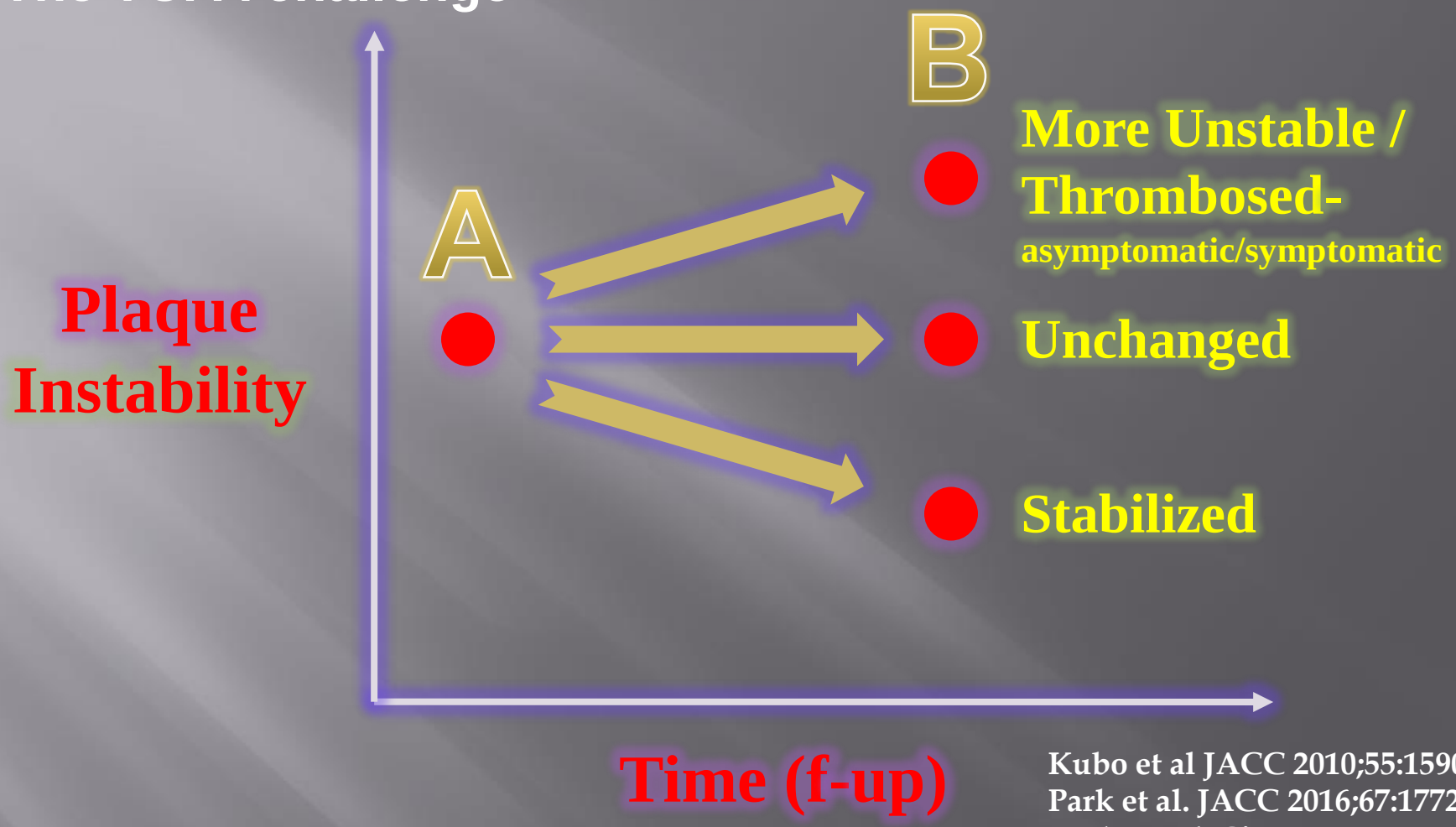
- Mean plaque composition-



Plaque subtype	N=2765
Fibrotic	2.5%
Fibrocalcific	1.0%
PIT	35.8%
Fibroatheroma	60.7%
- Thick cap	38.0%
- **VH-TCFA**	**22.0%**
- Single, - Ca	5.4%
- Single, + Ca	0.5%
- Multiple, - Ca	9.9%
- Multiple, + Ca	6.2%

Stone, G et al. N Eng J Med 2011

The TCFA challenge



Kubo et al JACC 2010;55:1590
Park et al. JACC 2016;67:1772
Burke et al. Circ 2001;103:934

Vulnerable plaque detection

- Can an intravascular device identify the specific plaque (TCFA) prior to it causing a thrombotic event?
- So far the answer is no but 3 large on-going trials are continuing to study the subject in 2 ° prevention

  - Prospect 2

  -Lipid Rich Plaque

  -PREVENT

Initial presentation of CAD based on Framingham Heart Study

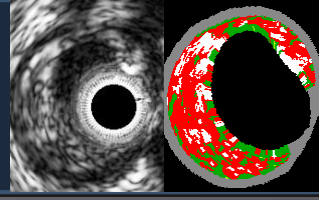
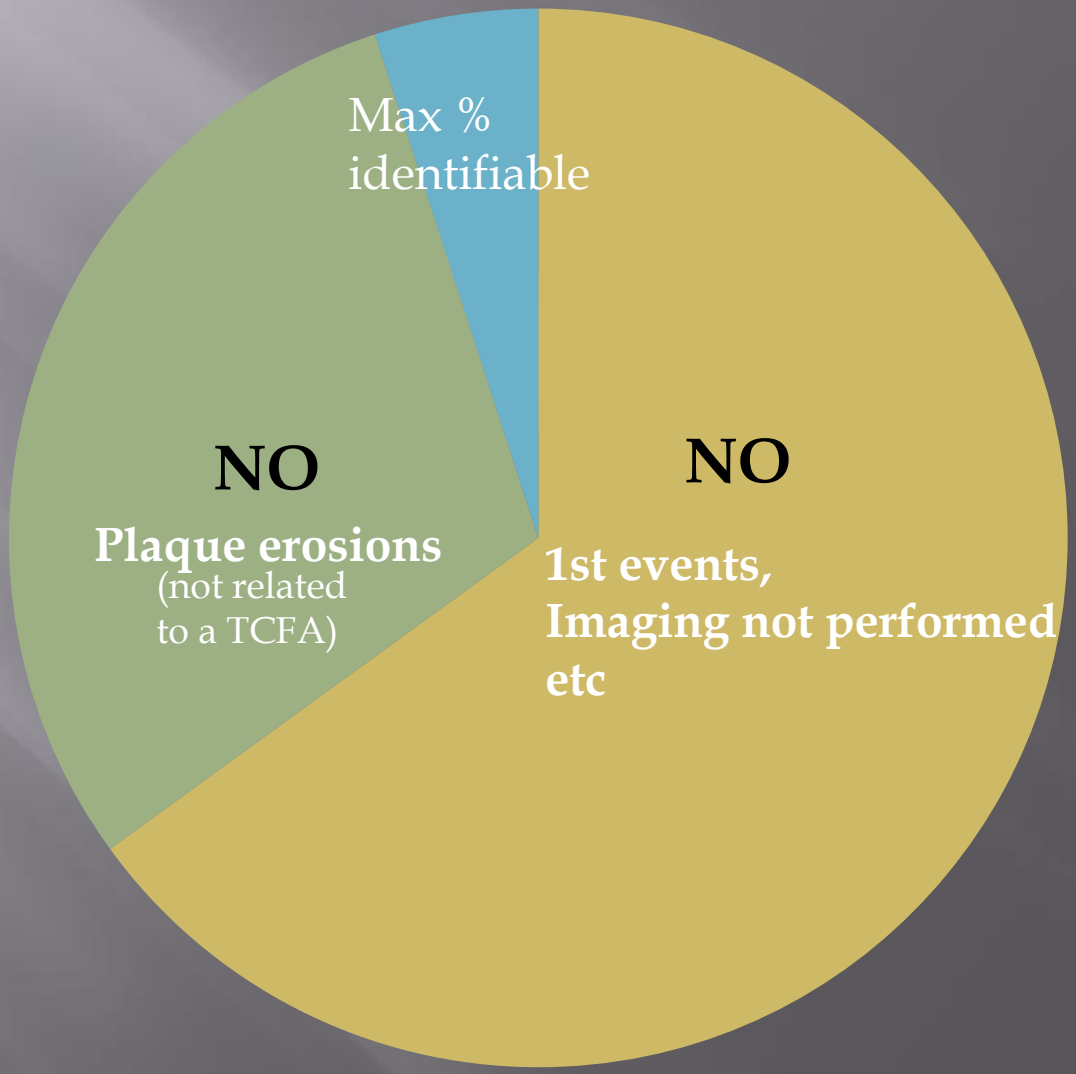


Table I. Manifestations of CHD by sex in subjects ages 35 to 84 years: 26-year follow-up, Framingham study

Clinical manifestations	*% of total events*		
	Men	*Women*	*Total*
Myocardial infarction	43	29	38
Sudden death	10	7	9
Angina pectoris			
Uncomplicated	26	47	34
With infarction	13	8	11
Coronary insufficiency (unstable angina)	8	9	8

Lerner and Kannel. AHJ 1986;111:383

My estimation of the percentage of patients with a future AMI/SCD that might be identified with an invasive vulnerable plaque detector for lipid-rich or other TCFAtype prior to the event



Conclusions

Can intravascular imaging save lives?

-Pathophysiology in CAD- No- not as presently utilized

- In PCI- Yes- if utilized and appropriately in trained hands

-VP detection- Unknown and of ? clinical relevance even with + studies

Swiss army knife

Swiss army catheter

The OCTo-IVUS-Lipido-Angioscopic-FFRascope


The end

THROMBOSED PLAQUE STRUCTURE

Leading to Fatal MI, Sudden Death

*in women (<50yrs), in non-exercise related events and in smokers, the incidence of erosion is higher

Farb et al. *Circulation* 1996;93:1354