Coronary Angioscopy

contribution to the coronary heart disease

Jun-ichi Kotani, MD, PhD, FACC

Chief in Cardiovascular Division, ER/CCU

National Cerebral and Cardiovascular Center

NCVC

“Clinical” diagnosis

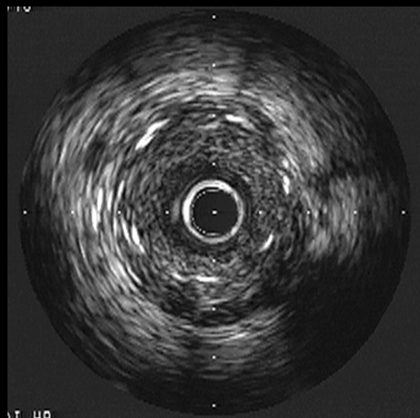
- In the clinical setting, diagnosis always has explored the *"pathological"* answer.

- And angioscopy has established the position for this theme;
  - i.e., acute coronary syndrome, plaque characteristics, healing process after PCI, etc…

Current Modalities

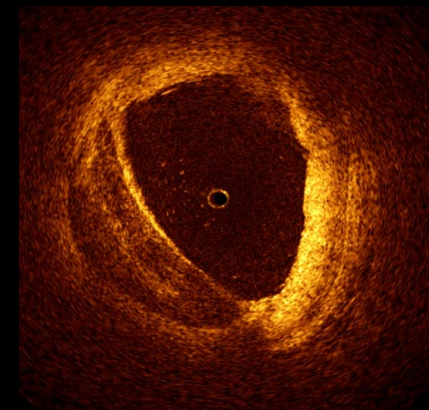
Sound

Light



ultrasound

visible ray



infra-red

	IVUS	CAS	OCT
Quantitative assessment	++	-	+
3D observation with full color	-	++	-
Tissue Characterization	+/-	++	+
Near field resolution	+	++	++
Affect of blood noise	-	++	++
Compatibility for 6 Fr. catheter	++	+	++

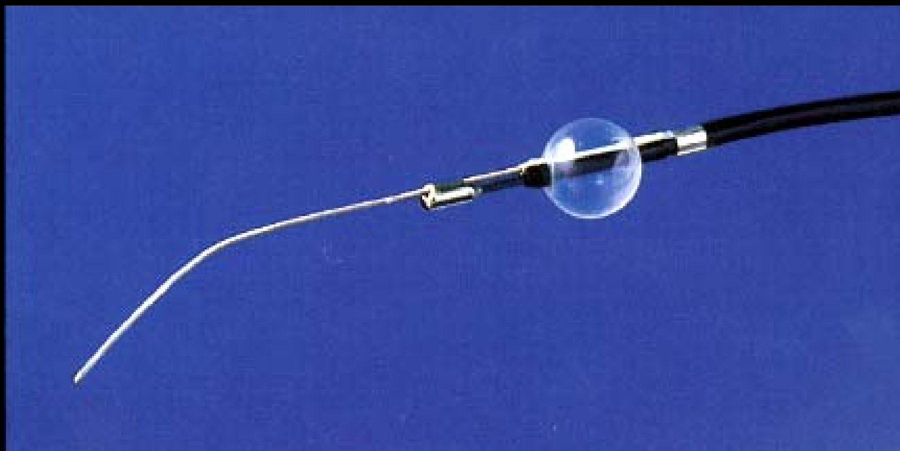
What has angioscopy taught us?

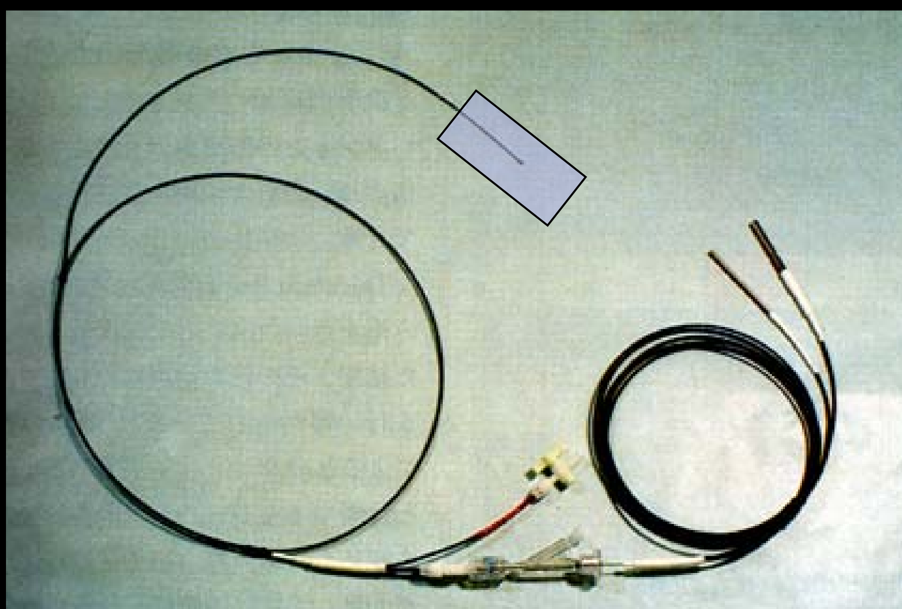
- Coronary angioscope gives the qualitative assessment with color information.
  - Thrombus; mural / occlusive; white /red /mixed.
  - Conditions of vessel surface; smooth/ irregular/ erosive.
  - Plaque/vessel characteristics; yellow, ruptured plaque.
  - Neointimal proliferation over the stent strut.

CAS Systems

- Two types of angioscope systems were available in Japan so far.
  - Monorail on guidewire systems (with occlusion balloon).
  - Bare fiber systems.
- Both system has each characteristics (advantage/disadvantage).
- Avoiding the blood flow by clear liquid flushing is required for clear visualization.

Angioscope System (monorail)





All angioscopic evaluation was conducted using the Vecmova™ coronary imaging catheter (Clinical Supply, Gifu, Japan) that provides 3000 pixel images.

The optical fiber was slowly pulled back to the proximal edge manually.

The images were recorded on digital videotape and the findings were taken by off-line analysis.

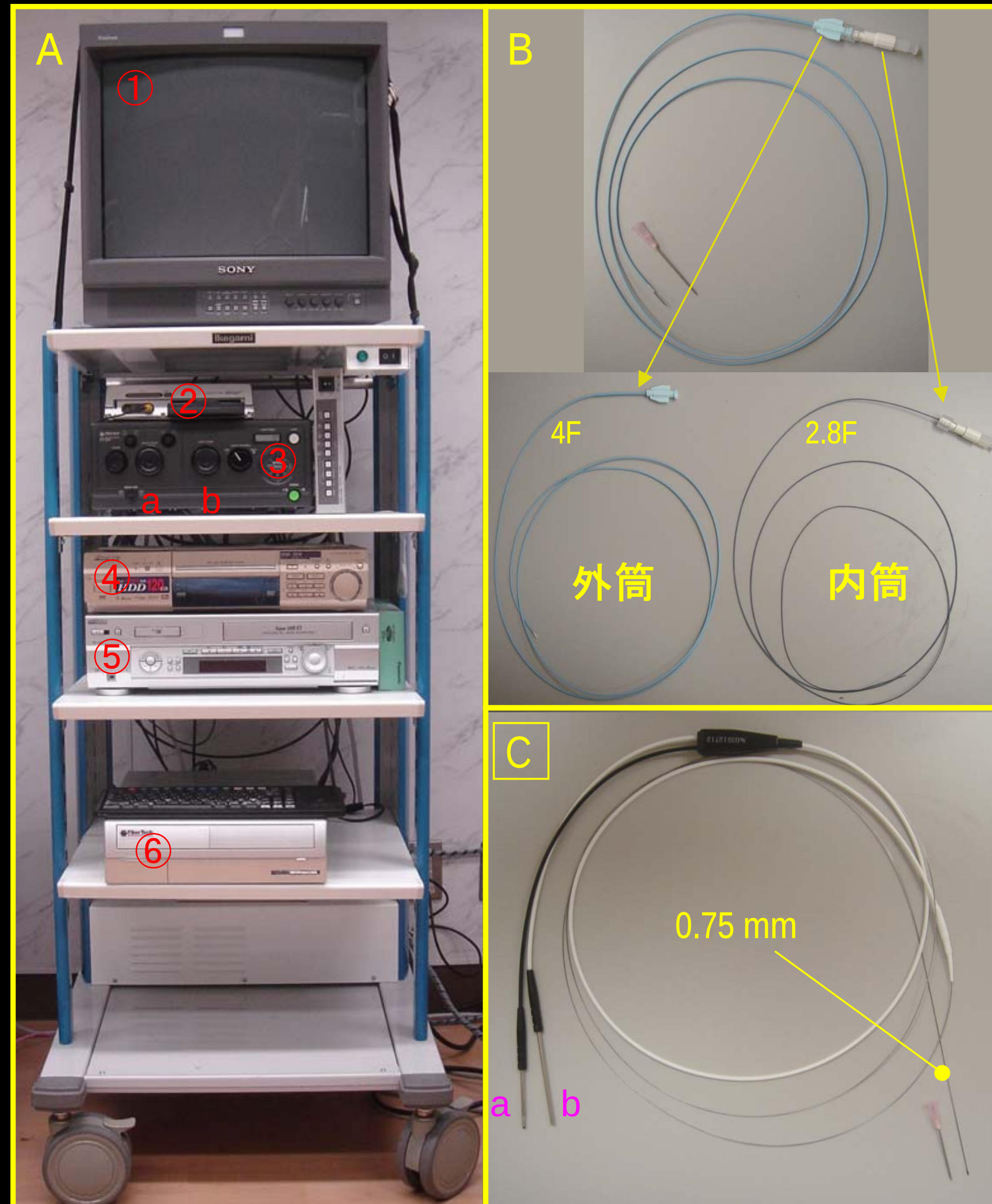
血管内視鏡システム（血流維持型）

A 本体
- ① モニター
- ② プリンター
- ③ 光源およびCCDカメラ
  - Fiber Imaging System FT-201
  - (Fiber Tech Co.)
  - a光源 bファイバー挿入部
- ④⑤⑥ 記録装置

B 誘導ガイドカテーテル
- PCキットMC
- (Intertec Medicals Co.)

C ファイバーカテーテル
- ファイバーカテーテルAS-003
- (Fiber Tech Co.)

手順; Pull back & observe

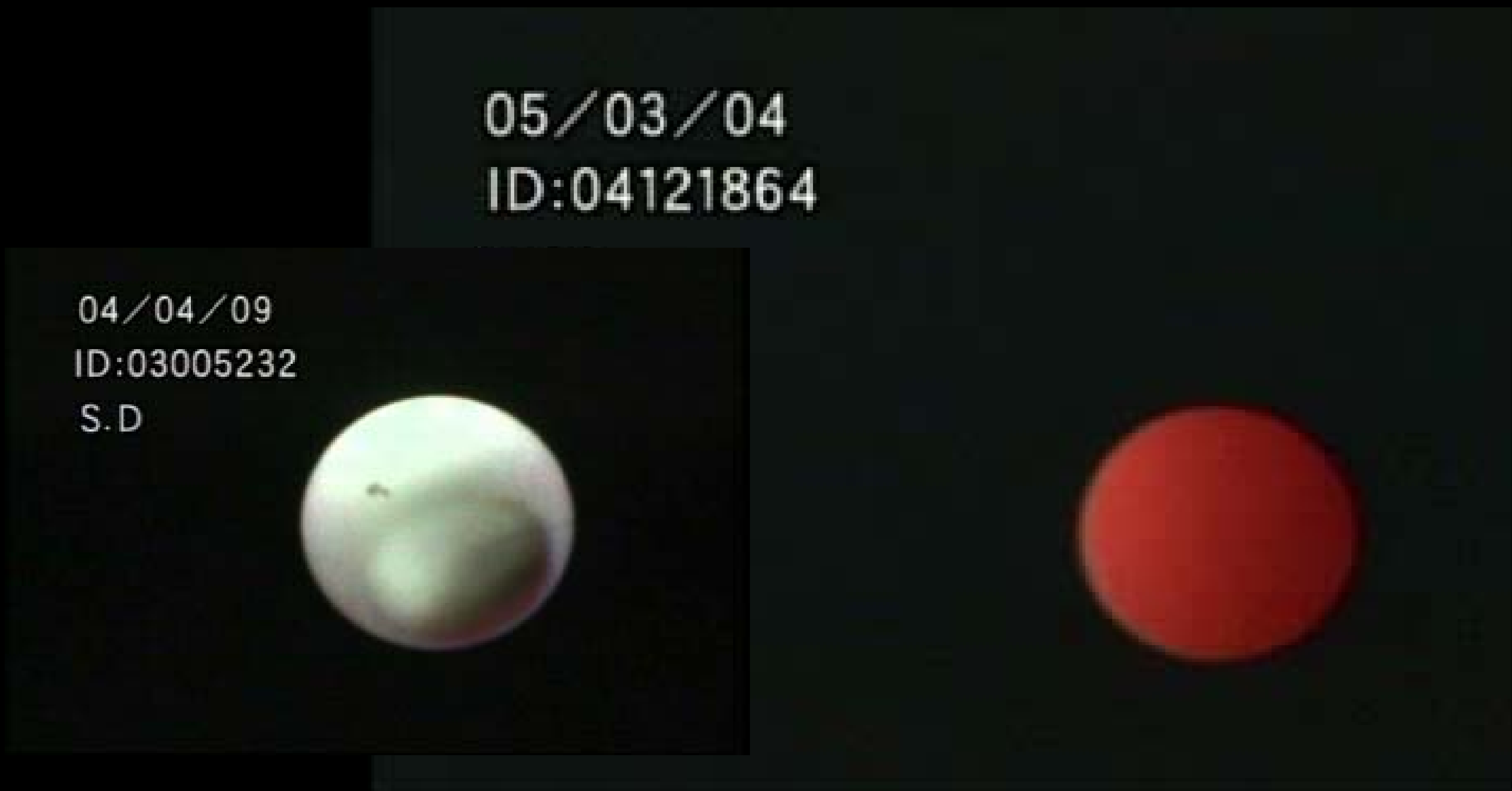


愛媛県立今治病院　川上先生　のご好意による

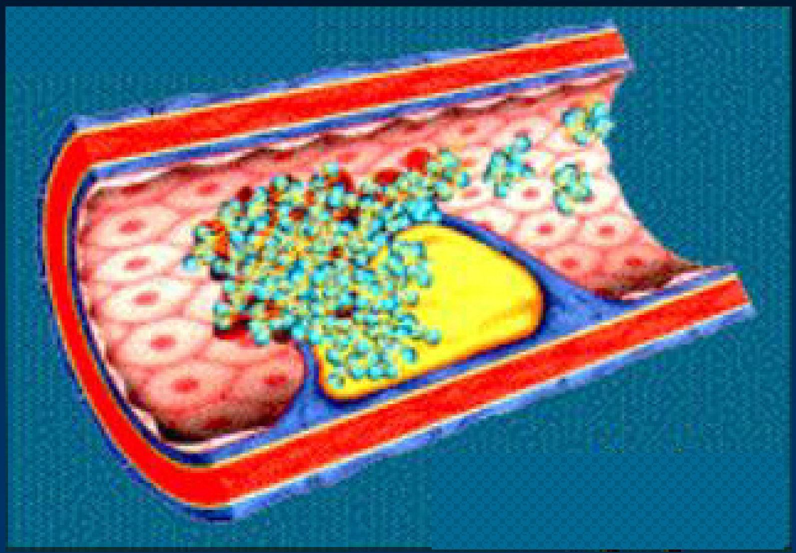
Image Comparison

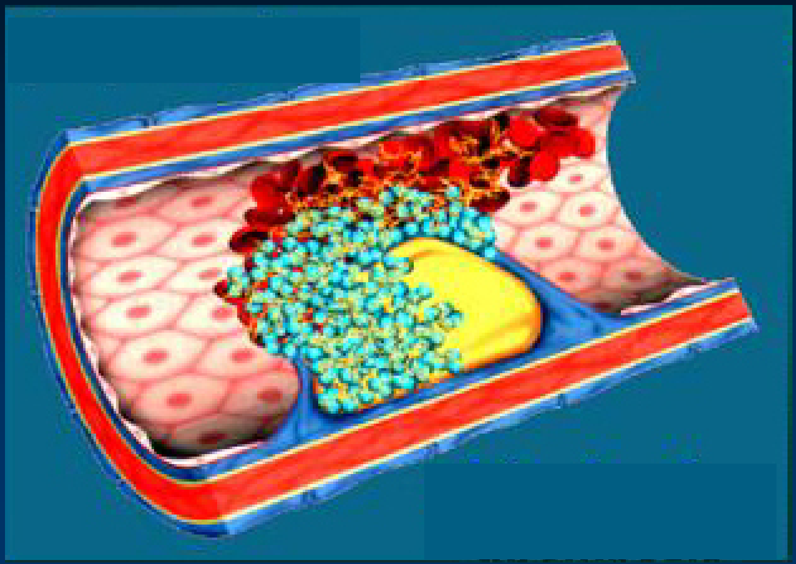
Bare fiber

Monorail

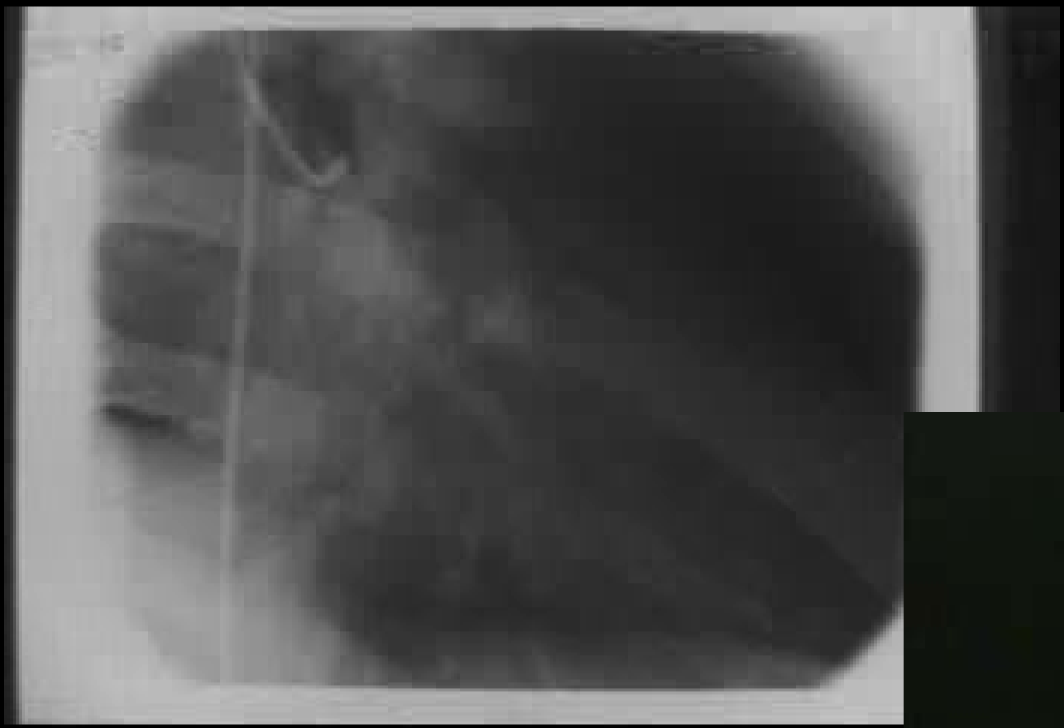


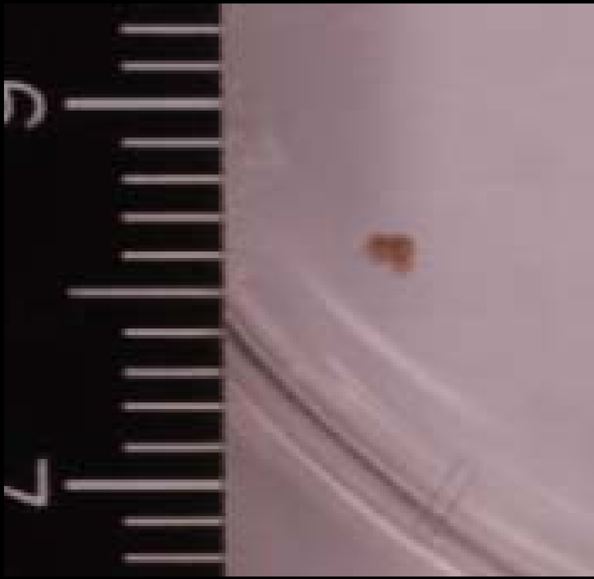
Process for ACS





Phase I : Platelets aggregation
Phase II : Lumen occupation by platelets and some fibrin complex.
-**NSTEMI or unstable angina** (White thrombus)
Phase III : Lumen obstruction by predominantly fibrin and RBC's.
-**STEMI** (Red thrombus)

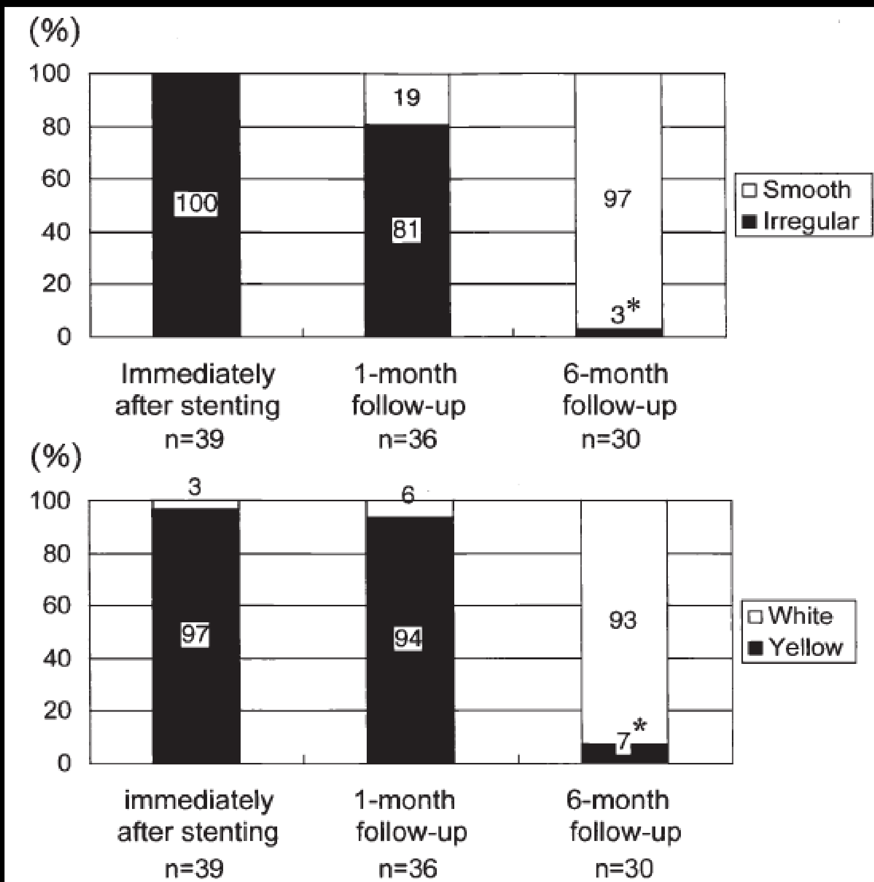


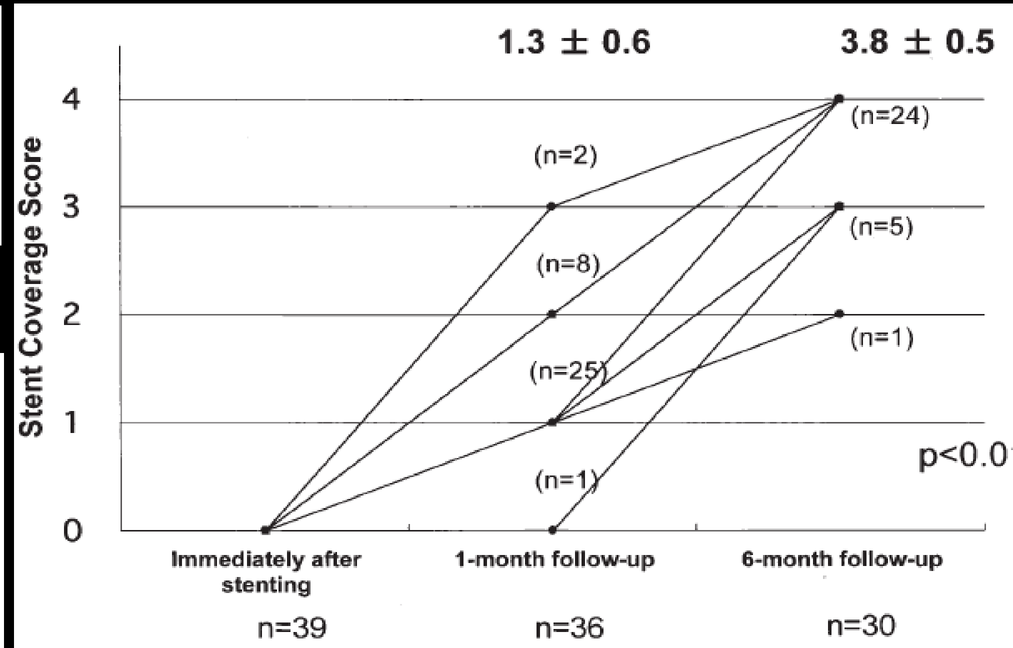


Morphologic Changes in Infarct-Related Plaque After Coronary Stent Placement

A Serial Angioscopy Study

Shunta Sakai, MD, Kyoichi Mizuno, MD, FACC, Shinya Yokoyama, MD, Jun Tanabe, MD, Takuroh Shinada, MD, Koji Seimiya, MD, Masamichi Takano, MD, Takayoshi Ohba, MD, Masato Tomimura, MD, Ryota Uemura, MD, Takahiro Imaizumi, MD
Chiba, Japan

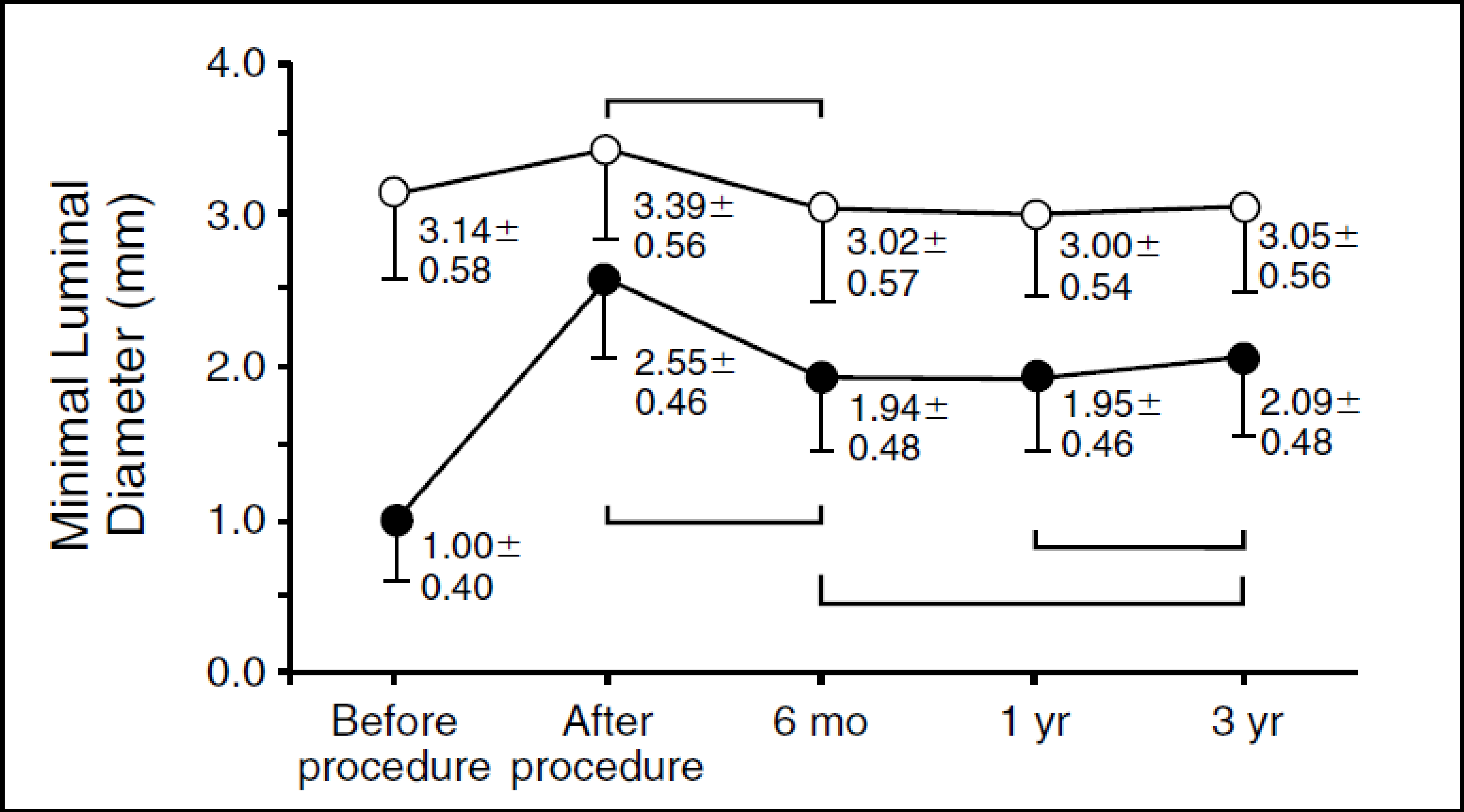




Conclusions. This angioscopic study demonstrated that the morphologic changes after stenting for unstable plaque were the following: 1) a stent compressed and covered a disrupted yellow plaque, with a protruding thrombus and intimal flap, leading to a wide vessel lumen; and 2) the stent induced angioscopic plaque stabilization (smooth and white and without thrombus) through neointimal proliferation, and the sealing was achieved at about six months after stenting, accompanied with complete neointimal stent coverage. Thus, a stent is like "a bandage on a wound." We suggest that mechanical plaque sealing by stenting may therefore be a potentially effective therapeutic strategy for achieving plaque stabilization.

JACC. 42;1558-1565:2003

Angiographic assessment following BMS implantation



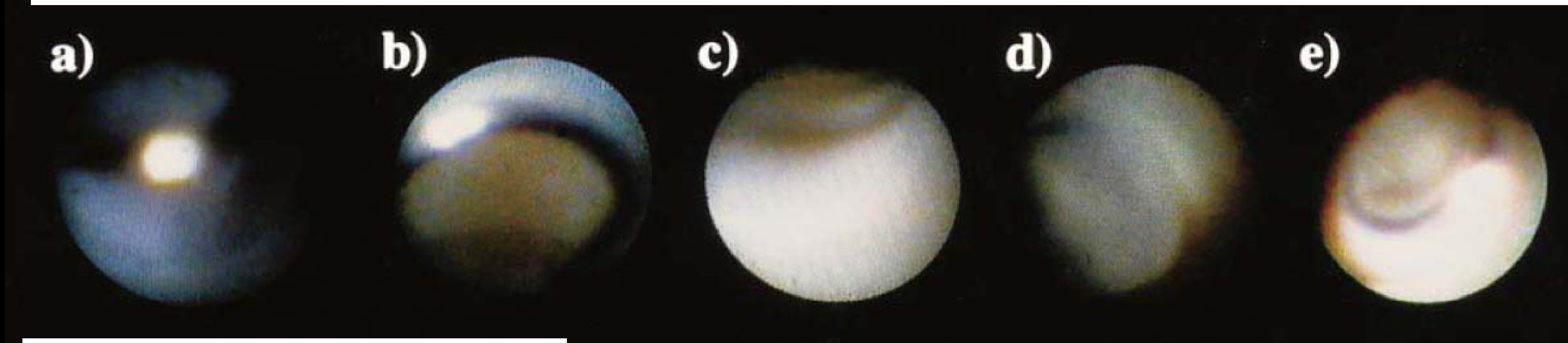
N Engl J Med. 1996;334:561-566.

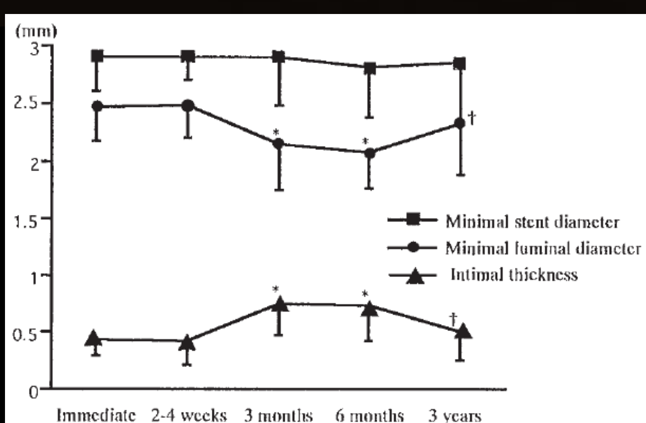
Brief Rapid Communications

Remodeling of In-Stent Neointima, Which Became Thinner and Transparent Over 3 Years

Serial Angiographic and Angioscopic Follow-up

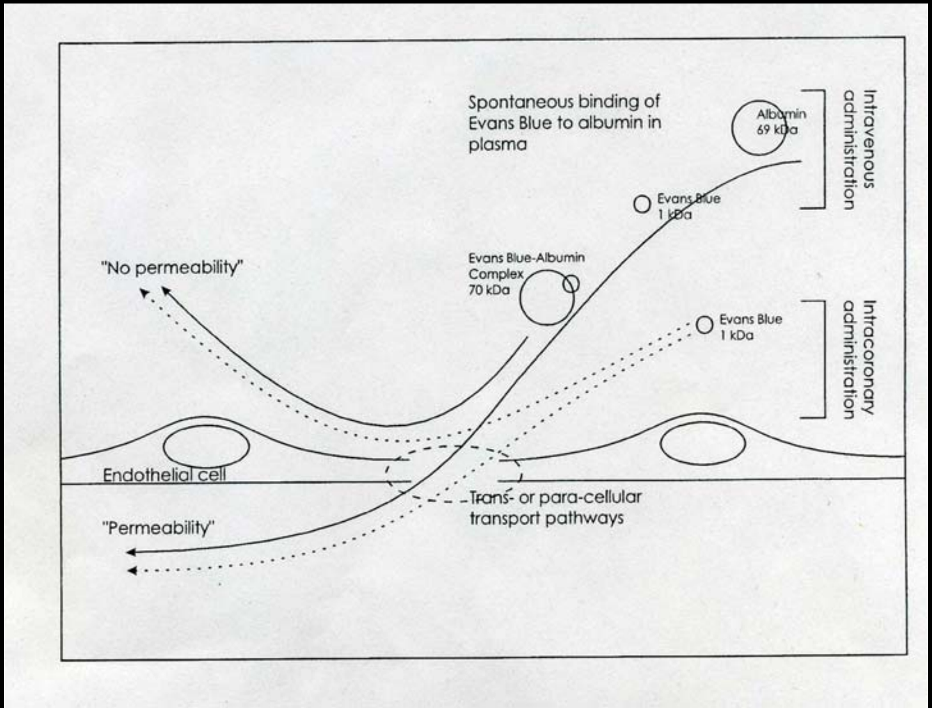
Masanori Asakura, MD; Yasunori Ueda, MD; Shinsuke Nanto, MD; Atsushi Hirayama, MD, PhD; Takayoshi Adachi, MD; Masafumi Kitakaze, MD, PhD; Masatsugu Hori, MD, PhD; Kazuhisa Kodama, MD, PhD





Circulation. 1998;97:2003-2006

Long-term endotherial dysfunction is more pronounced after stenting than after balloon angioplasty in porcine coronary arteries



- Arteries were analyzed using a dye-exclusion test and planimetry of permeable areas(34 stents and 14 POBA). Thereafter, the arteries were processed for light and scanning electron microscopy for assessment of morphology and proliferative response.
- Leakage of the endothelium for molecules such as EB-Alb as well as prolonged endothelial proliferation observed as late as 3 month after the intervention, and is more pronounced after stenting.

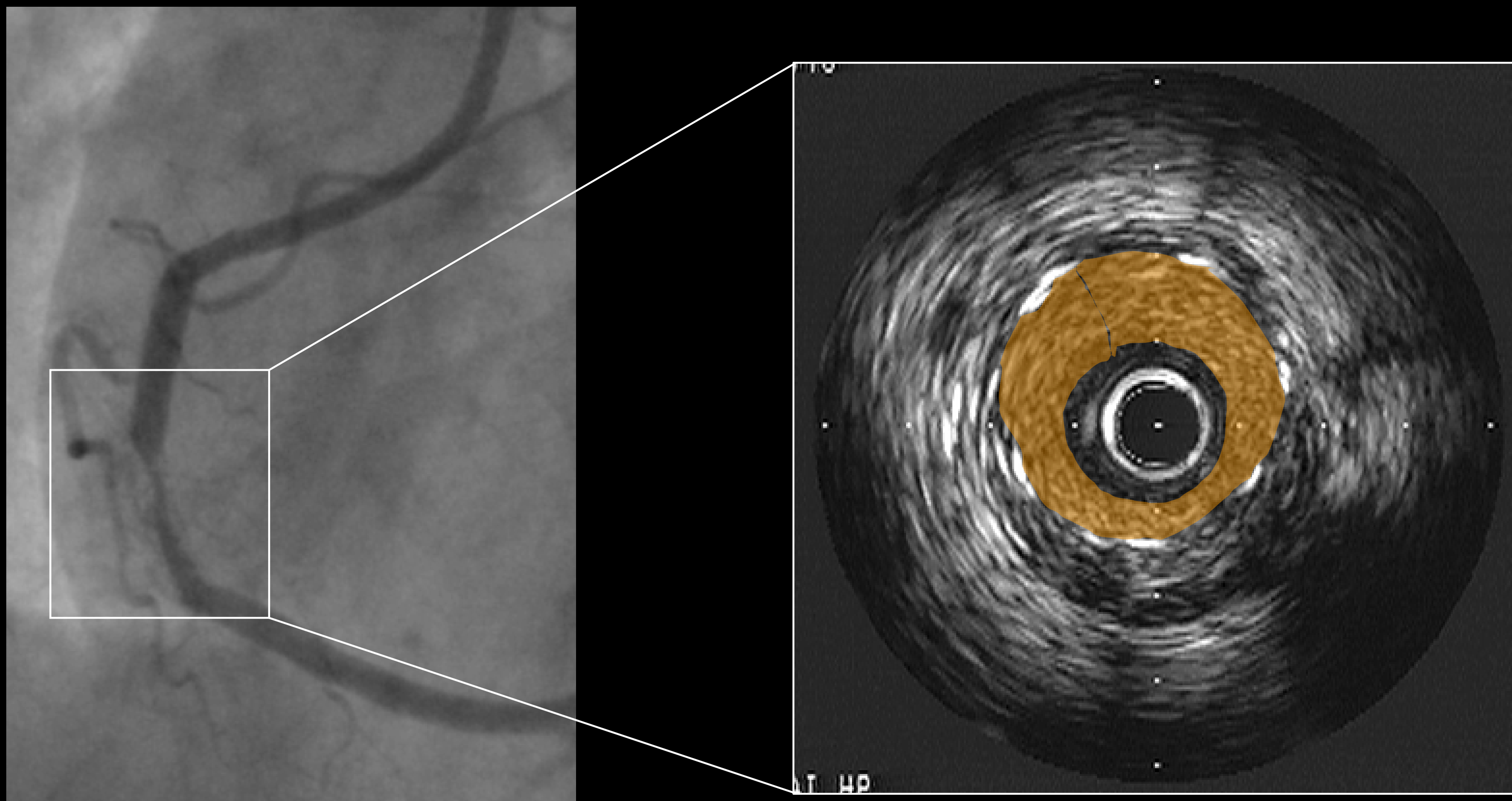
Stenting especially decreases long-term vascular integrity with respect to permeability and endotherial proliferation, and is associated with distinct morphologic characteristics.

Heleen MM, et al. J Am Coll Cardiol. 1998;32:1109-1117.

In-stent Restenosis

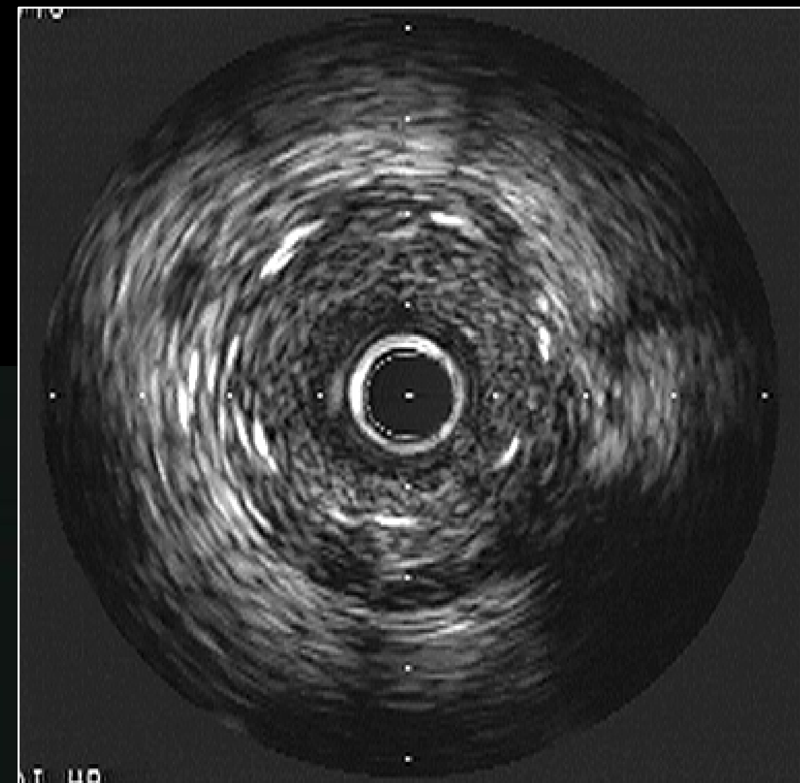
Is ISR formed by concentric smooth muscle tissue layer?

IVUS findings

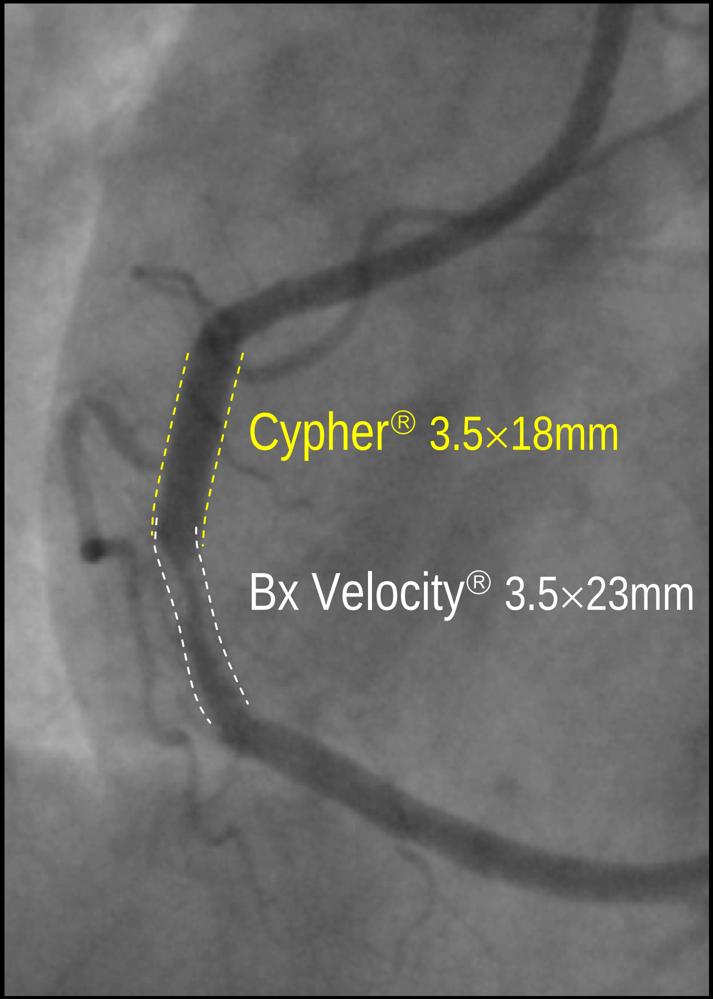


Restenosis of BMS (Bx Velocity) segment

Morphology of BMS-ISR



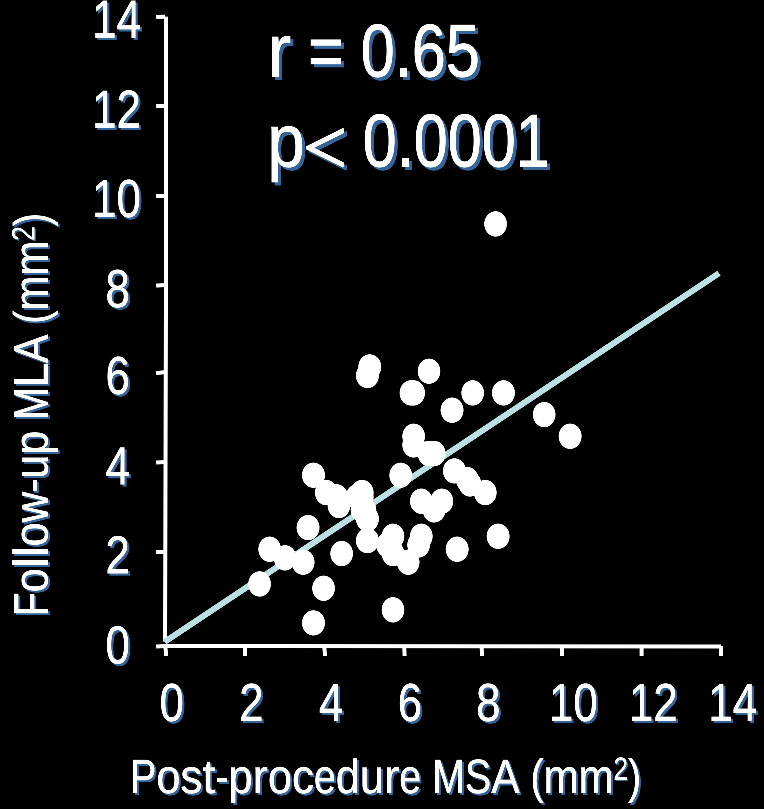
Different from BMS



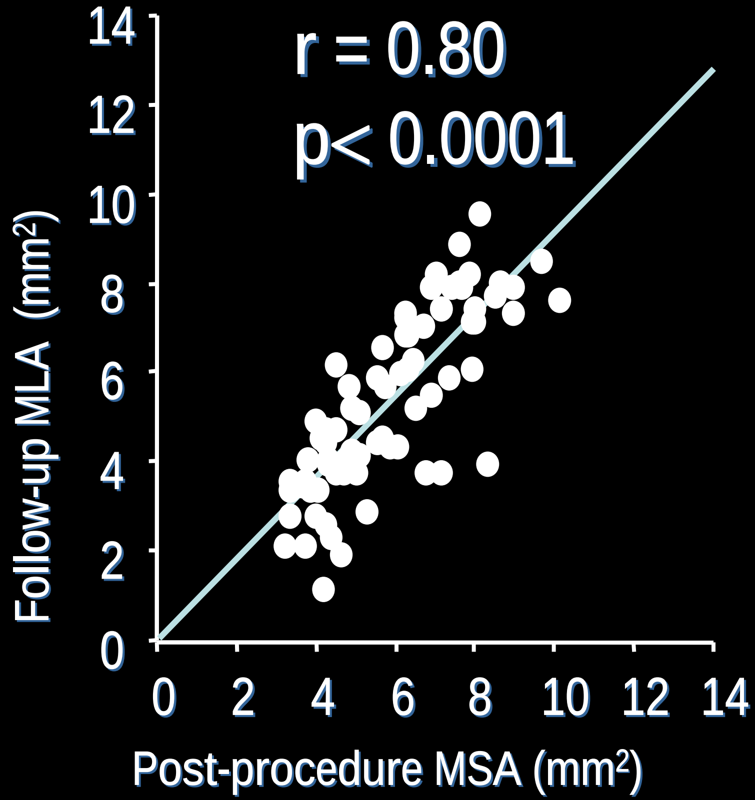
Follow-up CAG at 6 month

Polymer based sirolimus-eluting stent

BMS

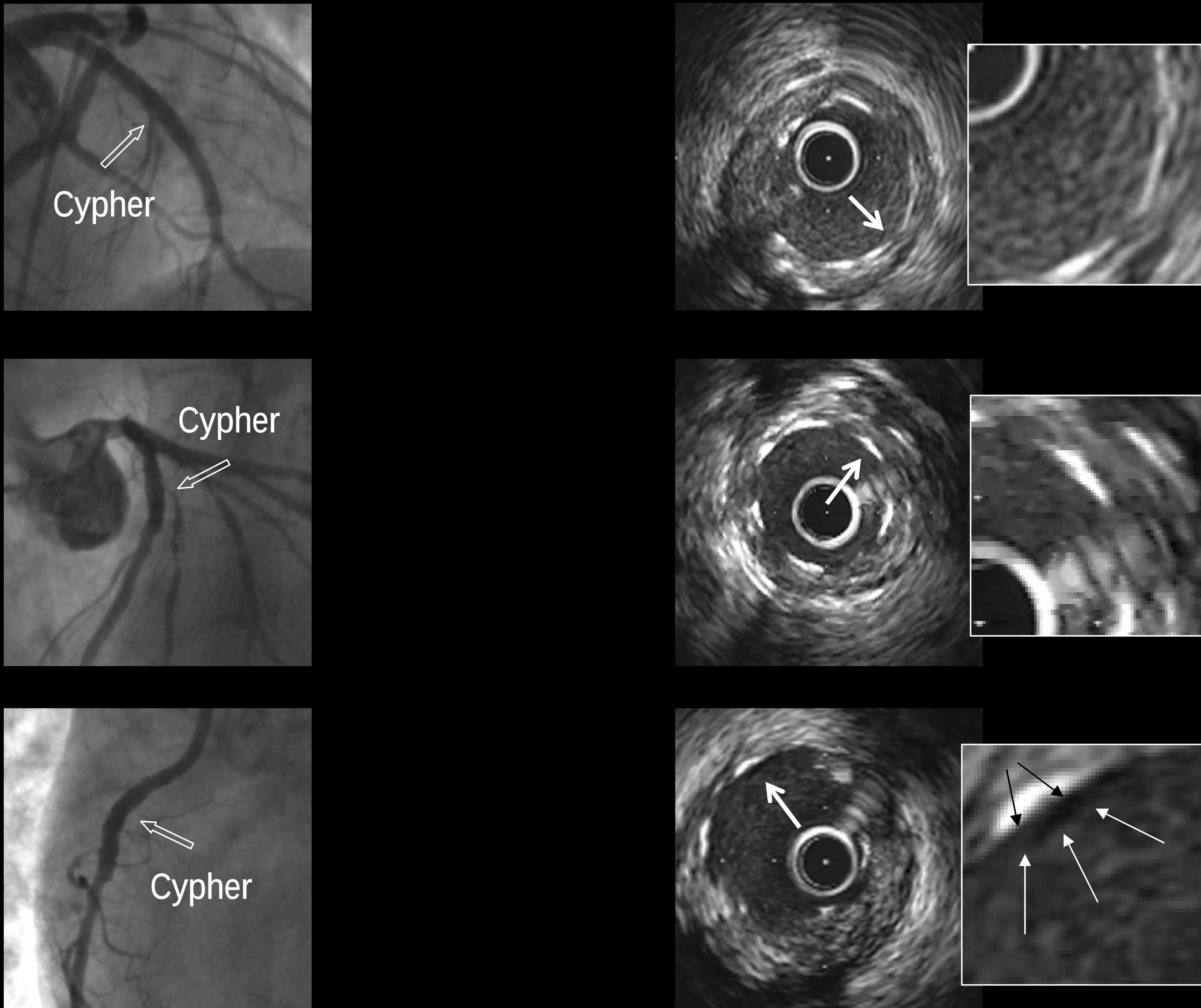


SES

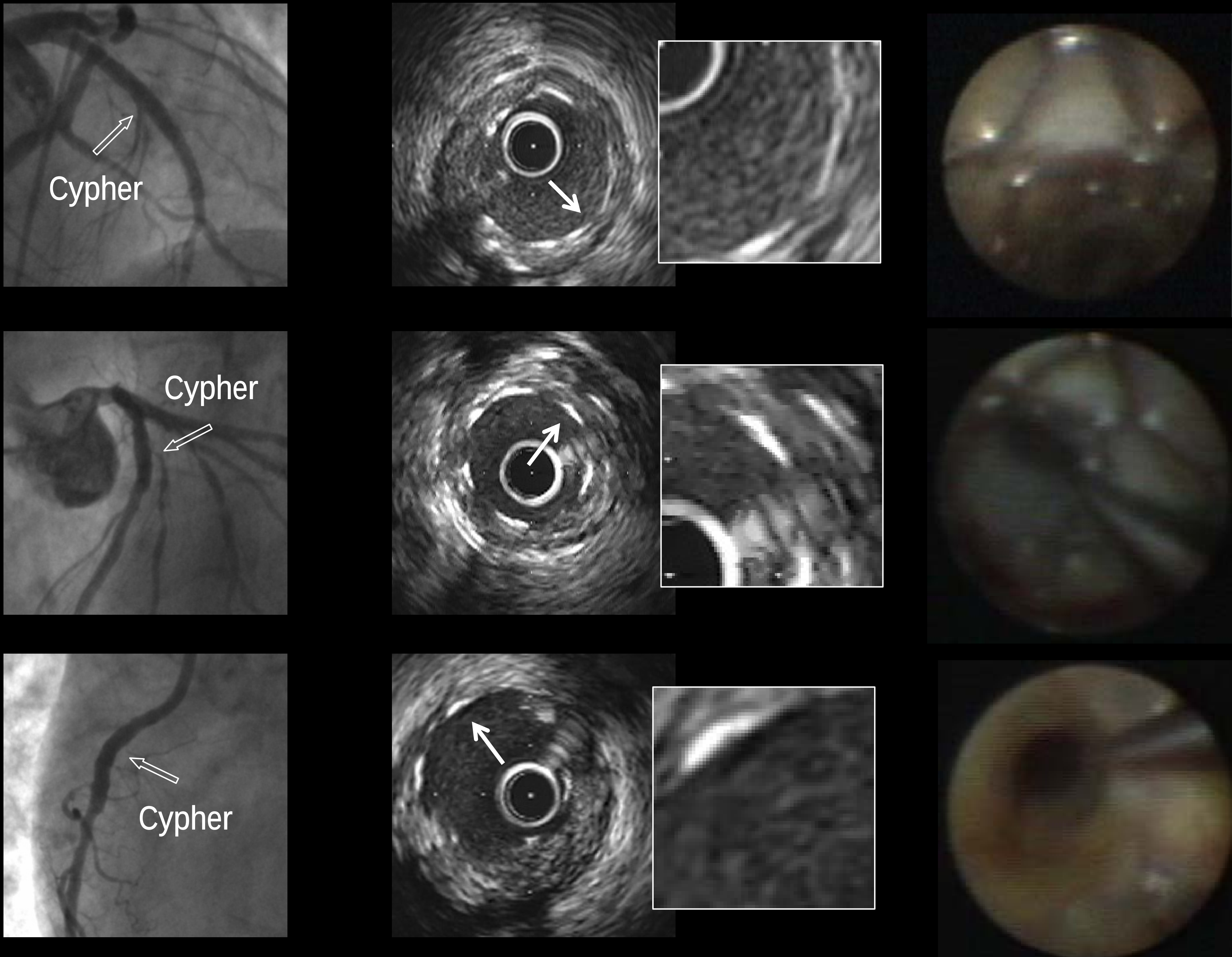


Cypher implantation promises minimum late lumen loss due to suppression of neointimal hyperplasia following angioplasty

Courtesy of Dr Sonoda.


Cypher
Cypher
Cypher

?


Cypher
Cypher
Cypher

Grading of Neointimal Coverage

Stent struts were:

0: Exposed similarly to the time of implantation.

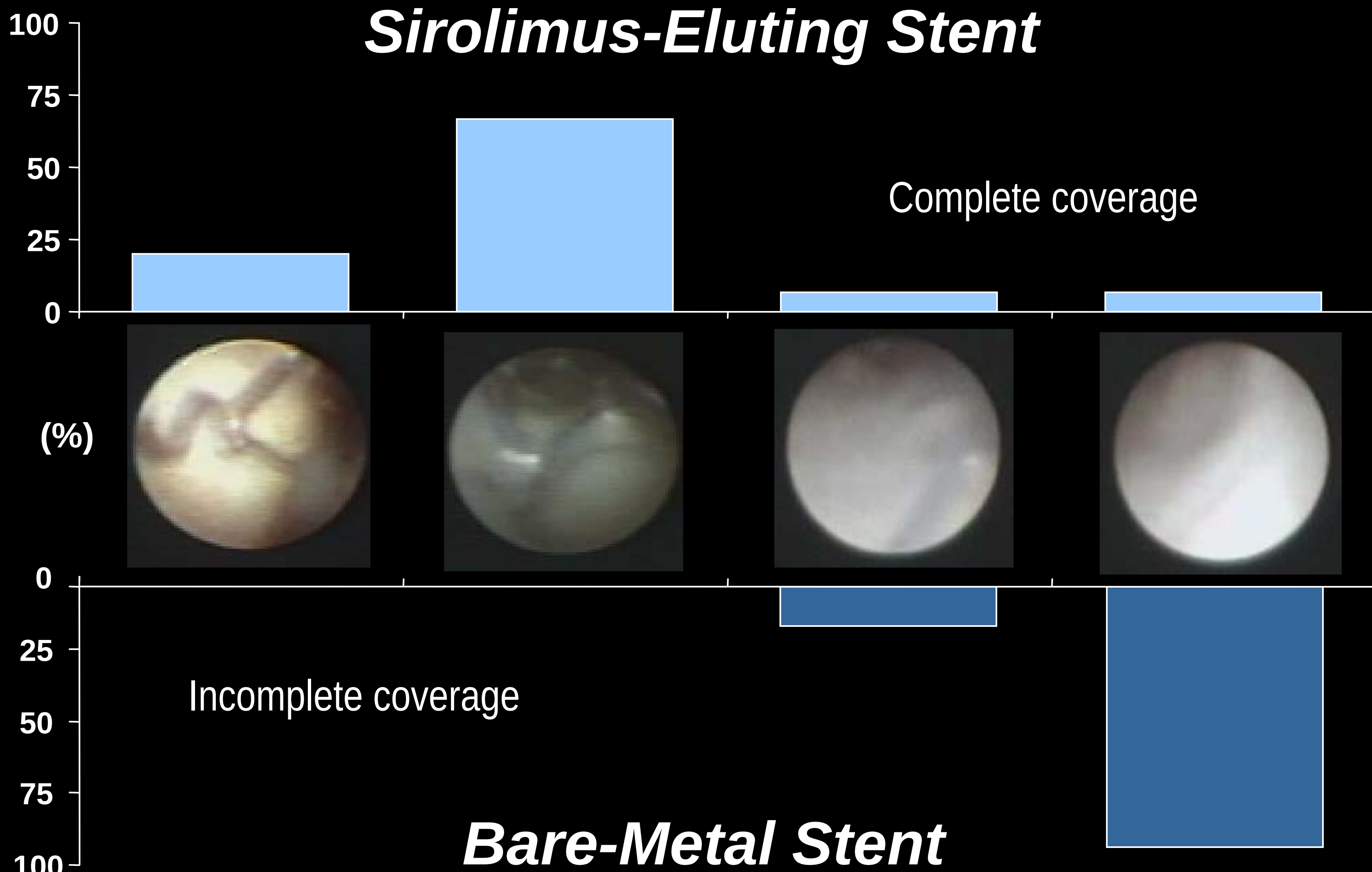
1: Convex into the lumen. Covered, but not embedded.

2: Embedded by neointima, but visible.

3: Fully embedded and invisible.

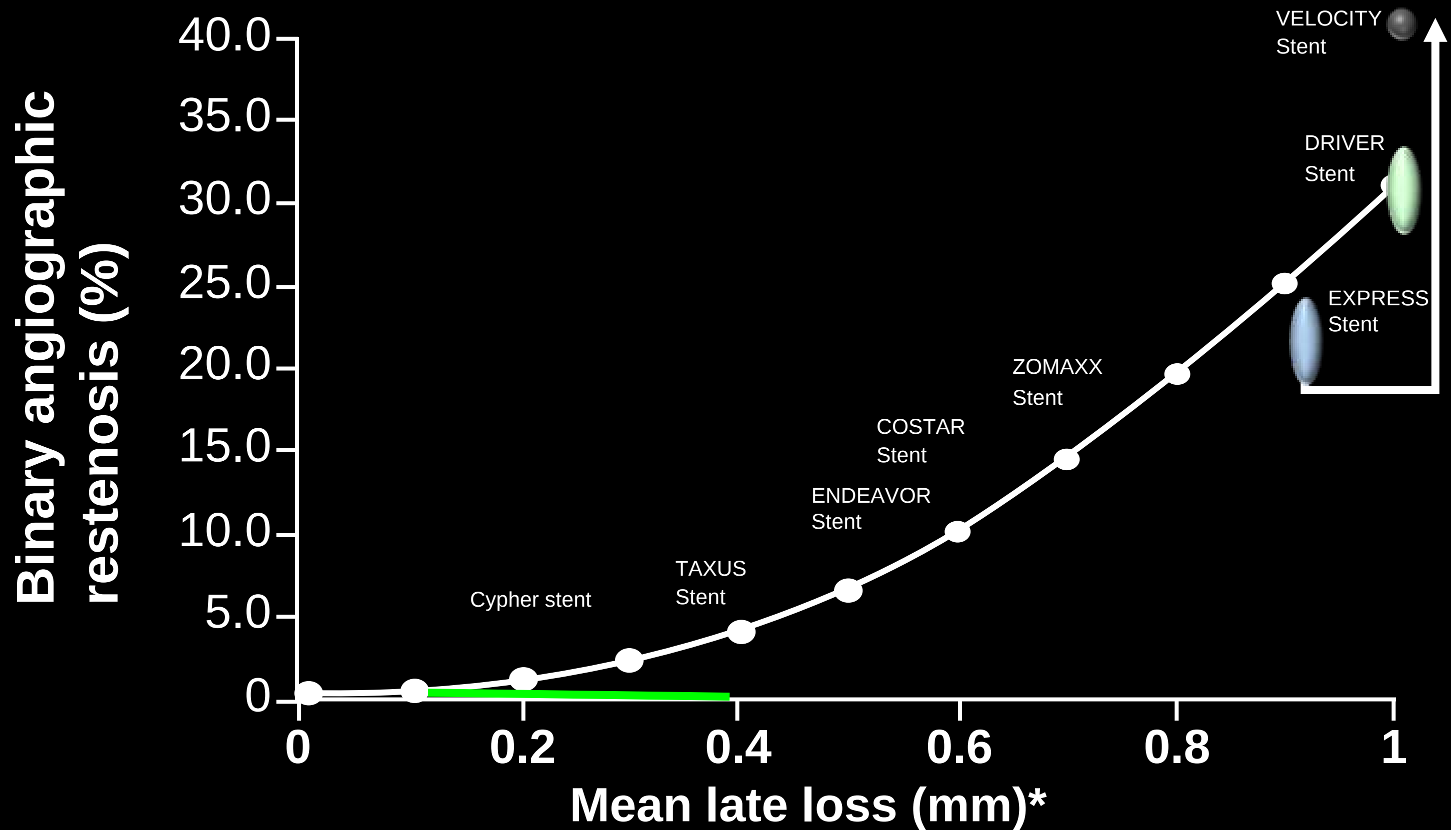
Kotani J, et al. *J Am Coll Cardiol*. 2006;47;2108-2111.

Comparing of Neointilmal Grade



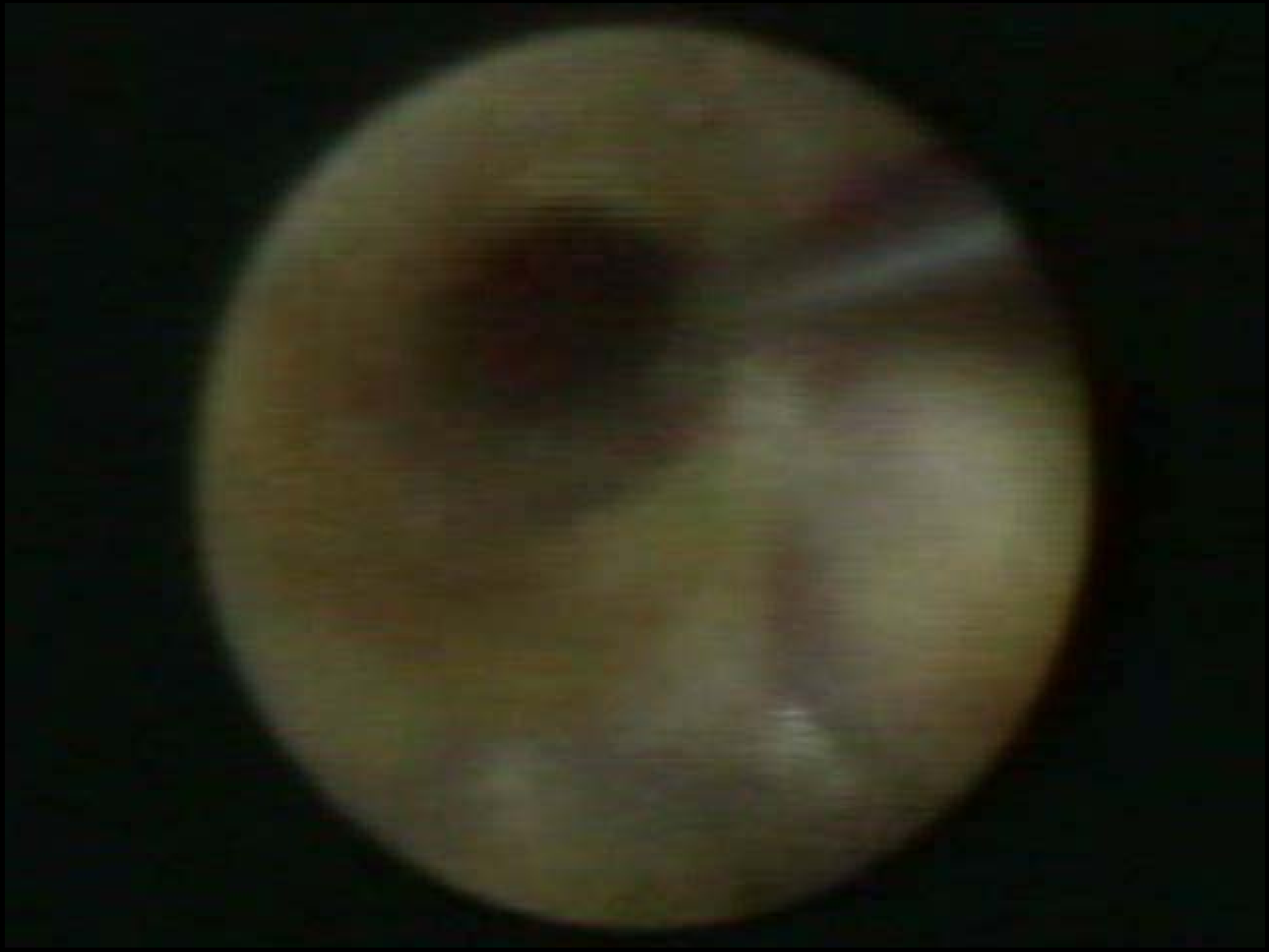
Kotani J, et al. *J Am Coll Cardiol.* 2006;47;2108-2111.

Restenosis and late lumen loss



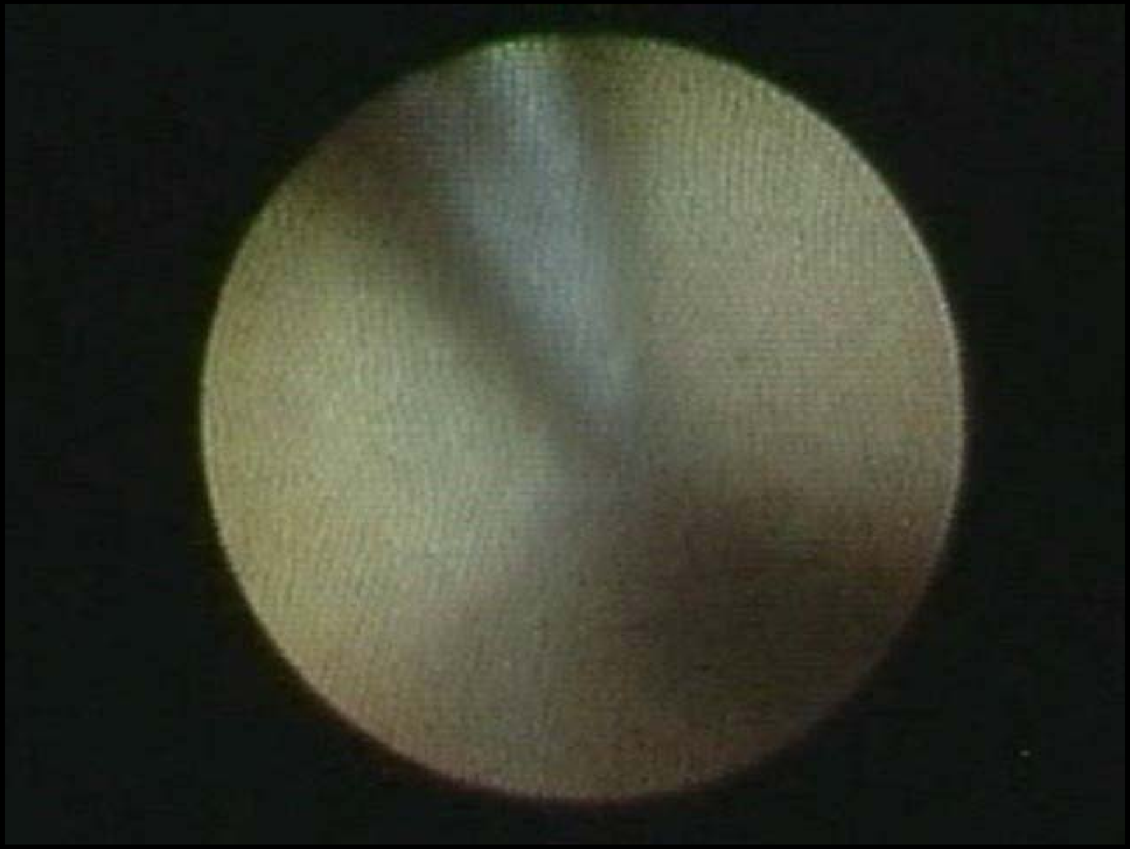
Modified from Mauri et al. *Circulation*. 2005;111:3435.

Sirilimus-Eluting Stent (SES)

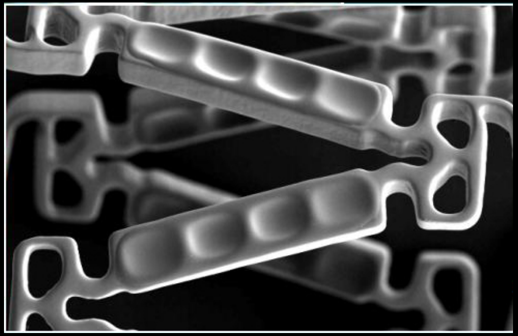


TAXUS

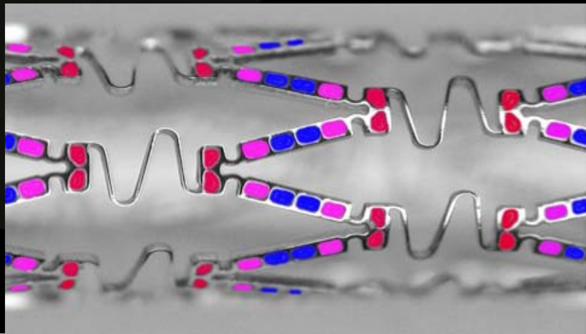
Zotarolimus-Eluring Stent



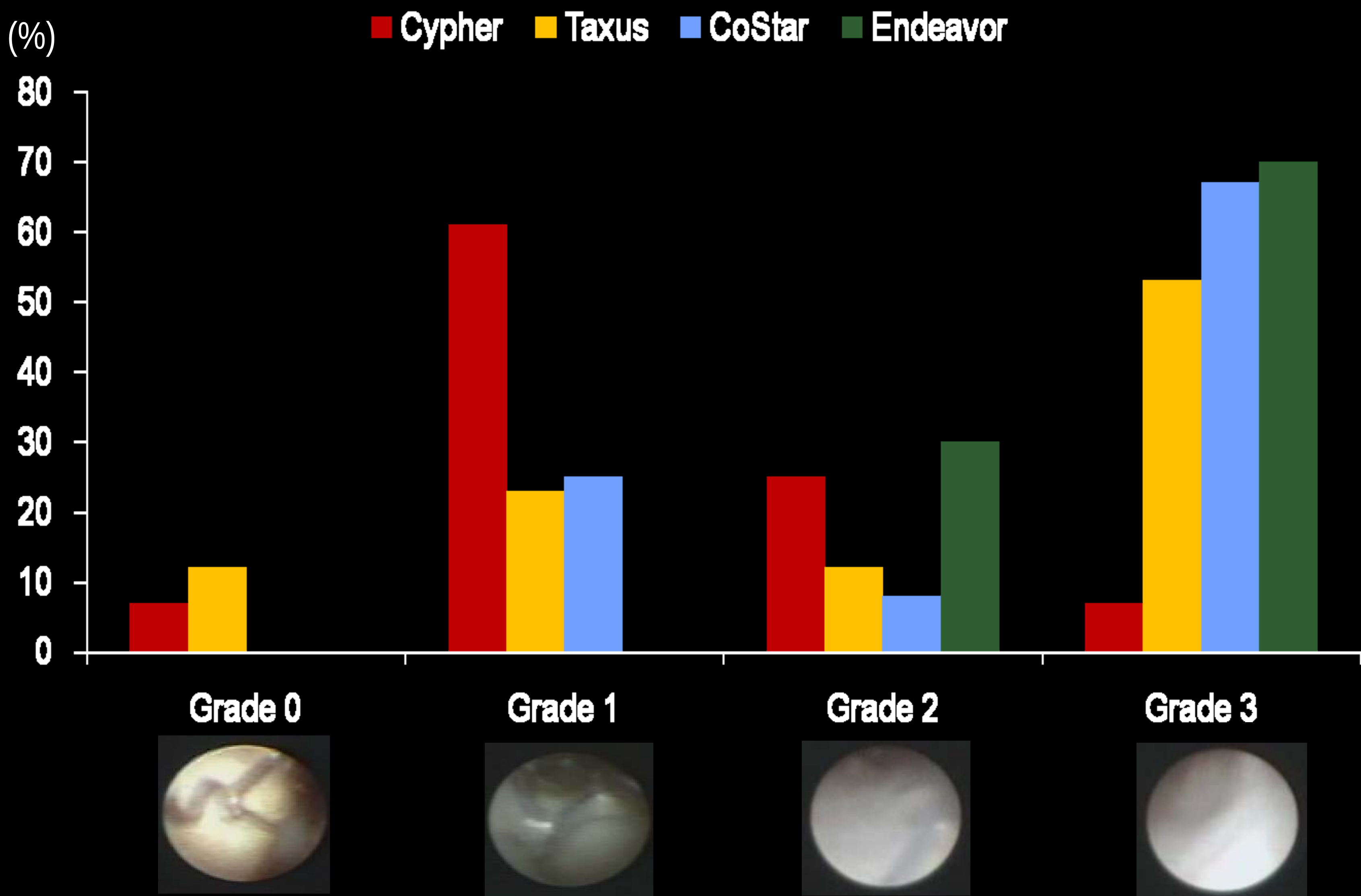
Awata, et al. JACC 2008



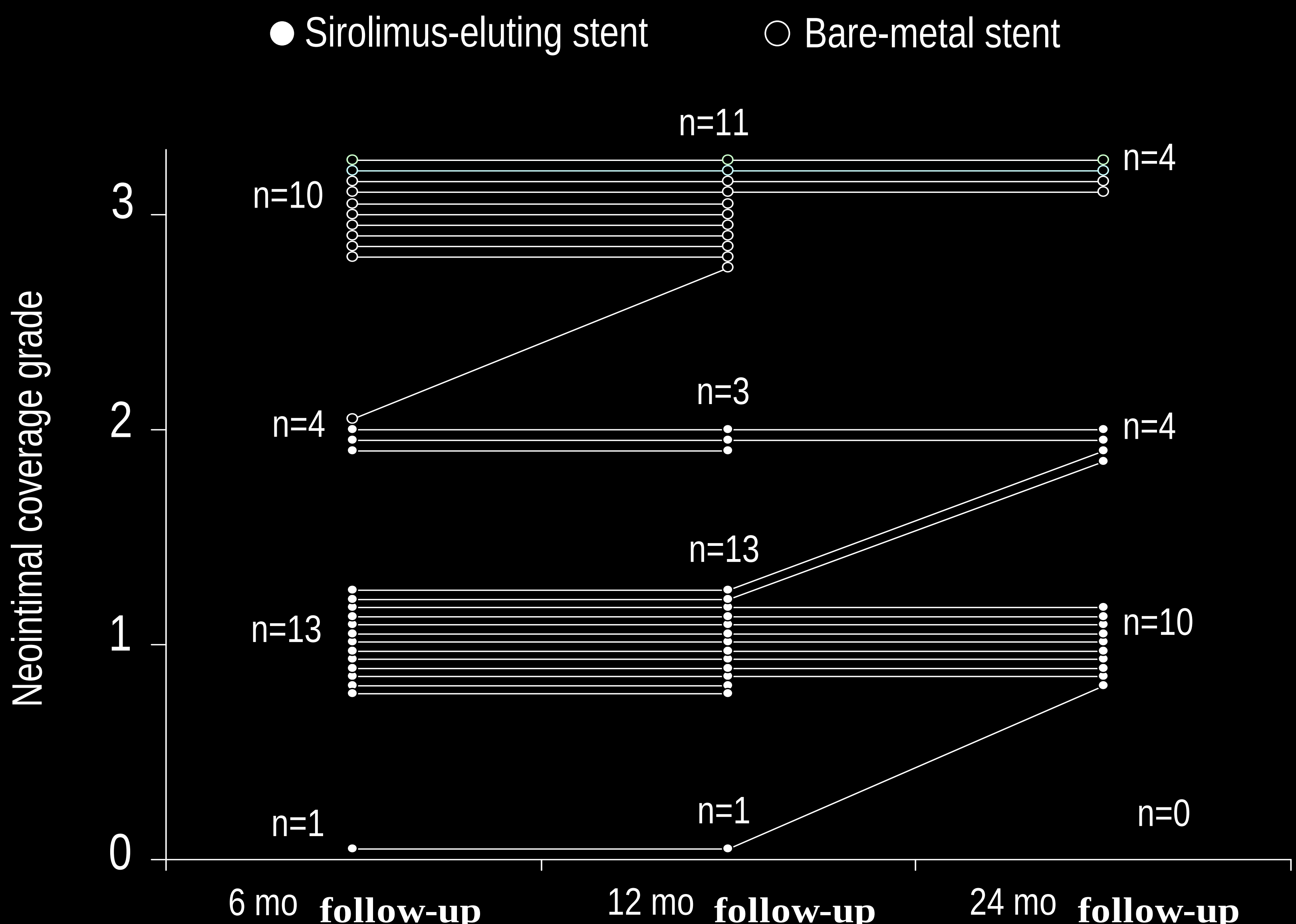
CoStar stent



Distribution of neointimal grade

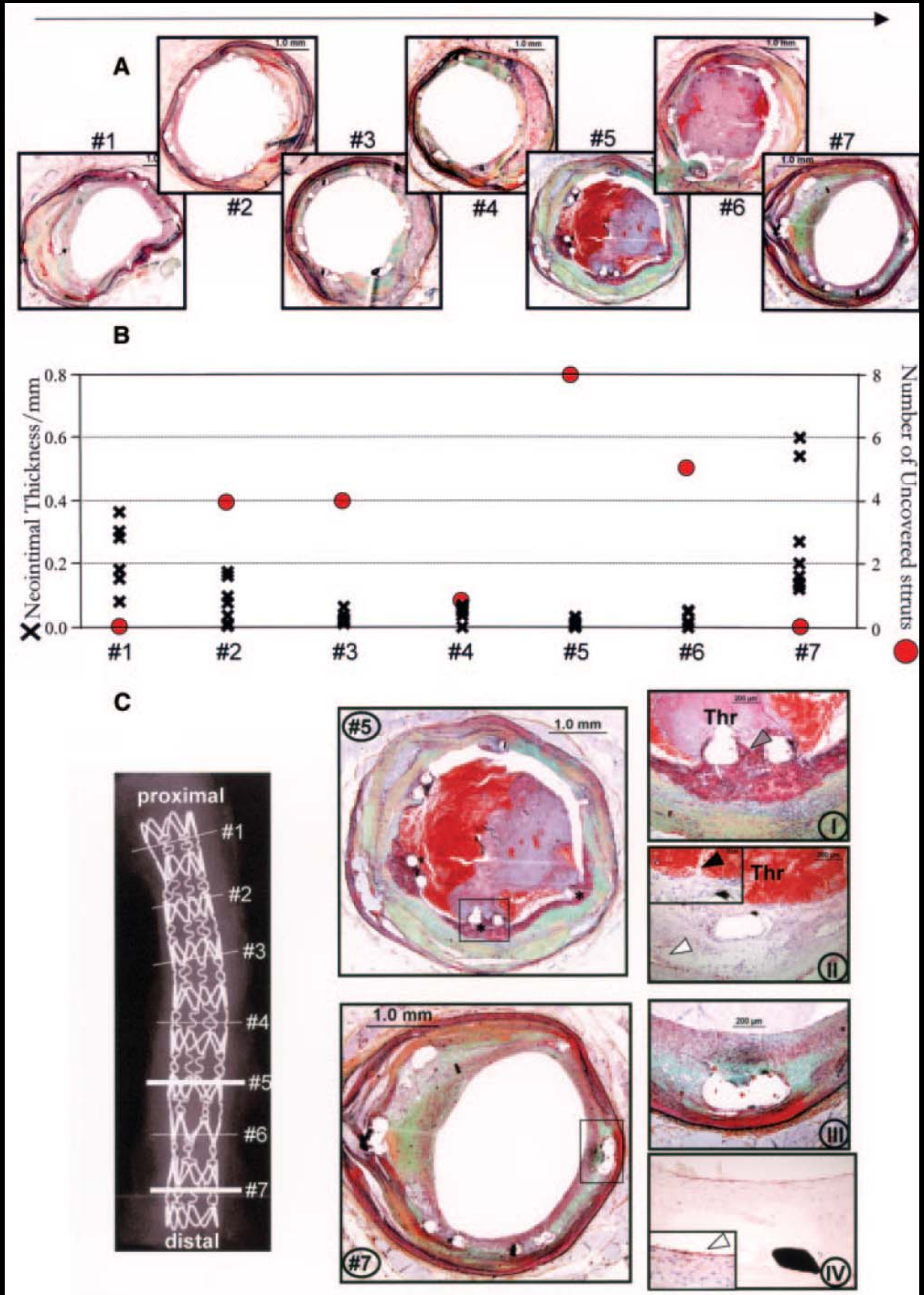


Changes of Neointimal Grade



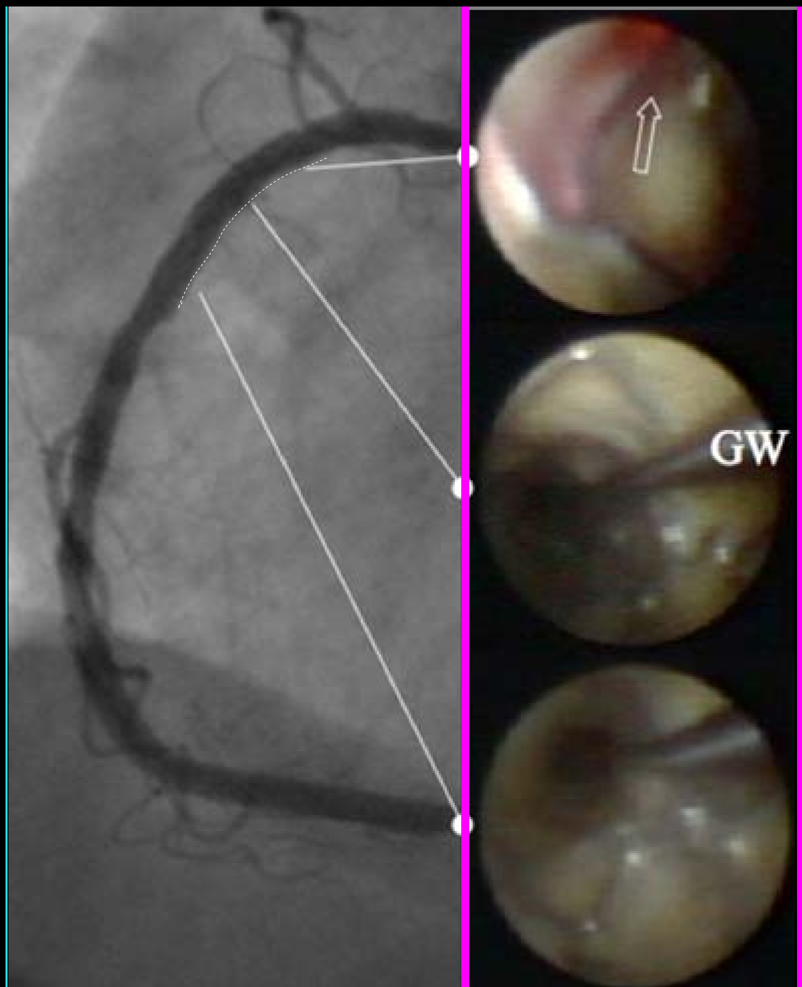
Awata M, Kotani, J, et al. *Circulation.* 116;910-916:2007.

Incomplete neointimal coverage and heterogeneity

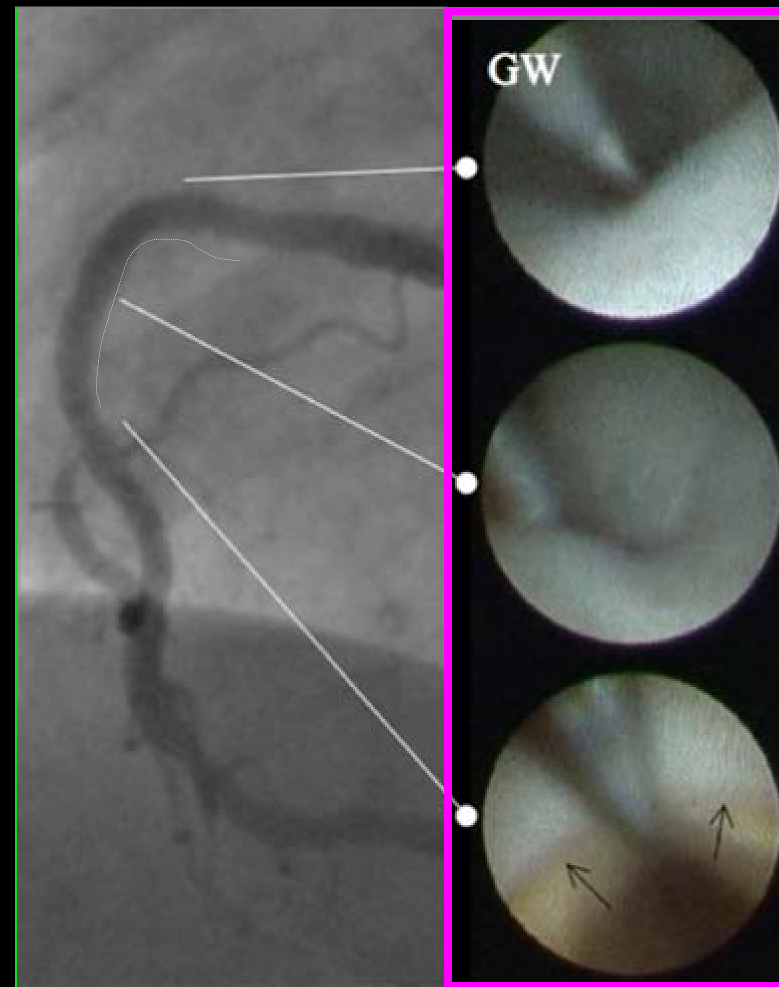


Circulation 2007;115:2324

Comparative Cases



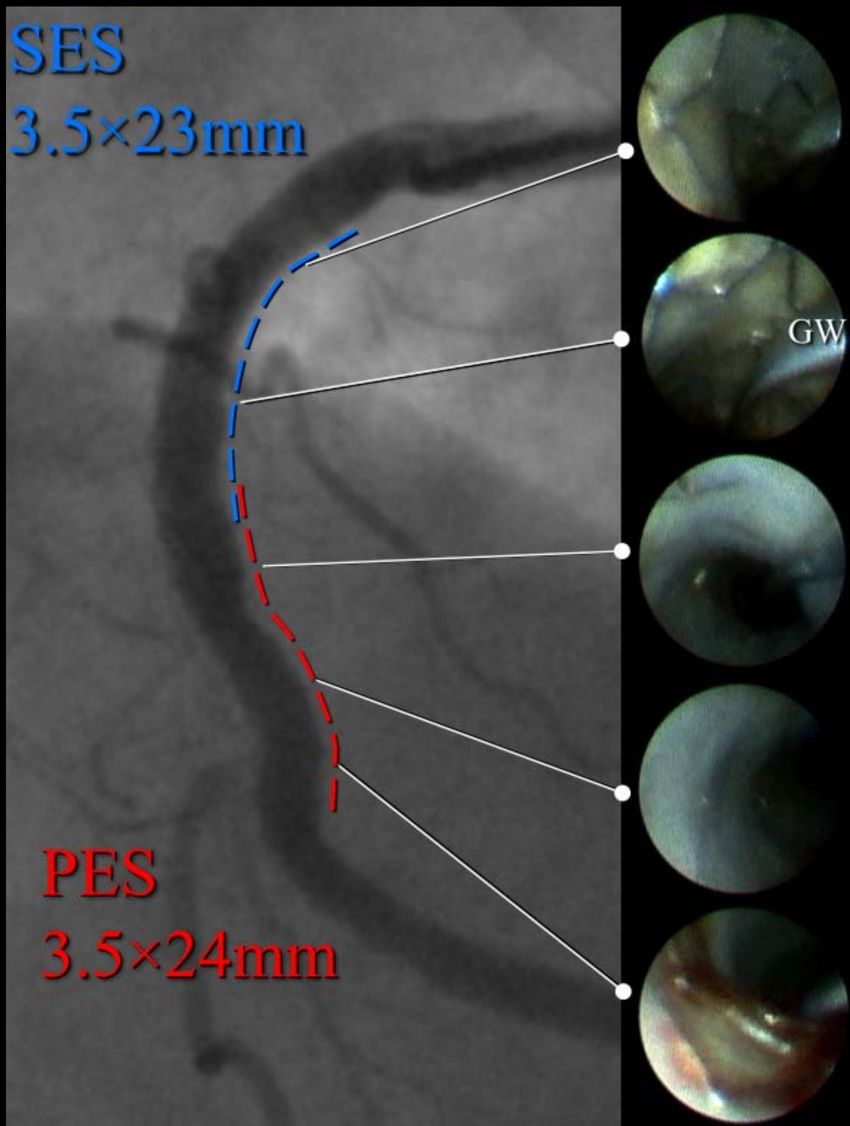
Sirolimus-eluting stent
(Cypher stent)

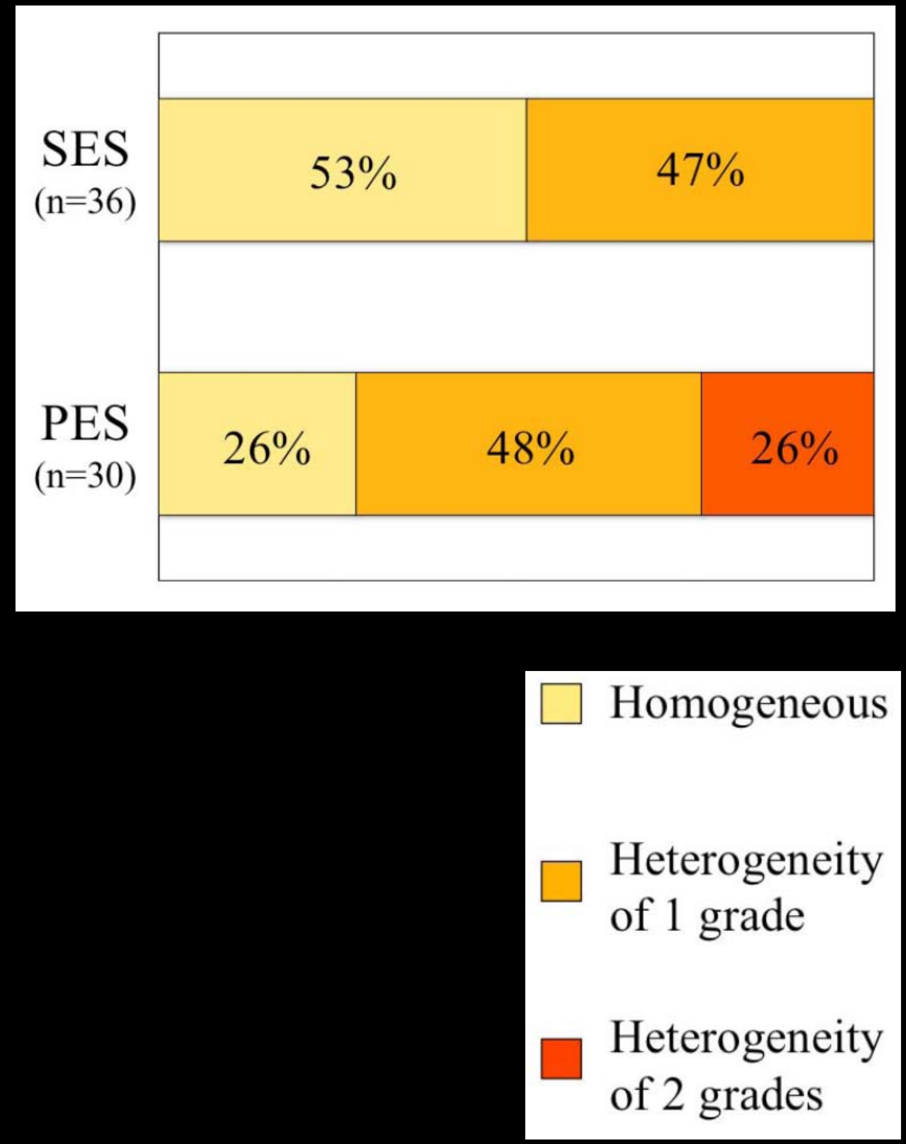


Zotarolimus-eluting stent
(Endeavor stent)

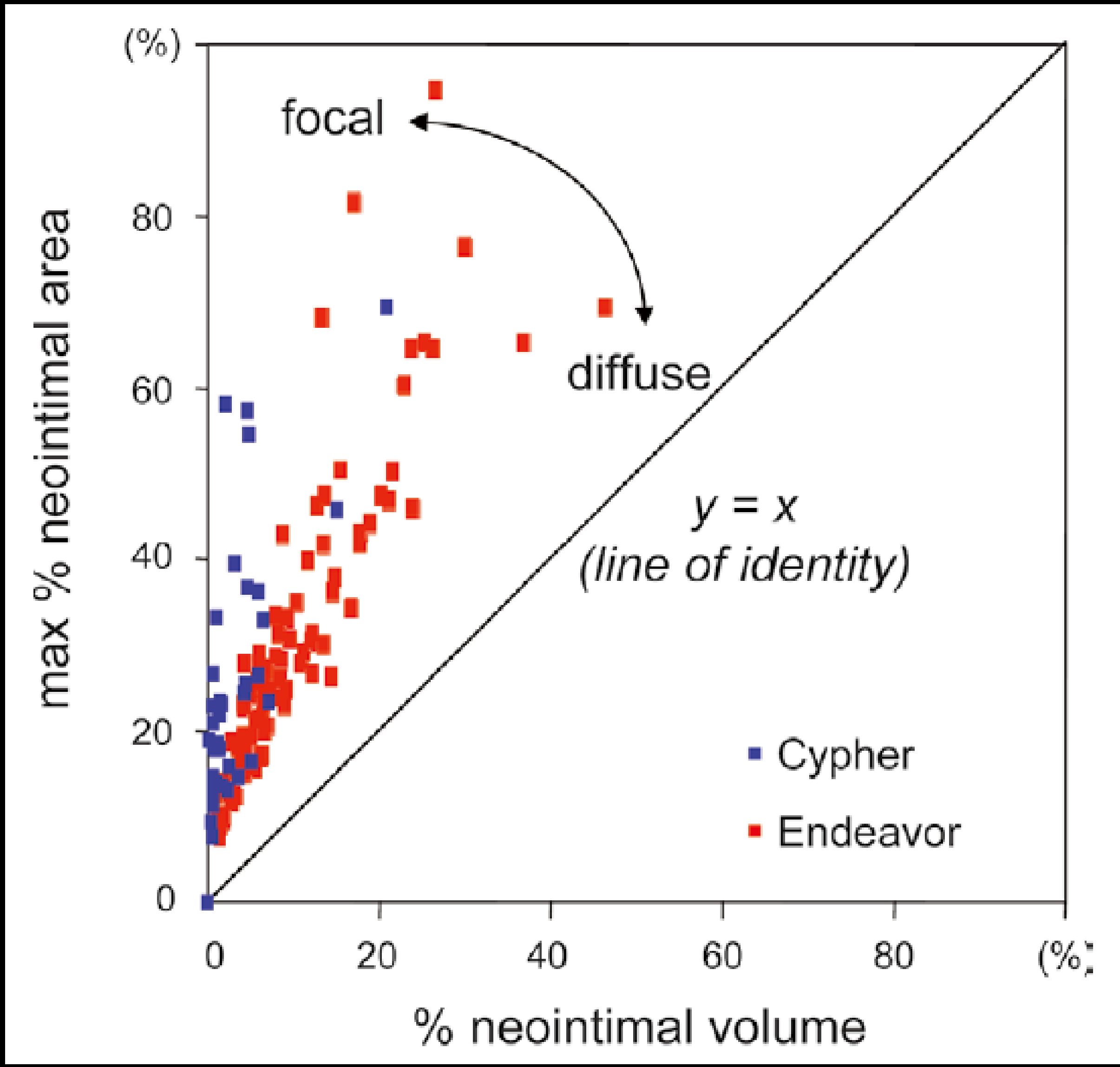
Awata M, et al. *JACC 2008 in press*

Heterogeneity of neointimal coverage





Awata, M, et al. JACC intervention 2009.


(%)
focal
diffuse
y = x
(line of identity)
Cypher
Endeavor
max % neointimal area
% neointimal volume
0
20
40
60
80
(%)

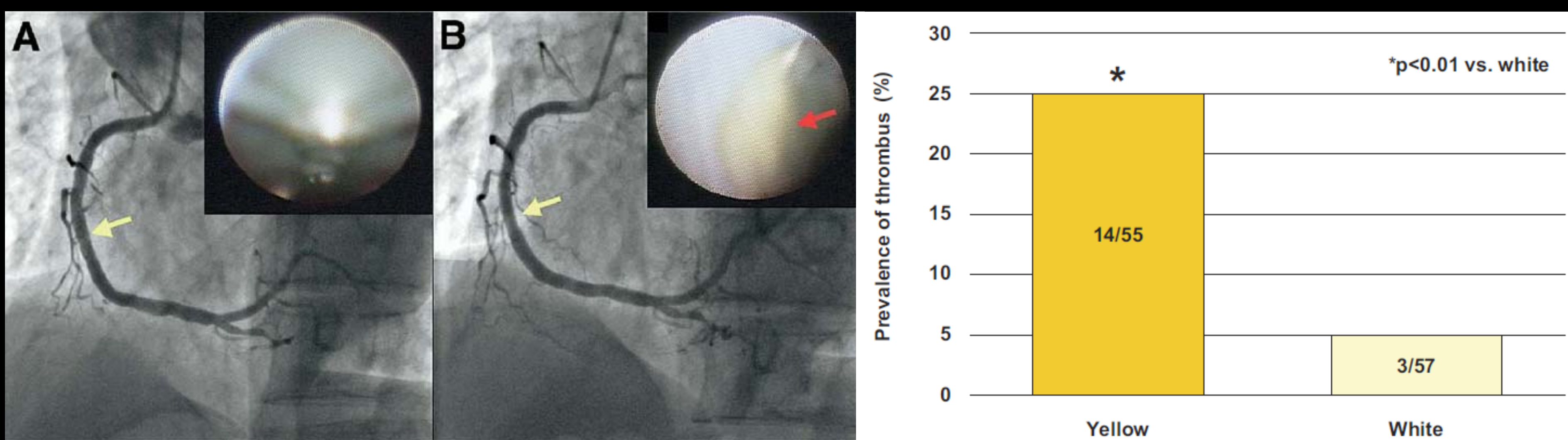
2009CJ

Atherosclerotic and Thrombogenic Neointima Formed Over Sirolimus Drug-Eluting Stent

An Angioscopic Study

Tomoaki Higo, MD, Yasunori Ueda, MD, PHD, Jota Oyabu, MD, Katsuki Okada, MD, Mayu Nishio, MD, PHD, Akio Hirata, MD, PHD, Kazunori Kashiwase, MD, PHD, Nobuyuki Ogasawara, MD, Shinichi Hirotani, MD, PHD, Kazuhisa Kodama, MD, PHD

Osaka, Japan



J Am Coll Cardiol Img 2009;2:616-618

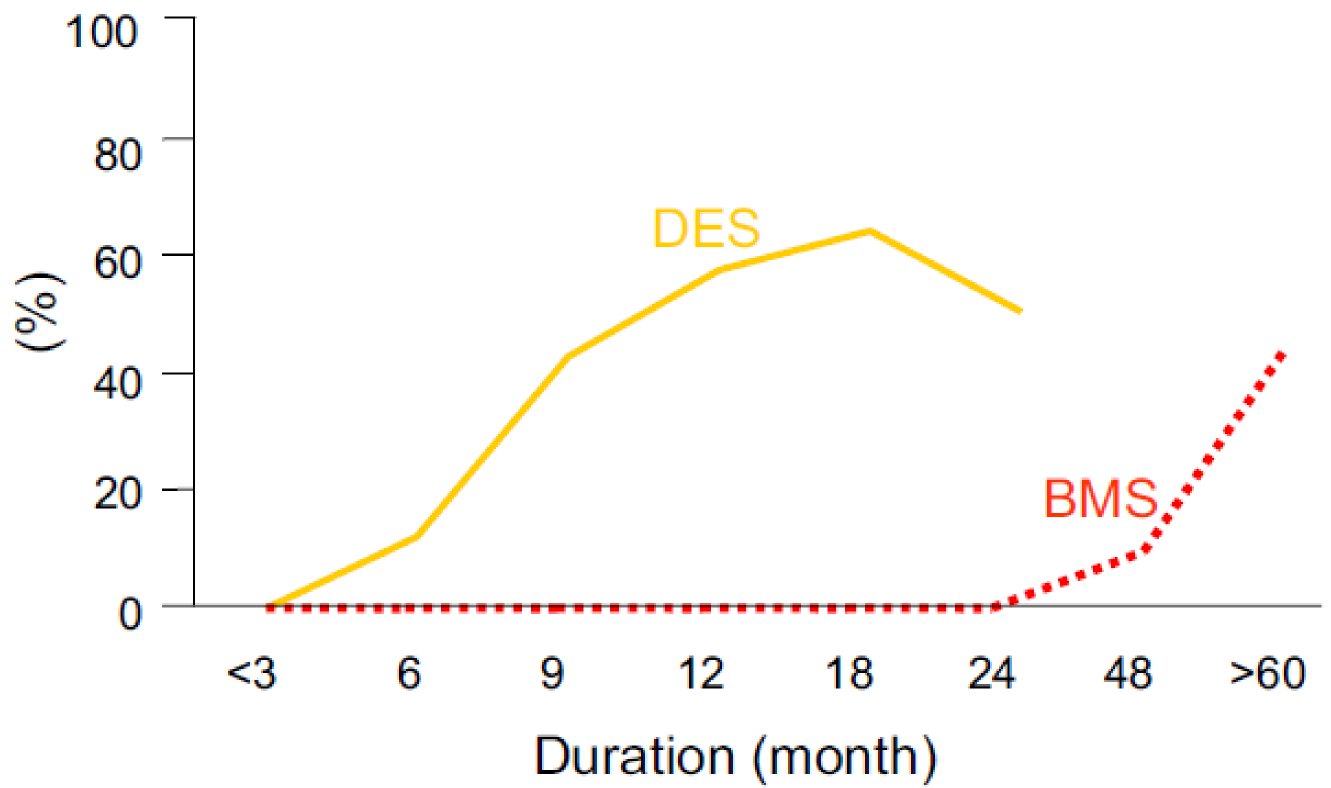


Figure 1. Graph Showing Percentage of Patients With Atherosclerotic Change in DES Versus BMS in Relation to Duration of Implant at Autopsy

Note the atherosclerotic change in sirolimus-eluting stents is seen in >40% of cases by 9 months; in bare-metal stent (BMS), the atherosclerotic change does not begin to appear until 2 years and remains a rare finding until 4 years. DES = drug-eluting stent(s).

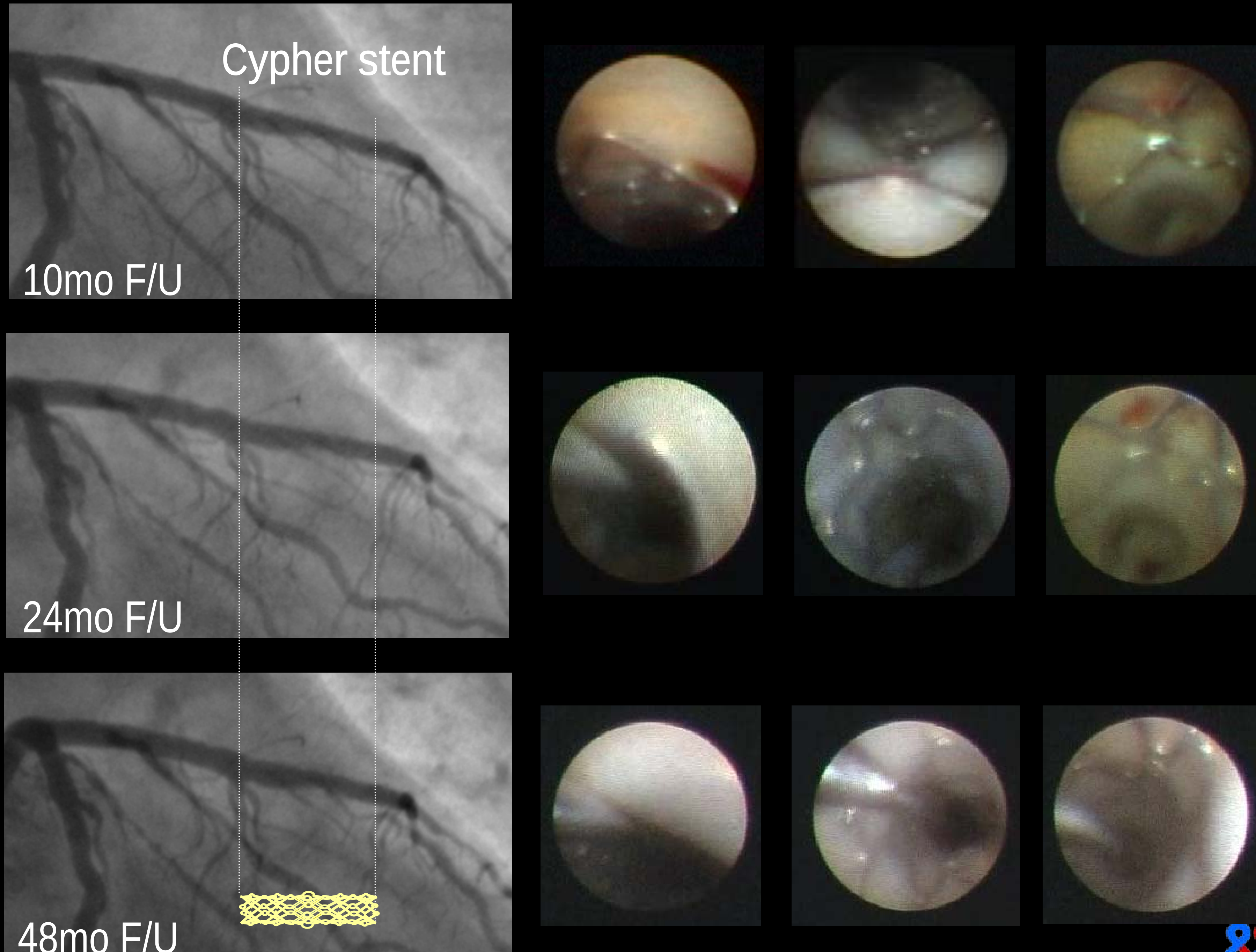
IJACC. 5;625-628:2009

EDITORIAL COMMENT

One Step Forward and Two Steps Back With Drug-Eluting-Stents

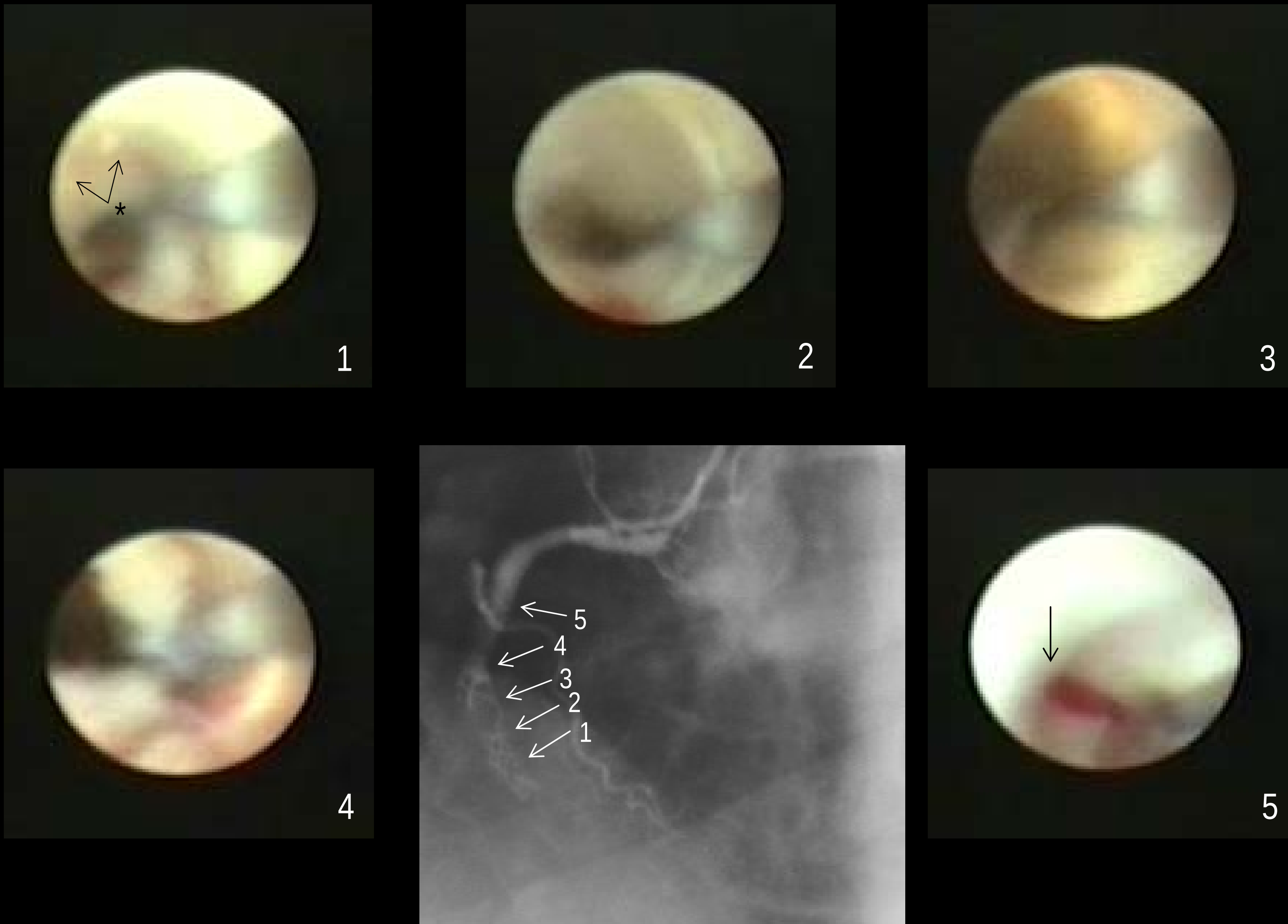
From Preventing Restenosis to Causing Late Thrombosis and Nouveau Atherosclerosis*

J Am Coll Cardiol Img 2009;2:625-628


Cypher stent
10mo F/U
24mo F/U
48mo F/U

Late Stent Thrombosis?
(BMS; Kansai Rosai Experience)

BMS stent was implanted 3 yrs before from this events.
The patient withdrew ASA by pt's decision.



This event *would not be caused* by “implanted stent”

Role of Angioscopy

- Coronary angioscopy gives full color visualization for coronary artery (disease).
- This helps to interpret between pathological knowledge and clinical investigation in catheterization laboratory.
- Coronary angioscopy may not correlate to clinical therapeutics directly. However given information would affect to operator’s decision.
- The possible future direction of coronary angioscopy are:
  - As the surrogate for pathology; e.,g., “*in-vivo*” pathology
  - Visualization of organ function; e.,g.,beyond the pathology