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Myocardial Bridge: Incidental Finding or Clinical Pathology?

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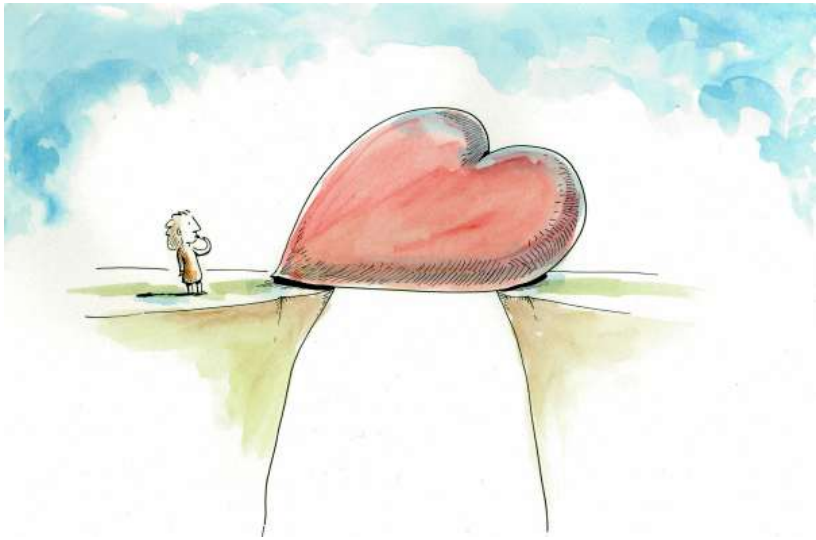


Myocardial Bridges

- Present in 30-80% of population by autopsy (<5% by angiography)
- Occurs in ~40% of patients with angina and normal coronary arteries
- Most common in the LAD
- Generally considered benign, but have been associated with myocardial ischemia/infarction, VT, and sudden death

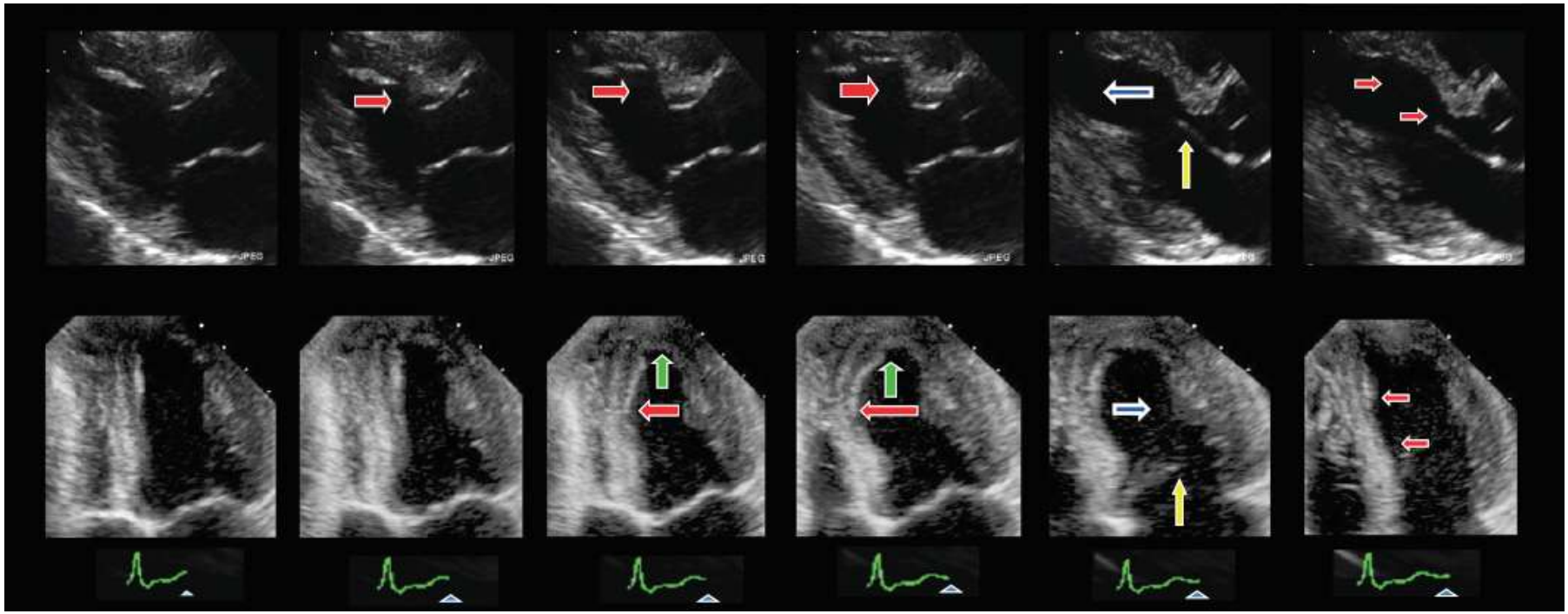
Alegria et al. Eur Heart J 2005;26:1159-1168

Presentation

- Symptoms typically do not develop before the third decade
- Patients typically have exertional chest pain, although CP may occur with mental stress. Over time, symptoms seem to become more persistent
- Patients often have a lot of PVCs, and VT/syncope can be a presenting symptom
- Reports of anteroseptal ischemia on nuclear perfusion scans, septal ischemia/infarction on MRI and autopsy
- Recently by stress echo, we have found a focal mid septal "buckling"

Focal mid septal “buckling”

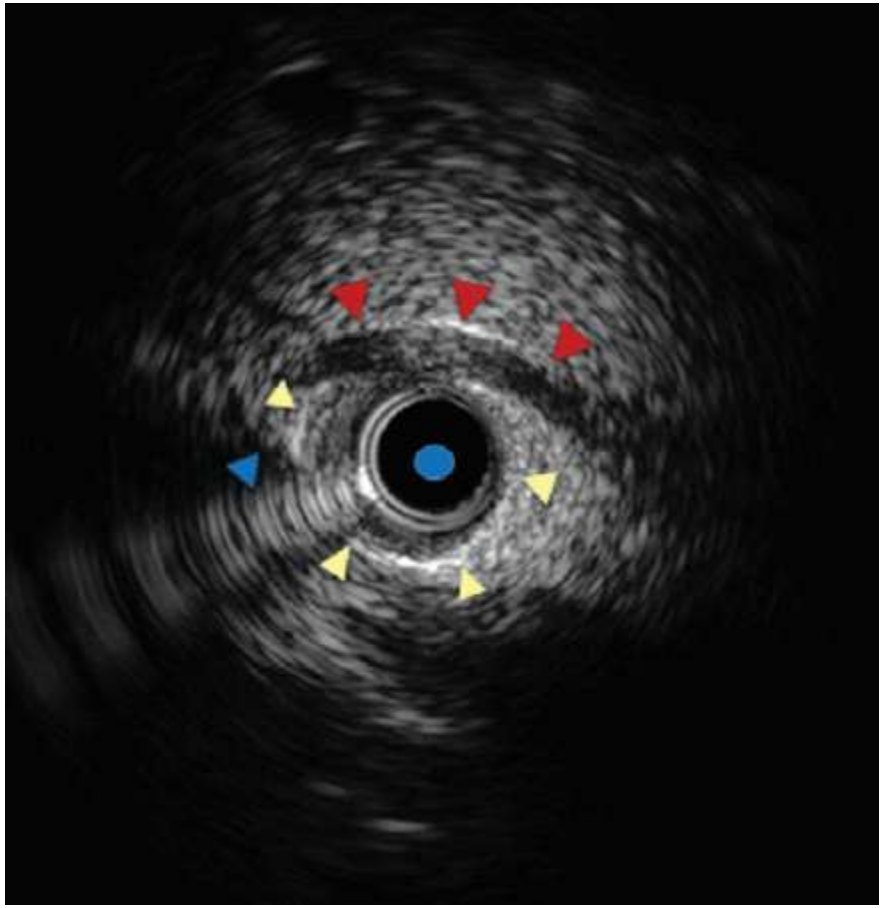
- Occurs end-systole/early diastole with apical sparing



Lin et al. J Am Heart Assoc 2013;2:e000097

Myocardial Bridging-Anatomy

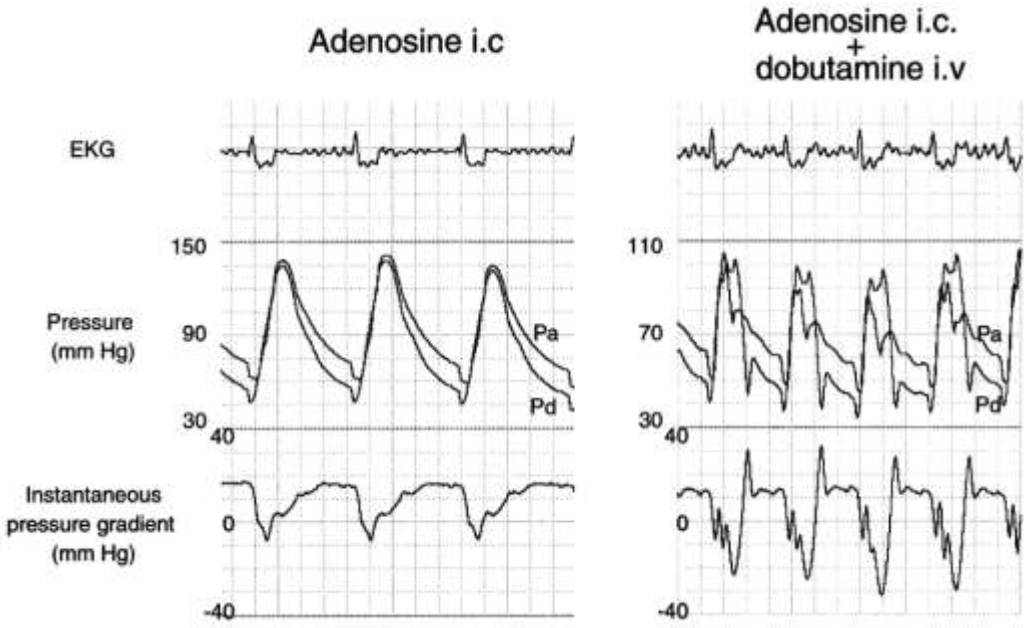
- Echo-lucent half moon sign (halo)→felt to be pathognomonic, although not 100% sensitive
- ≥10% systolic compression
- Normal LAD IVUS 57% positive

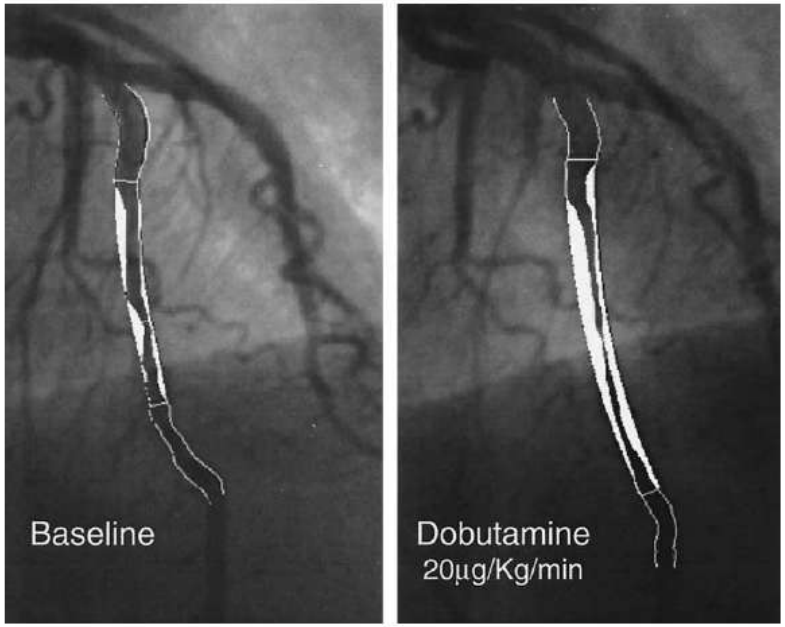


Lin et al. J Am Heart Assoc 2013;2:e000097

Myocardial Bridging-Pressure

- FFR with adenosine not sensitive enough for detecting ischemia with myocardial bridging—may improve sensitivity by diastolic FFR with dobutamine





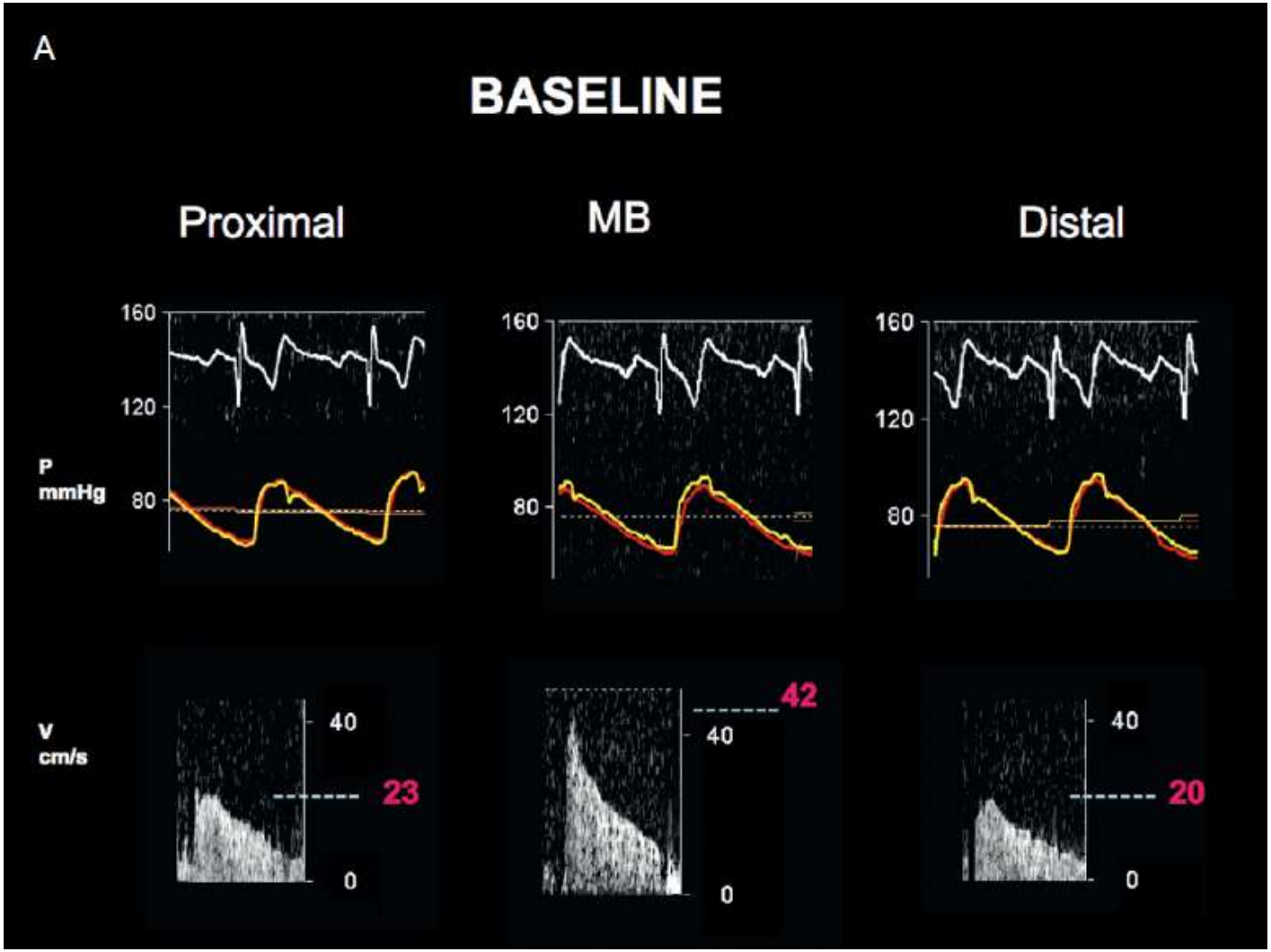
Escaned et al. J Am Coll Cardiol 2003;42:226-33

Ischemia Within Bridge

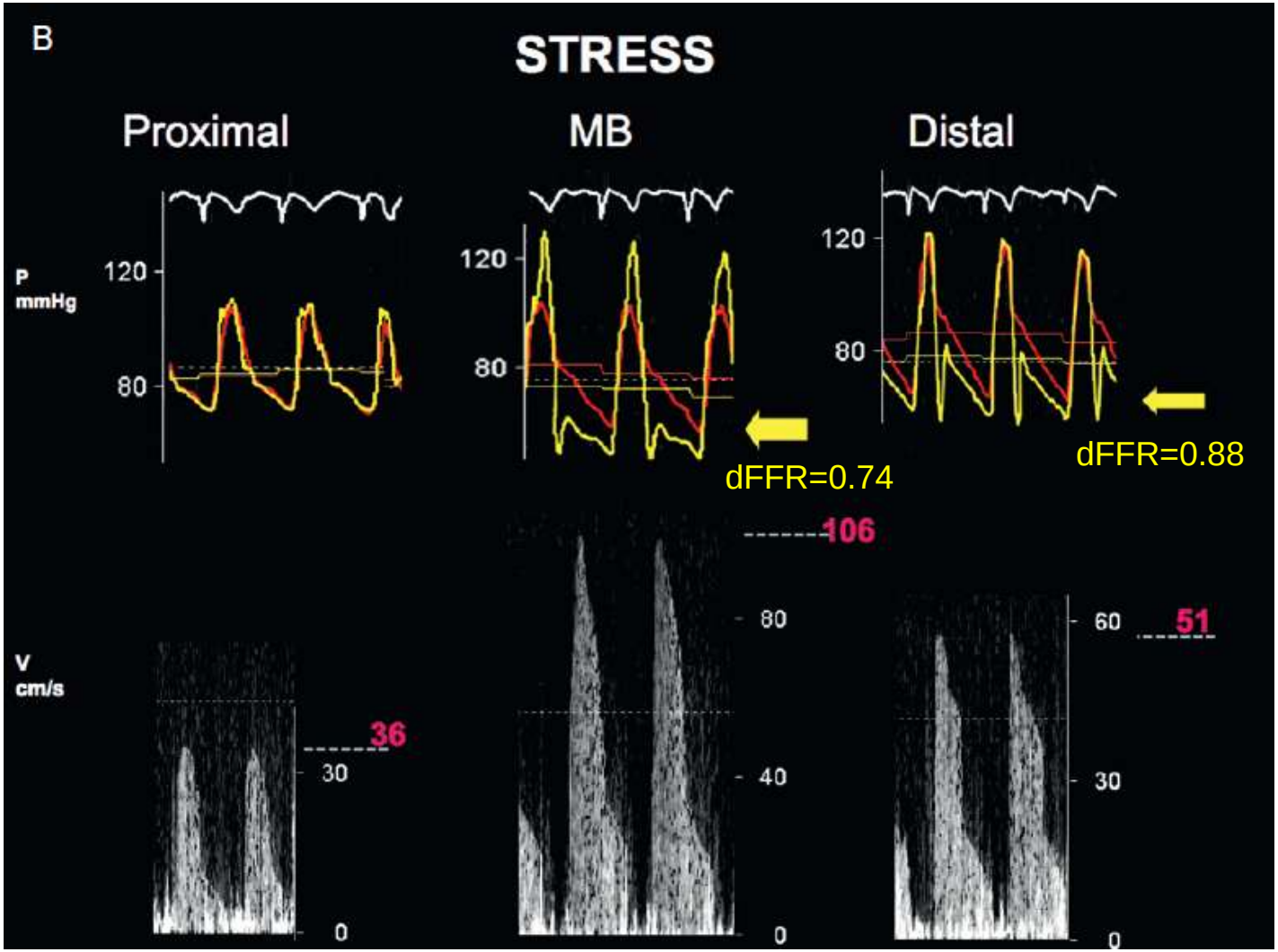
- Assumption has been that ischemia is distal to the myocardial bridge
- We hypothesized that the ischemia occurs within the bridge, rather than distal to it
- Studied ~60 patients with IVUS, as well as combination pressure and Doppler flow velocity proximal to, within, and distal to the bridge at baseline and with dobutamine stress
- Reported first 18 patients (age 16 to 62 years, median 43 years)

Lin et al. J Am Heart Assoc 2013;2:e000097

Baseline Pressure and Flow

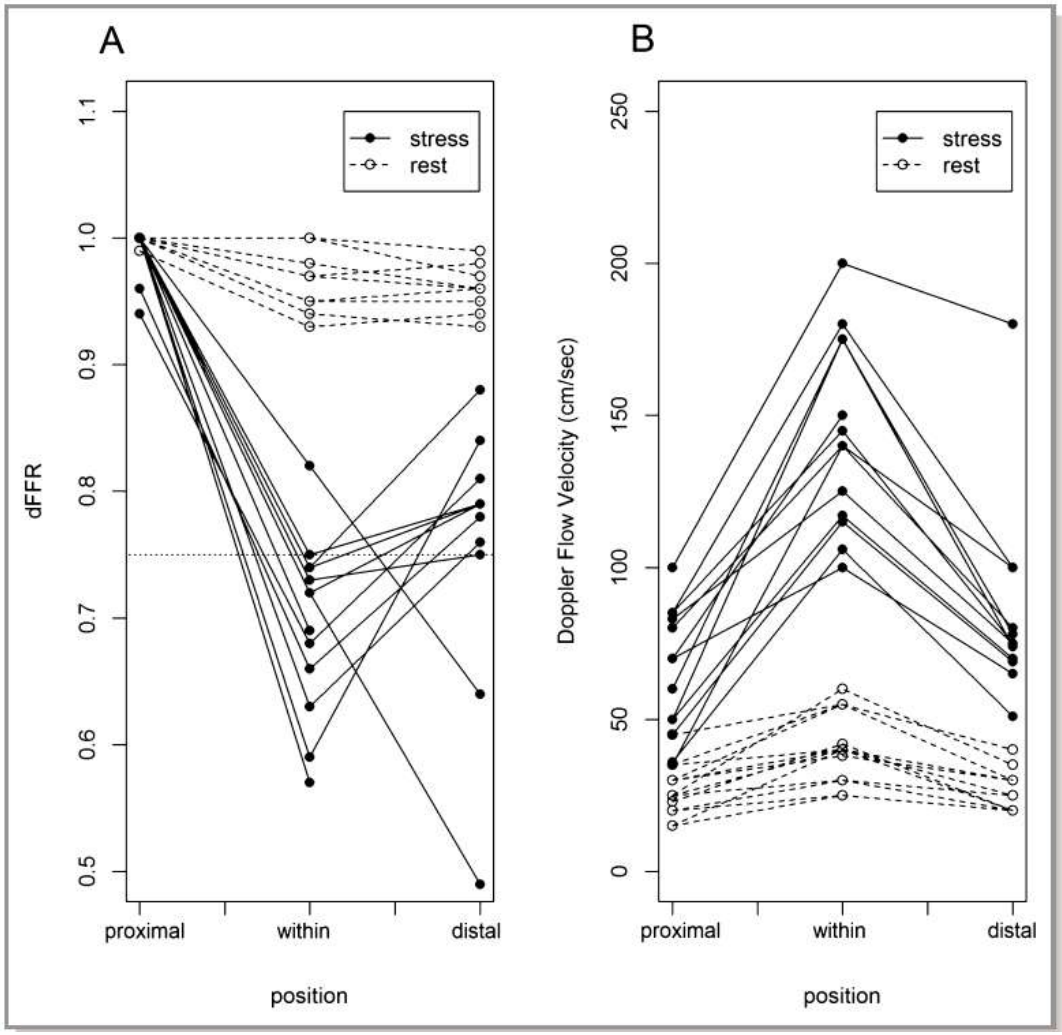


Pressure and Flow at Stress



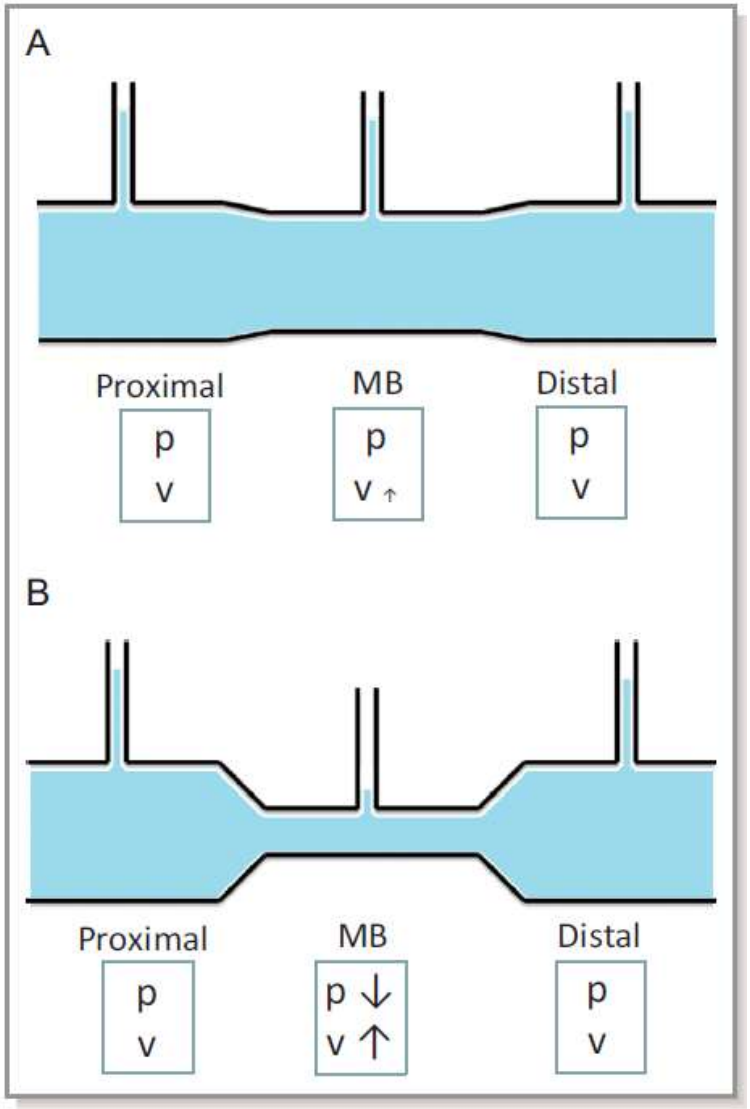
Significant dFFR Within Bridge

- All had significantly abnormal dFFRs
- The patients with the abnormal distal dFFR notably had the longest MBs (mean 40.5mm) and/or had 2 MBs
- With rest and stress, the peak diastolic flow velocities within the bridge were significantly higher than those proximally or distally



Ischemia Within Bridge due to Venturi Effect

- Venturi effect: moving through a narrowed area, velocity must increases (principle of continuity) with a required drop in pressure (conservation of energy by Bernoulli's equation)
- The narrowest lumen within a bridge is at end-systole/early diastole
- Conclude that ischemia is local to the MB rather than distal to it (ischemia within septal branches)
- Associate with findings on stress echo of focal mid septal buckling



Is Myocardial Bridging truly benign? Impact of myocardial bridging induced arterial compression on atherosclerotic plaque formation

Ryotaro Yamada, MD, PhD; Ingela Schnittger, MD;
Jennifer A. Tremmel, MD; Shin Lin, MD, PhD; Paul G. Yock, MD;
Peter J. Fitzgerald, MD, PhD; Yasuhiro Honda. MD

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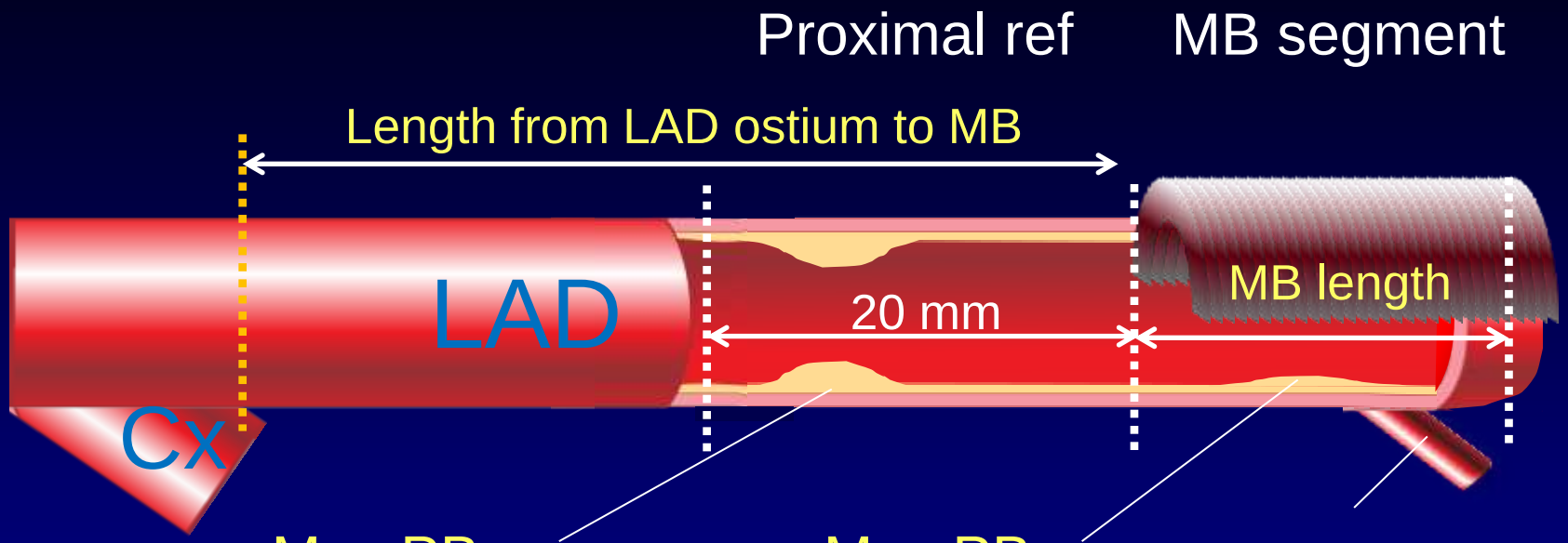
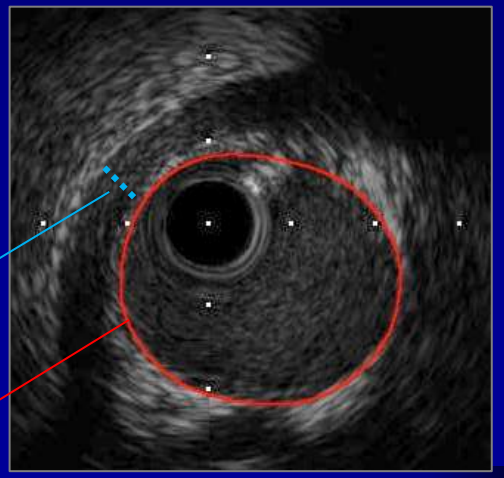
IVUS Parameters



Plaque burden (PB)

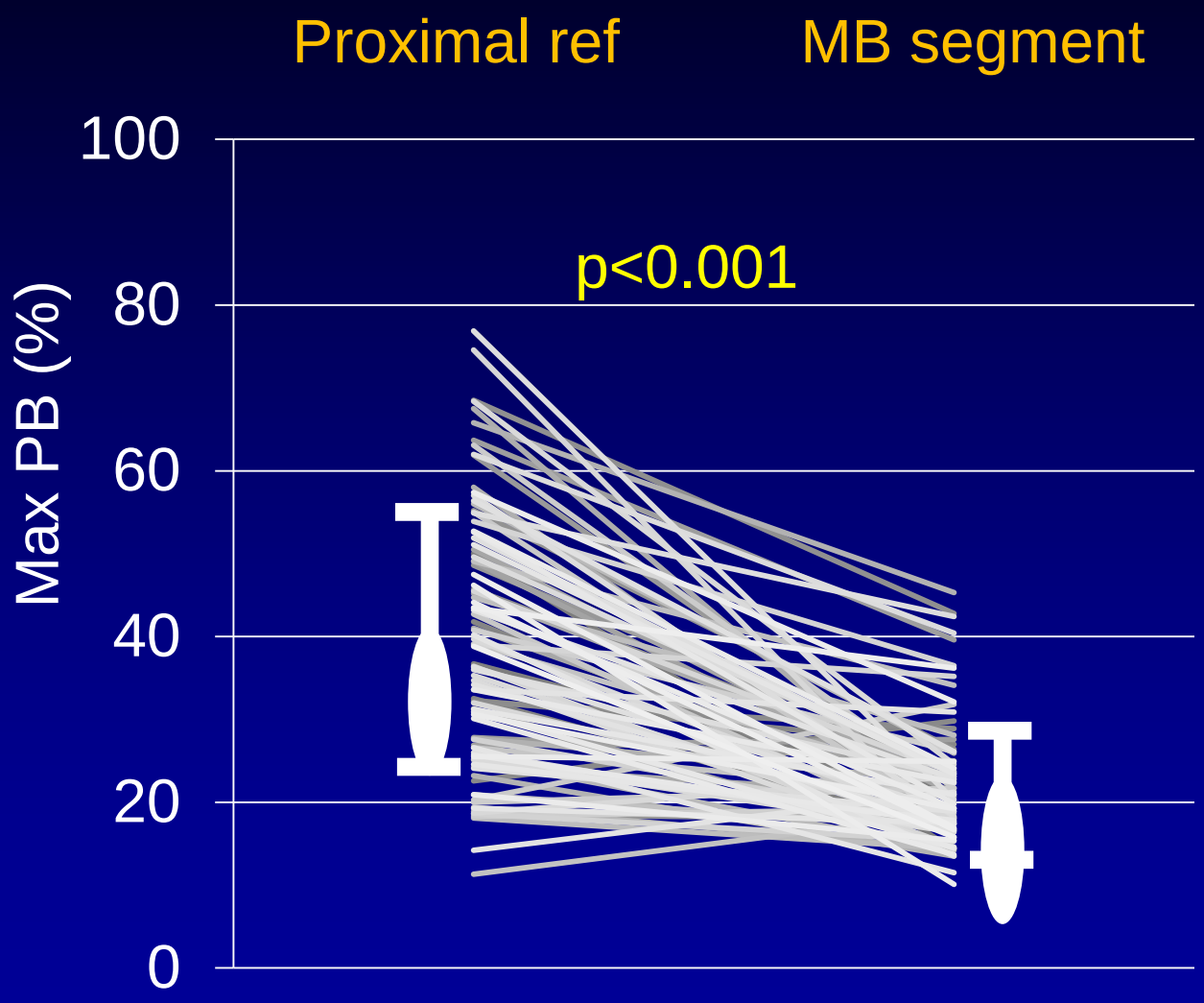
= (EEM-CSA – Lumen CSA) / EEM-CSA



IVUS Parameters

IVUS morphologic properties	(n=96)
Bridge length, mm	21.3 ± 13.2 (4.7 - 76.9)
Arterial compression, %	22.8 ± 12.2 (0.4 - 50.7)
EEM-CSA $_{(D)}$, mm^2	7.0 ± 2.7 (2.8 - 15.1)
EEM-CSA $_{(S)}$, mm^2	5.4 ± 2.4 (2.1 - 12.7)
Halo thickness, mm	0.65 ± 0.59 (0.11 - 3.17)
Length from LAD ostium, mm	38.3 ± 12.1 (10.9 - 77.5)
Presence of branches within MB, n (%)	77 (80.2)
Distance between Max PB and MB, mm	19.6 ± 11.7 (1.2 - 58.5)
Max PB $_{prox.}$, %	39.2 ± 15.2 (11.3 - 76.9)
Max PB $_{MB.}$, %	21.9 ± 7.3 (10.1 - 40.4)
	Mean ± SD (range)

Max PB in Proximal vs. MB segment



Predictors of Max PB prox

R^2=0.349, ANOVA p<0.001

	Univariate analysis			Multivariate analysis		
	Regression coefficient (β)	95% CI	p	Regression coefficient (β)	95% CI	p
Age	0.423	0.29 to 0.74	<0.001	0.301	0.14 to 0.59	0.017
Male	0.320	3.99 to 16.24	0.002	0.222	1.38 to 12.61	0.015
Hyperlipidemia	0.375	6.03 to 18.37	<0.001	0.228	1.49 to 13.31	0.015
Hypertension	0.140	-1.91 to 10.46	0.173	0.076	-3.25 to 7.88	0.411
Current smoker	-0.072	-24.14 to 11.54	0.485	-	-	-
Diabetes mellitus	0.101	-4.28 to 12.78	0.325	-	-	-
Arterial compression	0.265	0.08 to 0.57	0.009	0.206	0.04 to 0.48	0.023
Length from LAD ostium	0.102	-0.13 to 0.39	0.324	-	-	-
MB length	-0.081	-0.33 to 0.14	0.432	-	-	-
Halo thickness	0.073	-3.41 to 7.19	0.481	-	-	-

Univariate variables with a P value < 0.20 were inserted into multivariate models.

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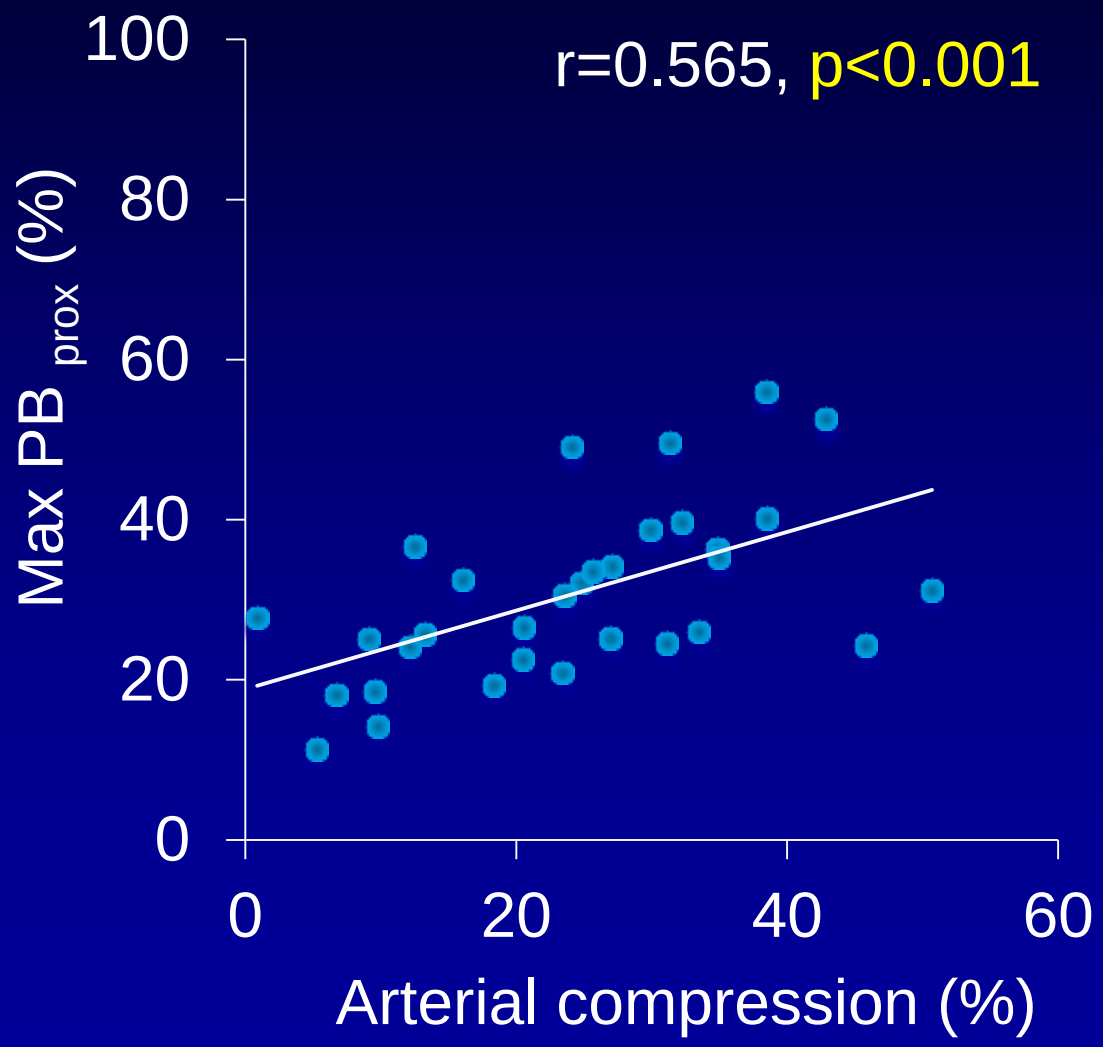
Arterial Compression and Max PB $_{prox}$

Younger adults (age ≤ 53 years) with ≤ one risk factor



Summary

- Max PB $_{prox}$ was significantly greater than Max PB $_{MB}$.
- Arterial compression had a significant positive correlation to Max PB $_{prox}$, but not to Max PB $_{MB}$.
- No other IVUS properties of MB correlated with Max PB $_{prox}$.
- In multivariate analysis, arterial compression was independently associated with Max PB $_{prox}$.
- When isolated from the influence of age and coronary risk factors, the correlation between arterial compression and Max PB $_{prox}$ showed an even stronger relationship.

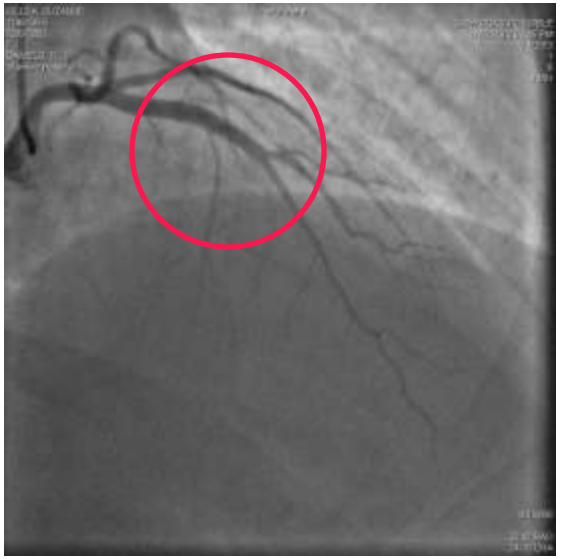
Ms. S. K.

- December 2012: 52 years old previously healthy woman admitted to OSH with NSTEMI and troponin of 0.8 with no ECG changes.
- January 2013: Coronary angiogram showed no significant CAD. Mid LAD myocardial bridge.

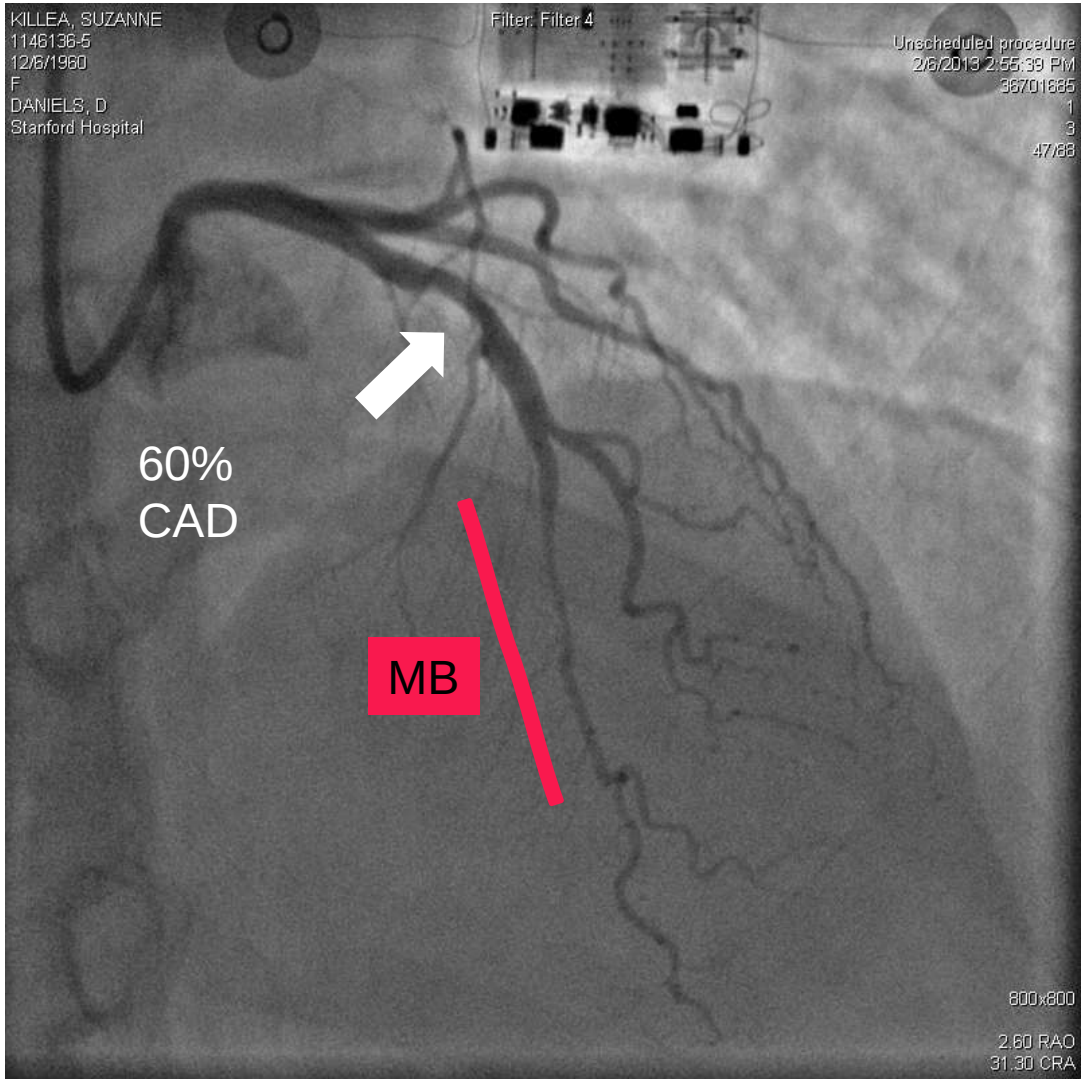
Ms. S. K.

1. Early February 2013: Admitted with recurrent severe chest pain. Second cor. angiogram showed rapid progression of CAD in one month, suggestive of plaque rupture.
2. IVUS showed 41 mm long MB, halo thickness of 1.0mm. Maximal systolic compression was 22% ($2.98mm^2/3.55mm^2$)

Ms. S.K. Angiogram II



January 2013:
Angiogram I



February 2013: Angiogram II

Conclusions

- Myocardial bridges are common, but not completely benign
- Coronary angiography rarely identifies them, IVUS is needed (stress echo and CTA can also be helpful)
- Hemodynamic assessment of symptomatic bridges shows an increase in flow velocity and a decrease in pressure (dFFR) within the bridge more so than distal to it, suggesting a local ischemic effect (i.e. septal ischemia).
- Such an assessment may be helpful in identifying hemodynamically significant bridges in patients with angina and normal appearing coronary arteries
- Plaque burden is increased in the proximal reference segment. Whether these plaques have increased vulnerability is unknown.