My Patient Needs a Stress Test

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Absolute and relative contraindications to exercise testing

Absolute

- Acute myocardial infarction (within two days)
- Unstable angina
- Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Active endocarditis
- Acute aortic dissection
- Acute noncardiac disorder that may affect exercise performance or be aggravated by exercise (eg, infection, renal failure, thyrotoxicosis)
- Inability to obtain consent

Relative*

- Left main coronary stenosis or its equivalent
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Severe hypertension (systolic 200 mmHg and/or diastolic 110 mmHg)
- Tachyarrhythmias or bradyarrhythmias, including atrial fibrillation with uncontrolled ventricular rate
- Hypertrophic cardiomyopathy and other forms of outflow tract obstruction
- Mental or physical impairment leading to inability to cooperate
- High-degree atrioventricular block

* Relative contraindications can be superseded if benefits outweigh risks of exercise.

Data from Fletcher, GF, Balady, GJ, Amsterdam, EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation 2001; 104:1694; and Gibbons, RJ, Balady, GJ, Bricker, JT, et al. ACC/AHA 2002 guideline update for exercise testing: summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines). Circulation 2002; 106:1883.

What should the patient expect?

- NPO
- Medication Adjustments
  - Hold Beta Blockers, modify insulin therapy
- No Caffeine x 24hrs
- 1-2 hrs for stress ecg alone, immediate results
- 2 hrs for stress echo, immediate results
- 2-4 hrs for stress nuclear, preliminary results available later that day

What kind of Stress Test?

- Stress: Treadmill vs. Pharmacologic
- Stress ECG alone (no imaging)
- Stress ECG with ECHO imaging
- Stress ECG with nuclear imaging
- Pharmacologic ECG with imaging
  - Adenosine vs. Persantine vs. Dobutamine
  - Nuclear with all
  - ECHO with Dobutamine

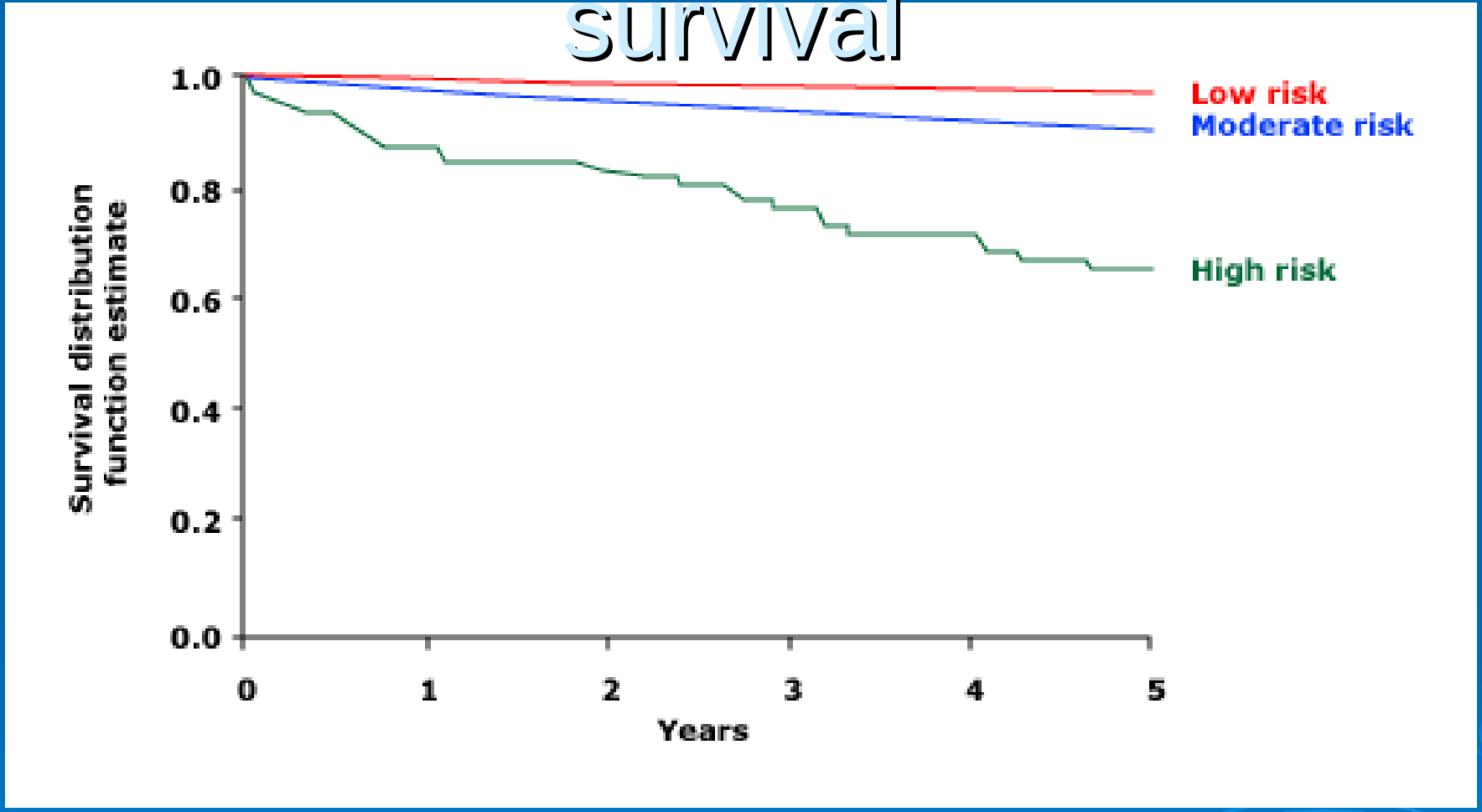
Stress ECG

- Well established, inexpensive, non-invasive, no radiation, simple
- Indirectly detects myocardial ischemia
- Limited sensitivity and specificity compared with coronary angiography
- Answers clinical questions regarding exercise tolerance and heart disease

Stress ECG

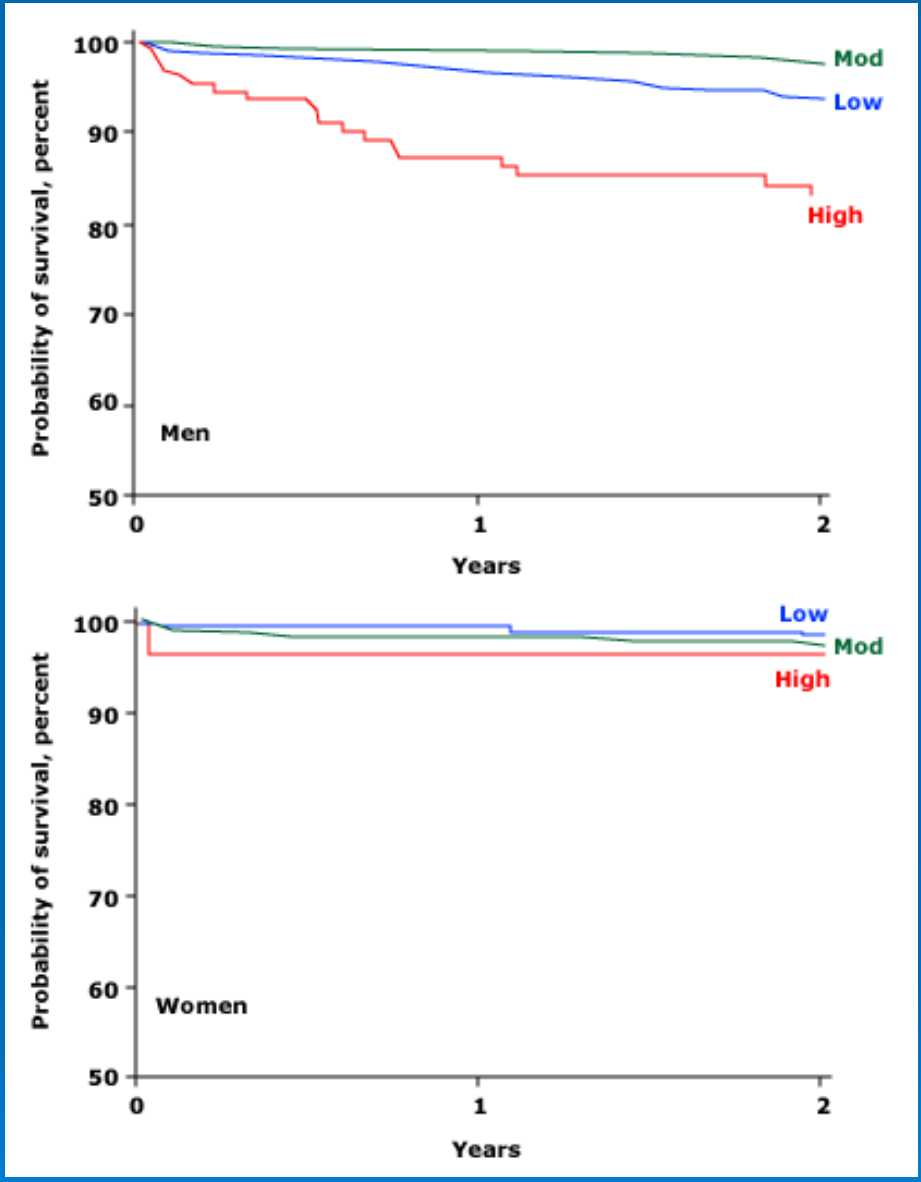
- Clinical questions...
  - Functional capacity
  - BP response to exercise
  - HR response to exercise
  - Assess arrhythmias, both atrial and ventricular
  - Assess effect of medications
  - Gives significant prognostic information in patients with known CAD

Duke Treadmill score predicts survival



In a group of 2758 consecutive patients undergoing ECG exercise testing (70 percent male), the prognosis was related to the risk category which was established by Duke treadmill score based upon exercise duration, the degree of ST segment depression, and the presence and severity of angina. The five year survival was 65 percent in high risk patients with a score of -11 compared with a survival of 90 percent in moderate risk patients with a score of -10 to +4 and over 97 percent in low risk patients with a score of +5 ($p<0.00001$). Data from Shaw, LJ, Peterson, ED, Shaw, LK, et al. Circulation 1998; 98:1622.

Predictive value of Duke treadmill score



Kaplan-Meier curves for two-year survival in 2249 men (top panel) and 976 women (bottom panel) with chest pain and suspected coronary disease with low (+5), moderate (-10 to +4), and high risk (-11) Duke treadmill scores. The treadmill score effectively risk stratified men but not women. A possible explanation for the lack of predictive value in women is that the mean age was 51 years, an age at which there is a low frequency of clinically important CHD in women. Data from Alexander, KP, Shaw, LJ, Delong, ER, et al, J Am Coll Cardiol 1998; 32:1657.

Patients excluded from Stress ECG

- Patient who fails to achieve 85% MPHR

(220-age in years)*0.85 = MPHR

  - Leg claudication
  - Arthritis
  - Deconditioning
  - Pulmonary disease
  - BETA BLOCKER therapy

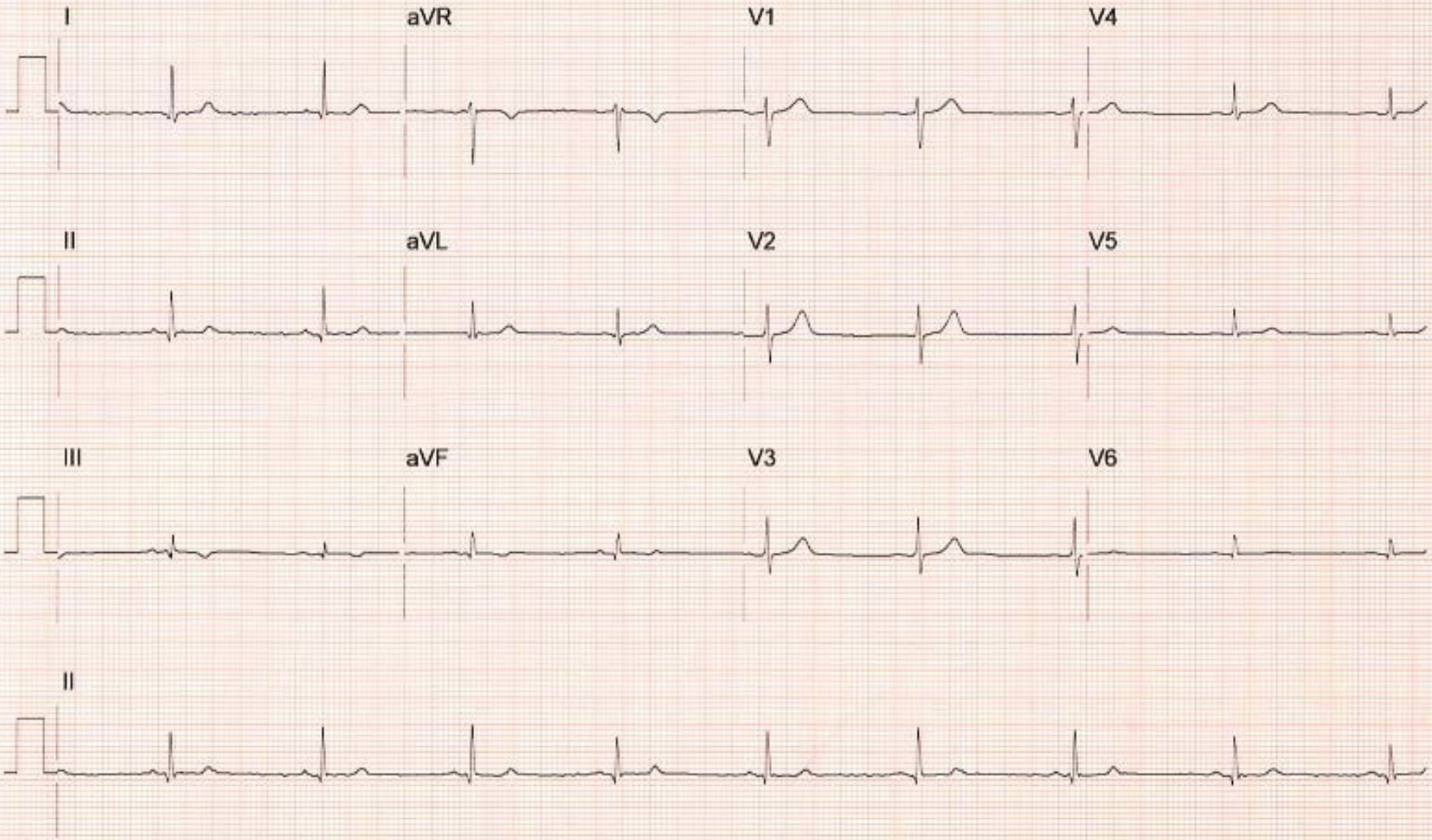
Patients excluded from Stress ECG

- Abnormal baseline ECG
  - WPW, paced rhythm, LBBB
  - > 1mm ST depression at rest
  - Digoxin
  - LVH
  - Prior MI

Stress ECG Examples

[redacted]
900055054
2/1/1955
12-Lead Manual (sequential)

Protocol	Bruce		RPE	–	HR	56						
	Stage	Rest 20:30	METs(a)	1.0	Target HR	141	II	LVL	0.0	SLP	0
	Spd/Grd	0.0 mph 0.0%	BP	122/80	Max HR	56	V2	LVL	0.7	SLP	6
			Previous BP	—/—	HRxBP	6832	V5	LVL	0.1	SLP	0



4/24/2009 8:14:46 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 5 of 24 I /①

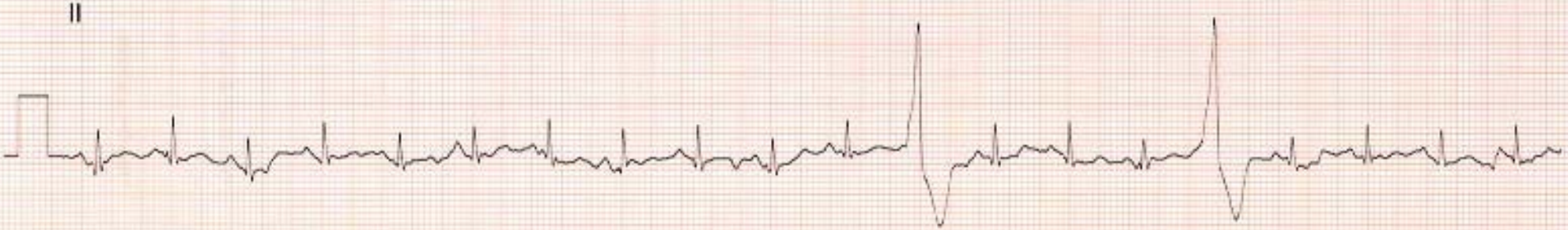
[redacted]

900055054
2/1/1955 Protocol Bruce
10-second Write Screen Manual Stage 2 01:13 04:13
Spd/Grd 2.5 mph 12.0%

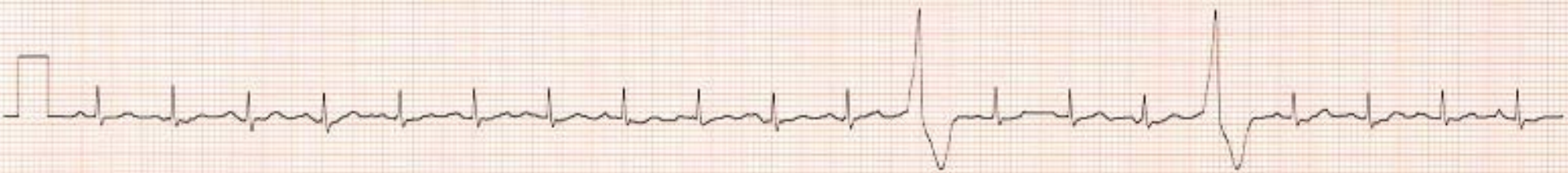
RPE	–	HR	121					
METs(a)	7.0	Target HR	141	II	LVL	0.0	SLP	3
BP	—/—	Max HR	121	V2	LVL	0.6	SLP	10
Previous BP	138/64	HRxBP	——	V5	LVL	0.1	SLP	4

I

II

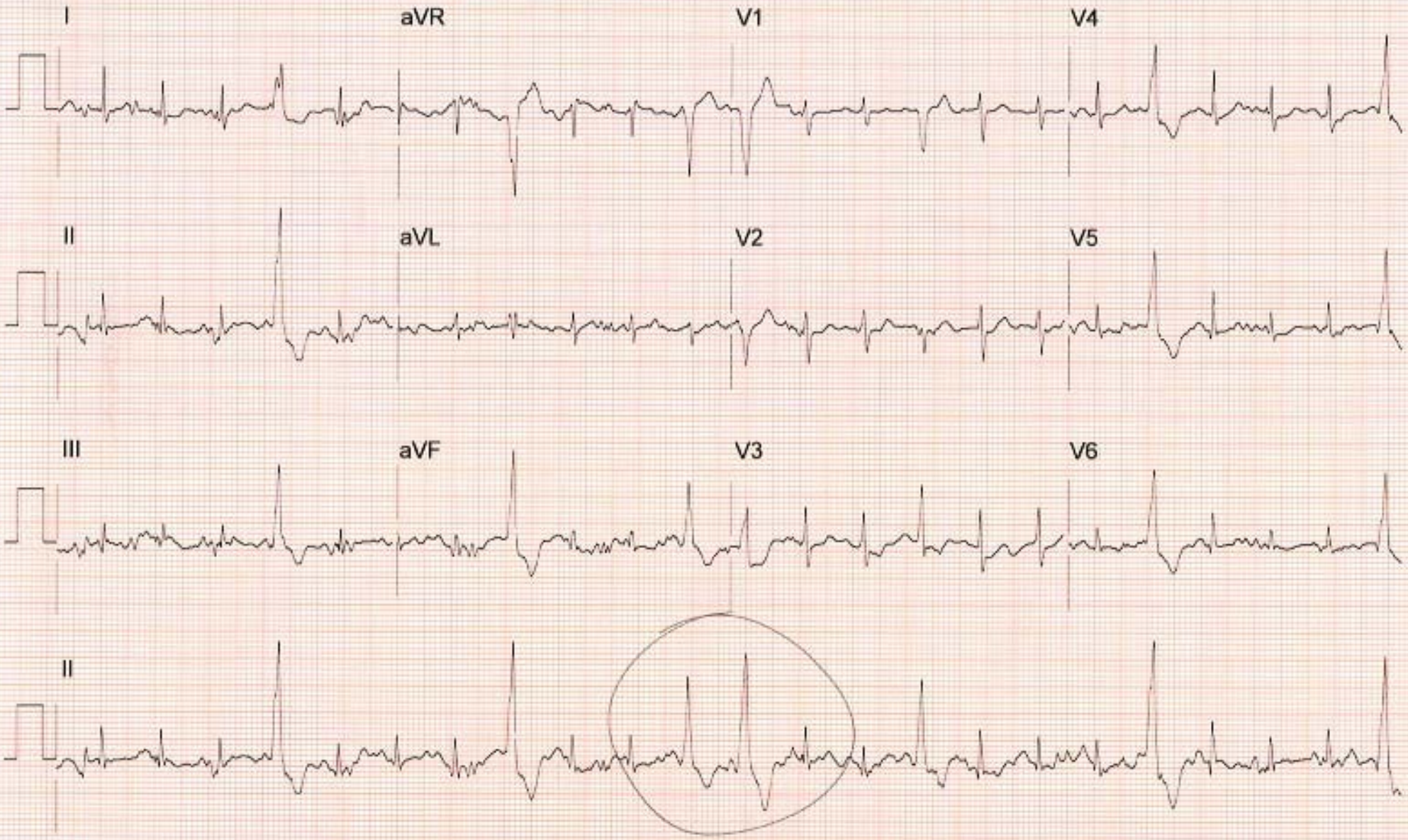


V5



[redacted]
900055054
2/1/1955
12-Lead Manual (sequential)

Protocol	Bruce		RPE	–	HR	137				
	Stage	3 00:41 06:41	METs(a)	7.0	Target HR	141	II	LVL	-0.3	SLP	7
	Spd/Grd	3.4 mph 14.0%	BP	–/–	Max HR	137	V2	LVL	0.3	SLP	10
			Previous BP	146/70	HRxBP	——	V5	LVL	-0.3	SLP	6



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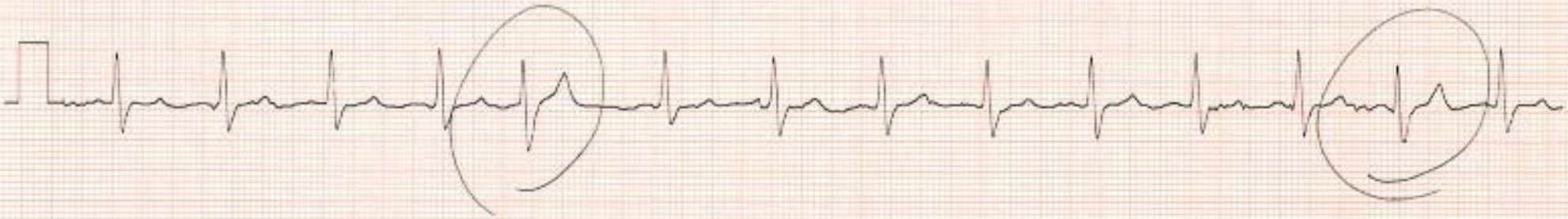
900166361
5/6/1956 Protocol Bruce
10-second Write Screen Manual Stage 1 00:27 00:27
Spd/Grd 1.7 mph 10.0%

RPE	–	HR	83					
METs(a)	1.0	Target HR	143	II	LVL	0.2	SLP	4
BP	—/—	Max HR	88	V2	LVL	1.7	SLP	12
Previous BP	114/80	HRxBP	——	V5	LVL	0.2	SLP	2

I

II

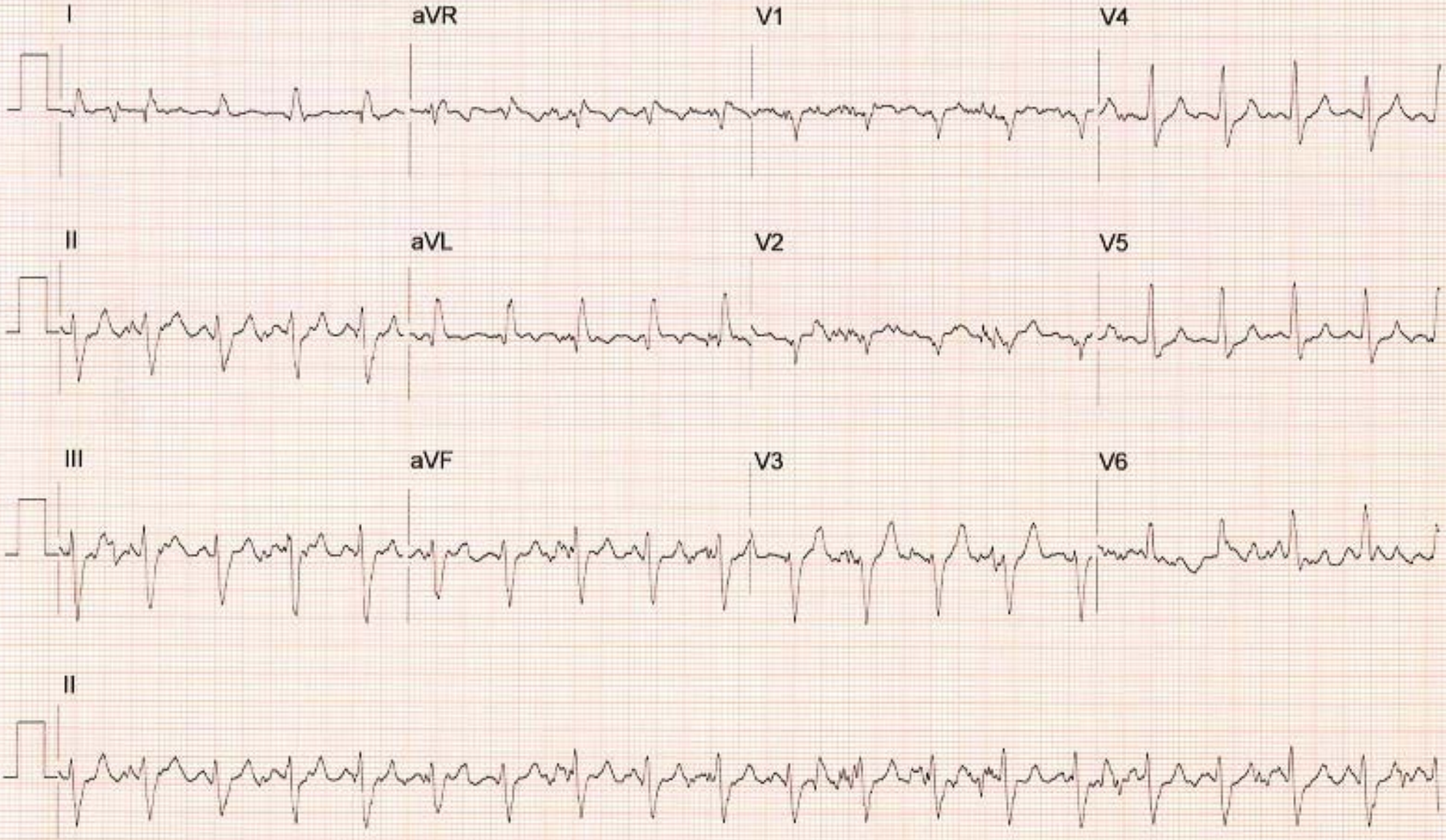
V5



1/20/2009 8:24:17 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 8 of 29 II/3

[redacted]
900166361
5/6/1956
12-Lead (sequential)

Protocol	Bruce		RPE	–	HR	116					
	Stage	3 02:50 08:50	METs(a)	10.1	Target HR	143	II	LVL	0.6	SLP	10
	Spd/Grd	3.4 mph 14.0%	BP	138/82	Max HR	116	V2	LVL	2.0	SLP	20
			Previous BP	144/80	HRxBP	16008	V5	LVL	0.0	SLP	7



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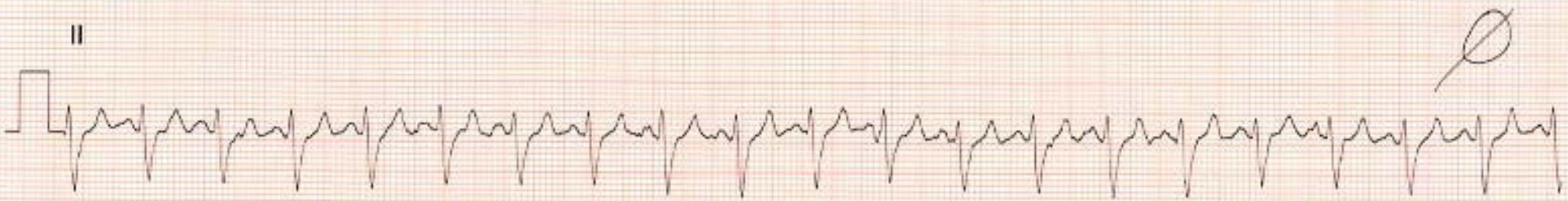
900166361
5/6/1956
Avg Beat

Protocol Bruce
Stage Recov 00:10
Spd/Grd 1.2 mph 0.0%

RPE	–	HR	135					
METs(a)	12.8	Target HR	143	II	LVL	0.4	SLP	14
BP	—/—	Max HR	135	V2	LVL	2.2	SLP	23
Previous BP	138/82	HRxBP	—	V5	LVL	-0.4	SLP	2

	Rest	Current
I	LVL 0.0 SLP 1	LVL 0.1 SLP 10
II	LVL 0.1 SLP 8	LVL 0.4 SLP 14
III	LVL 0.2 SLP 8	LVL 0.3 SLP 5
aVR	LVL -0.1 SLP -5	LVL -0.2 SLP -12
aVL	LVL -0.1 SLP -3	LVL 0.0 SLP 2
aVF	LVL 0.2 SLP 7	LVL 0.4 SLP 9
V1	LVL 0.6 SLP 0	LVL 1.2 SLP 3
V2	LVL 1.6 SLP 10	LVL 2.2 SLP 23
V3	LVL 1.8 SLP 15	LVL 5.9 SLP 50
V4	LVL 0.7 SLP 7	LVL 1.2 SLP 19
V5	LVL 0.2 SLP 6	LVL -0.4 SLP 2
V6	LVL -1.6 SLP 2	LVL -0.3 SLP 0

II



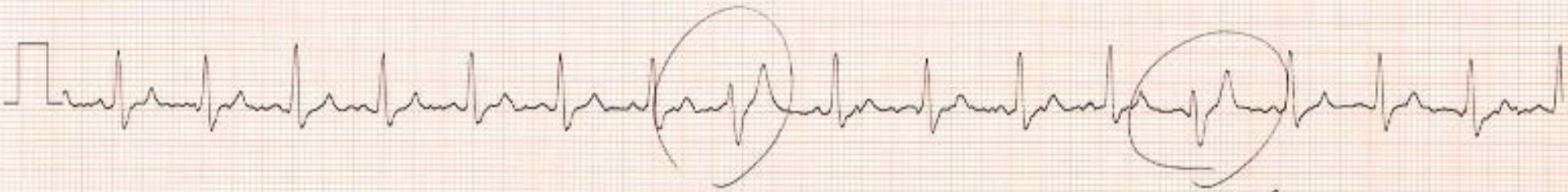
[redacted]
900166361
5/6/1956 Protocol Bruce
10-second Write Screen Manual Stage Recov 01:03
Spd/Grd 0.0 mph 0.0%

RPE	–	HR	99					
METs(a)	12.8	Target HR	143	II	LVL	1.5	SLP	17
BP	154/72	Max HR	135	V2	LVL	2.4	SLP	24
Previous BP	138/82	HRxBP	15246	V5	LVL	0.7	SLP	9

I

II

V5

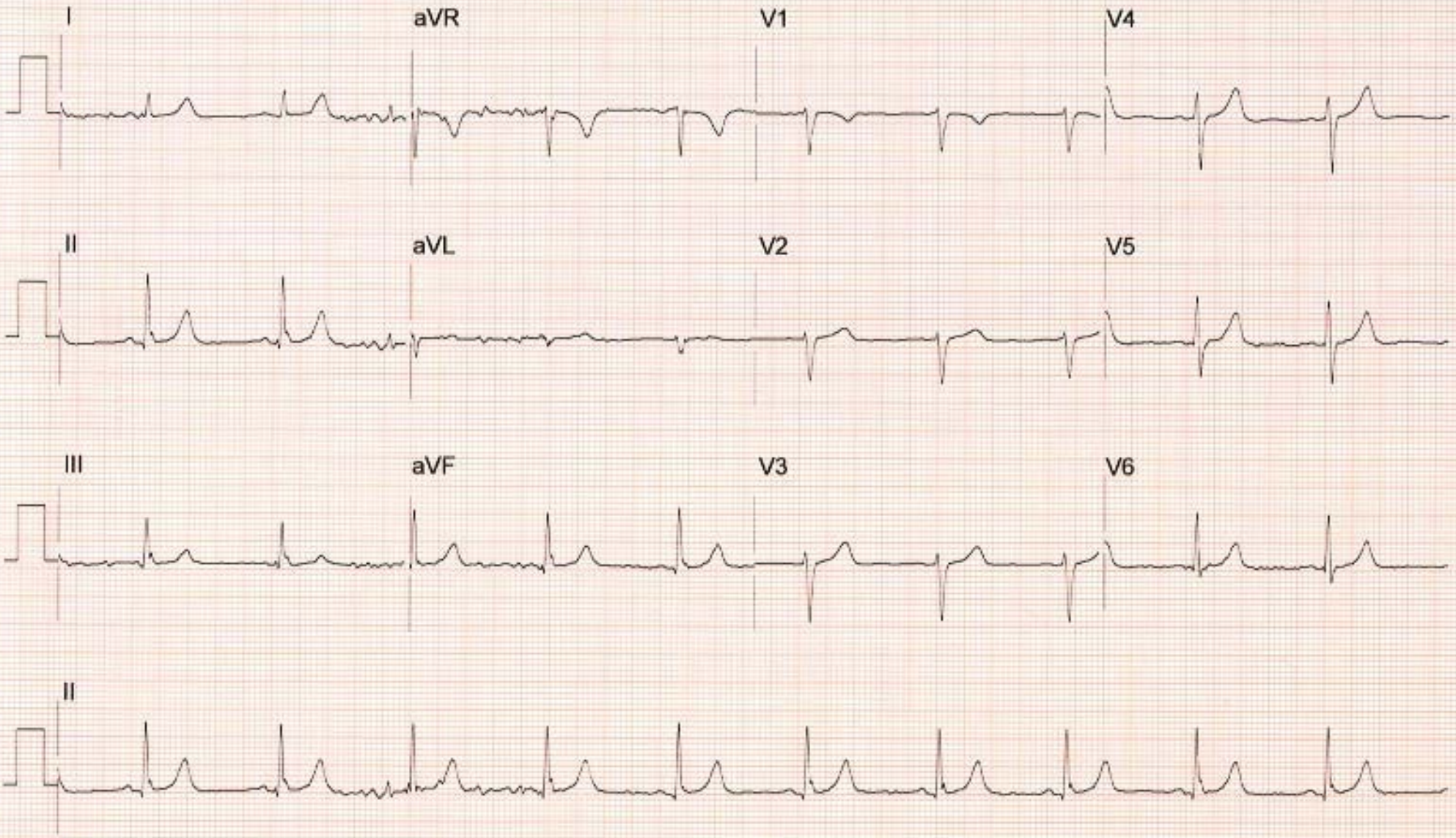


burn @ HR

[redacted]
900204960

12-Lead Manual (sequential)

Protocol	Bruce		RPE	–	HR	64					
Stage	Rest 01:06		METs(a)	1.0	Target HR	136	II	LVL	0.7	SLP	7
Spd/Grd	0.0 mph	0.0%	BP	150/80	Max HR	64	V2	LVL	0.8	SLP	4
			Previous BP	—/—	HRxBP	9600	V5	LVL	1.0	SLP	8



2/17/2009 9:24:40 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 5 of 35

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900204960

	Protocol	Manual Treadmill		RPE	–	HR	124				
10-second Write Screen Manual		Stage	1 02:56 02:56	METs(a)	4.6	Target HR	136	II	LVL	0.8	SLP 20
		Spd/Grd	1.4 mph 0.0%	BP	210/90	Max HR	127	V2	LVL	0.7	SLP 7
				Previous BP	150/80	HRxBP	26040	V5	LVL	1.6	SLP 25

I

II

V5

2/17/2009 9:39:15 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On

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900204960

Protocol	Manual Treadmill	RPE	–	HR	128				
10-second Write Screen Manual	Stage 1 03:15 03:15	METs(a)	4.6	Target HR	136	II	LVL	0.9	SLP 20
	Spd/Grd 1.4 mph 0.0%	BP	210/90	Max HR	128	V2	LVL	0.8	SLP 6
		Previous BP	150/80	HRxBP	26880	V5	LVL	1.7	SLP 25

236/110

I

II

1 2 2

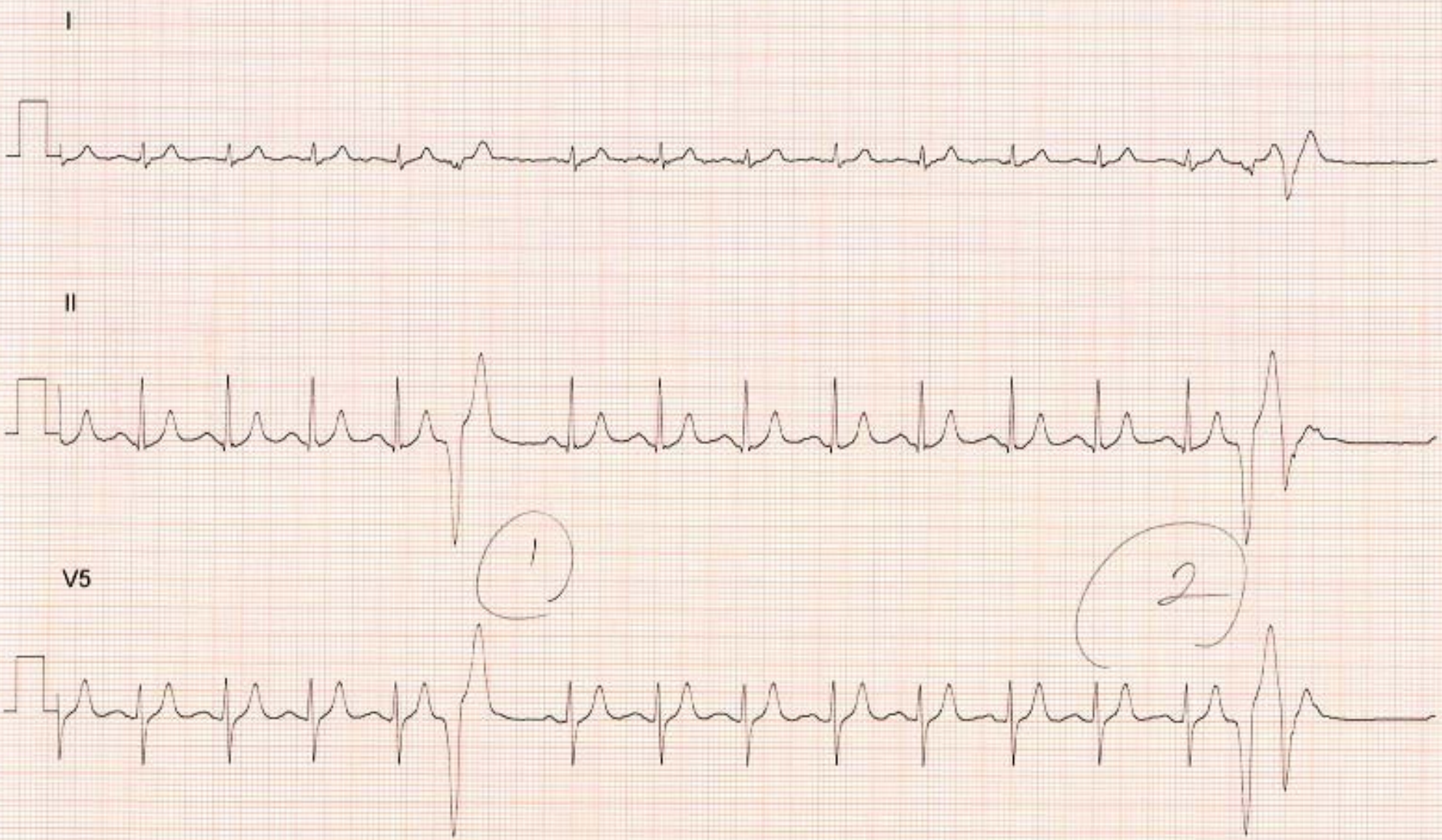
V5

2/17/2009 9:39:34 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 13 of 35

[redacted]

900204960

Protocol	Manual Treadmill	RPE	–	HR	94				
10-second Write Screen Manual	Stage Recov 01:48	METs(a)	4.6	Target HR	136	II	LVL	1.3	SLP 22
	Spd/Grd 0.0 mph 0.0%	BP	236/110	Max HR	129	V2	LVL	0.9	SLP 7
		Previous BP	210/90	HRxBP	22184	V5	LVL	1.9	SLP 25

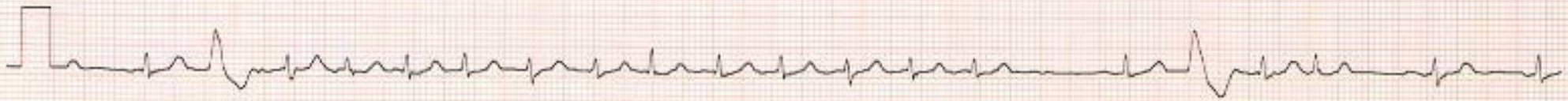


2/17/2009 9:42:33 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 26 of 35

[redacted]
900204960

Protocol	Manual Treadmill	RPE	–	HR	128				
10-second Write Screen Manual	Stage Recov 02:08	METs(a)	4.6	Target HR	136	II	LVL 1.1	SLP	19
	Spd/Grd 0.0 mph 0.0%	BP	208/100	Max HR	136	V2	LVL 0.7	SLP	5
		Previous BP	236/110	HRxBP	26624	V5	LVL 1.5	SLP	20

I



II

V5

SVT

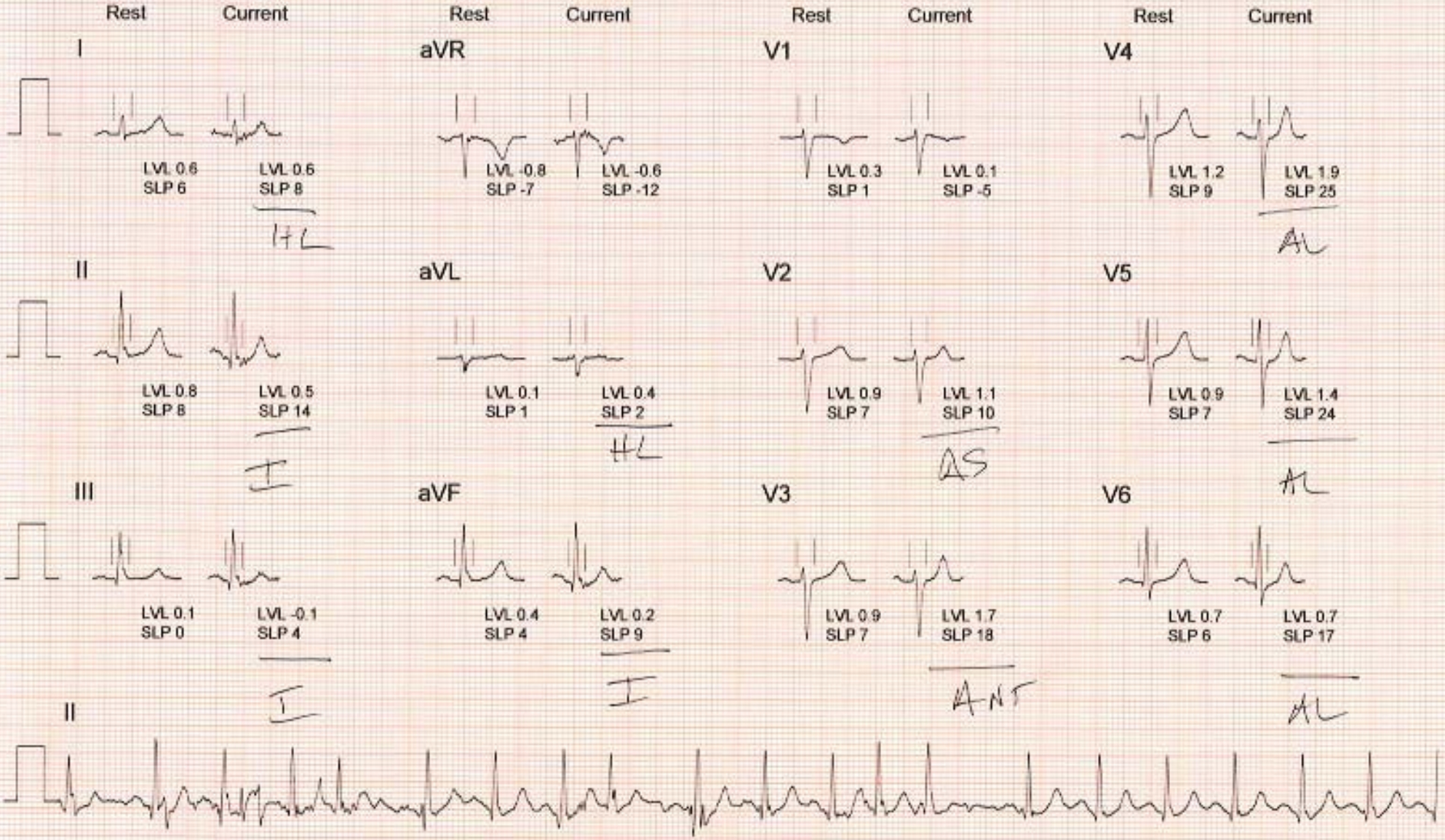
2/17/2009 9:42:53 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On

[redacted]

900204960

Avg Beat

Protocol	Manual Treadmill		RPE	–	HR	125					
Stage	Recov 00:10		METs(a)	4.6	Target HR	136	II	LVL	0.5	SLP	14
Spd/Grd	0.8 mph	0.0%	BP	—/—	Max HR	129	V2	LVL	1.1	SLP	10
			Previous BP	210/90	HRxBP	——	V5	LVL	1.4	SLP	24



2/17/2009 9:40:55 AM 25 mm/sec 10 mm/mV BWF On MAF On Line On 40Hz On Page 22 of 35

11/12

[redacted]

OLEFERUK, ISABELLE A

Stage	Total Stage Time	HR	Current ER	BP	HRxBP	TM Speed mph	TM Grade %	LVL II	LVL V2	LVL V5
REST	*12:45*	78	0	150/ 80	11700	1.2	0.0	0.8	0.9	0.9
Stage 1	Protocol changed to Manual Treadmill									
	01:00	106	0	---/---	---	1.7	4.0	0.6	0.7	1.0
	02:00	119	1	210/ 90	24990	1.7	4.0	0.9	0.6	1.6
	03:00	126	1	210/ 90	26460	1.4	0.0	0.8	0.7	1.6
	Radionuclide Injected									
	04:00	124	18	210/ 90	26040	1.3	0.0	0.4	0.9	1.2
	04:26	122	13	210/ 90	25620	1.3	0.0	0.5	0.8	1.3
Stop exercise at 04:26										
RECOVERY	*01:00*	109	0	236/110	25724	0.0	0.0	1.2	1.1	1.8
	02:00	98	6	236/110	23128	0.0	0.0	1.2	0.7	1.7
	03:00	85	0	208/100	17680	0.0	0.0	1.0	0.6	1.2
	04:00	83	0	208/100	17264	0.0	0.0	0.6	0.5	1.0
	05:00	82	1	172/ 92	14104	0.0	0.0	0.4	0.6	0.8
	06:00	77	2	172/ 92	13244	0.0	0.0	0.3	0.6	0.8
	07:00	70	1	150/ 90	10500	0.0	0.0	0.2	0.6	0.7
	08:00	76	1	150/ 90	11400	0.0	0.0	0.2	0.6	0.6
	08:20	73	1	150/ 90	10950	0.0	0.0	0.2	0.6	0.5

HTNSV

RTE

never got Target HR

[redacted]

Rest	Worst	Rest	Worst	Rest	Worst	Rest	Worst
I		aVR		V1		V4	
LVL 0.1 SLP -1	LVL -0.5 SLP 3 1 0:19	LVL -0.1 SLP 1	LVL -0.3 SLP -2 1 0:59	LVL 0.3 SLP 3	LVL -0.1 SLP 2 1 0:29	LVL 0.2 SLP -1	LVL -1.9 SLP 8 3 0:59
II		aVL		V2		V5	
LVL 0.1 SLP -1	LVL -1.3 SLP 6 3 1:19	LVL 0.0 SLP 0	LVL -0.4 SLP 4 1 0:19	LVL 0.6 SLP 3	LVL 0.0 SLP -1 1 0:29	LVL 0.1 SLP -1	LVL -1.9 SLP 5 3 1:29
III		aVF		V3		V6	
LVL 0.1 SLP 0	LVL -1.3 SLP -1 3 1:19	LVL 0.1 SLP 0	LVL -1.3 SLP 2 3 1:19	LVL 0.6 SLP 2	LVL -0.2 SLP 0 1 0:59	LVL 0.0 SLP -2	LVL -1.5 SLP 5 3 1:29

IV/2

Tabular Summary

[redacted]

Stage	Total Stage Time	HR	Current ER	BP	HRxBP	TM Speed mph	TM Grade %	LVL II	LVL V2	LVL V5
REST	Standing									
	14:44	57	0	160/ 82	9120	1.2	0.0	0.1	0.6	0.1
Stage 1	*01:00*	93	0	---/---	---	1.7	10.0	0.0	0.1	-0.5
	02:00	105	0	---/---	---	1.7	10.0	-0.3	0.4	-0.3
Stage 2	*01:00*	119	0	---/---	---	2.5	12.0	-0.5	0.3	-0.7
	02:00	123	0	180/100	22140	2.5	12.0	-0.7	0.4	-0.9
	03:00	127	0	180/100	22860	2.5	12.0	-1.0	0.4	-1.3
Stage 3	Stage held Protocol changed to Manual Treadmill									
	01:00	141	0	---/---	---	3.7	14.0	-1.0	0.6	-1.8
	Stage resumed *01:43*	143	0	---/---	---	3.7	3.5	-1.0	0.7	-1.9
Stop exercise at 06:43										
RECOVERY	*01:00*	92	0	208/110	19136	0.0	0.0	0.5	0.5	0.0
	02:00	74	0	208/110	15392	0.0	0.0	-0.3	0.4	-0.4
	03:00	66	0	170/100	11220	0.0	0.0	-0.4	0.3	-0.4
	04:00	68	0	170/100	11560	0.0	0.0	-0.6	0.4	-0.5
	05:00	67	0	168/ 98	11256	0.0	0.0	-0.5	0.4	-0.3
	06:00	66	1	168/ 98	11088	0.0	0.0	-0.4	0.6	-0.5
	06:55	64	0	168/ 98	10752	0.0	0.0	-0.4	0.6	-0.5

Worst Case

[redacted]

Rest	Worst	Rest	Worst	Rest	Worst	Rest	Worst
I		aVR		V1		V4	
LVL 0.2 SLP 1	LVL -0.2 SLP 0 2 5:12	LVL -0.1 SLP 0	LVL -0.4 SLP -3 1 0:12	LVL 0.0 SLP 0	LVL 0.0 SLP 0 Rest	LVL 0.0 SLP 0	LVL -0.7 SLP 9 Recovery 0:06
II		aVL		V2		V5	
LVL 0.1 SLP -1	LVL -1.2 SLP 2 2 5:12	LVL 0.2 SLP 2	LVL 0.1 SLP 2 1 0:32	LVL 0.1 SLP 1	LVL 0.1 SLP 1 Rest	LVL 0.0 SLP 0	LVL -0.9 SLP 8 Recovery 0:06
III		aVF		V3		V6	
LVL -0.2 SLP -3	LVL -1.3 SLP -4 2 4:52	LVL -0.1 SLP -2	LVL -1.1 SLP -1 2 4:52	LVL 0.1 SLP -2	LVL -0.9 SLP 0 2 5:12	LVL 0.1 SLP -2	LVL -1.1 SLP 2 2 4:32

Tabular Summary

[redacted]

Stage	Total Stage Time	HR	Current ER	BP	HRxBP	TM Speed mph	TM Grade %	LVL II	LVL V2	LVL V5
REST	*15:55*	89	0	119/ 80	10591	1.2	0.0	0.2	0.4	0.6
Stage 1	*01:00*	107	0	---/---	---	1.7	10.0	0.0	0.5	0.3
	02:00	117	0	---/---	---	1.7	10.0	0.0	0.5	0.4
	03:00	124	0	168/ 90	20832	1.7	10.0	0.0	0.4	0.4
Stage 2	*01:00*	133	0	---/---	---	2.5	12.0	-0.1	0.3	0.1
	Protocol changed to Manual Treadmill									
	02:00	137	0	---/---	---	2.5	0.0	-0.4	0.4	0.0
	Radionuclide Injected									
	02:59	132	0	180/ 90	23760	2.5	0.0	-0.1	0.5	0.4
Stop exercise at 05:59										
RECOVERY	*01:00*	121	0	---/---	---	0.8	0.0	0.2	0.7	0.5
	02:00	108	0	---/---	---	0.0	0.0	0.2	0.4	0.4
	03:00	100	0	148/ 68	14800	0.0	0.0	0.0	0.3	0.2
	04:00	96	0	148/ 68	14208	0.0	0.0	-0.1	0.4	0.1
	04:32	95	0	148/ 68	14060	0.0	0.0	0.0	0.4	0.1

Abnl HR recovery

lightheaded c nl BP RTE

Rest	Worst	Rest	Worst	Rest	Worst	Rest	Worst
I		aVR		V1		V4	
LVL 0.1 SLP 2	LVL -0.1 SLP 0 2 1:06	LVL -0.2 SLP -3	LVL -0.5 SLP -12 2 2:36	LVL 0.2 SLP 0	LVL 0.0 SLP 0 1 0:16	LVL 0.8 SLP 10	LVL 0.4 SLP 7 1 1:06
II		aVL		V2		V5	
LVL 0.2 SLP 4	LVL -0.6 SLP 15 2 1:16	LVL 0.1 SLP 1	LVL -0.1 SLP -8 Recovery 1:47	LVL 0.4 SLP 3	LVL 0.3 SLP 2 1 0:06	LVL 0.6 SLP 8	LVL 0.0 SLP 17 2 1:06
III		aVF		V3		V6	
LVL 0.0 SLP 1	LVL -0.5 SLP 12 2 1:16	LVL 0.0 SLP 2	LVL -0.5 SLP 14 2 1:16	LVL 0.9 SLP 10	LVL 0.6 SLP 8 1 0:56	LVL 0.3 SLP 4	LVL -0.3 SLP 14 2 1:56

Stress with Imaging

- TM vs. Pharmacologic
  - Similar accuracy
  - Similar positive and negative predictive values
- Pharmacologic Stress
  - Accurate assessment of CAD in patients unable to exercise
  - Very useful in pre-op risk assessment
  - Relatively safe
  - ECG abnormalities more predictive
  - More specific in patients with LBBB
  - Contraindicated in hypotension, SSS, asthma

Stress echo vs Stress MPI

Advantages of stress echocardiography

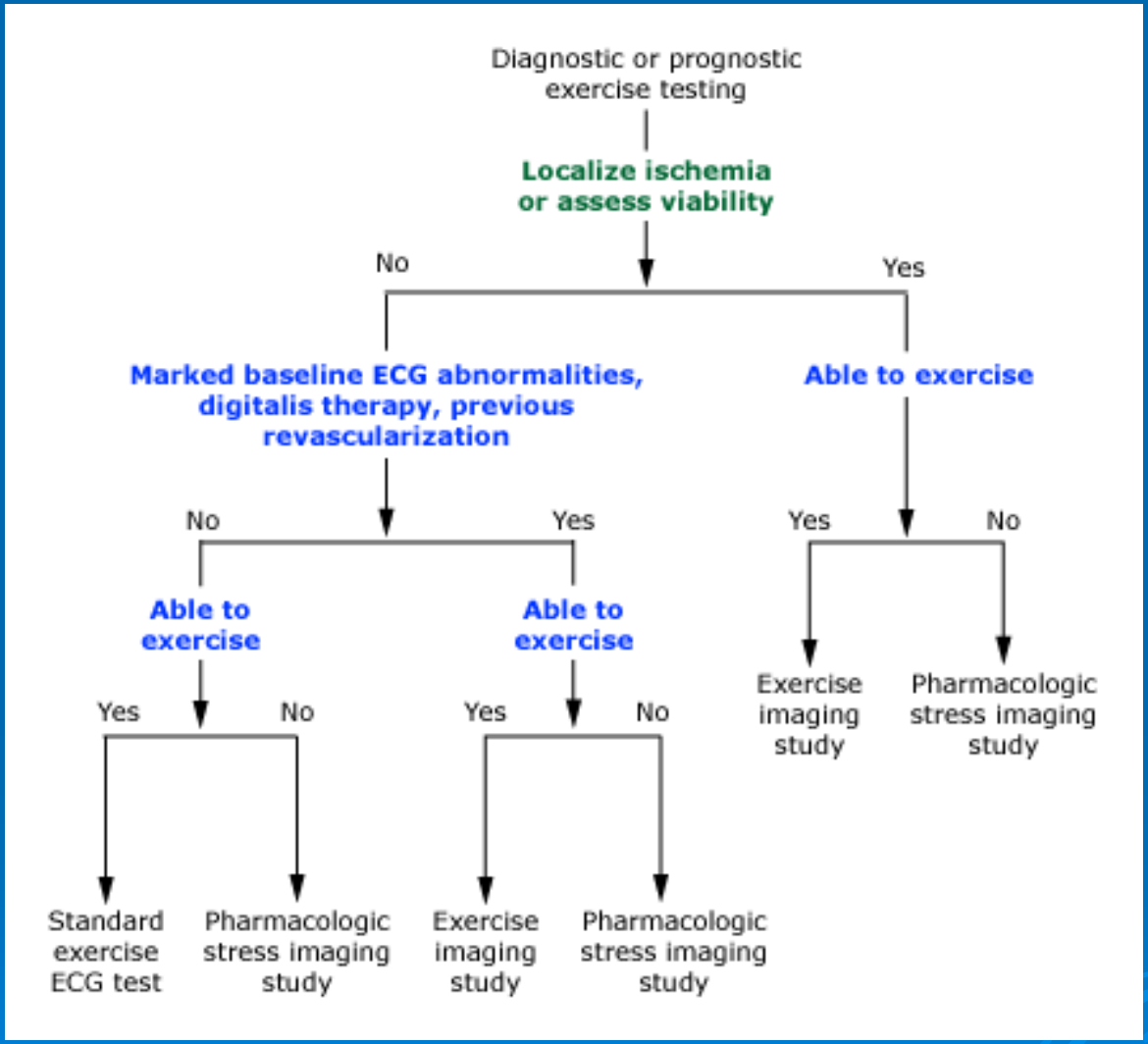
1. Higher specificity
2. Versatility - more extensive evaluation of cardiac anatomy and function
3. Greater convenience, efficacy, availability
4. Lower cost

Advantages of stress perfusion imaging

1. Higher technical success rate
2. Higher sensitivity - especially for single vessel coronary disease involving the left circumflex
3. Better accuracy in evaluating possible ischemia when multiple resting left ventricular wall motion abnormalities are present
4. More extensive published data base - especially in evaluation of prognosis

From: ACC/AHA 2002 guideline update for the management of patients with chronic stable angina--summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Chronic Stable Angina). Circulation 2003; 107:149.

Choice of exercise testing modality in different clinical settings



Marked baseline ECG abnormalities" include preexcitation (Wolff-Parkinson-White) syndrome, more than 1 mm of ST depression at rest, and patients taking digoxin or with ECG criteria for left ventricular hypertrophy, even if they have less than 1 mm of baseline ST depression. Evaluation of patients with left bundle branch block or paced ventricular rhythm is not included in this algorithm. UpToDate – Performance of exercise ECG Testing

Pearls for the referring practitioner

- Stage I Bruce protocol
  - 3 minutes @ 1.7mph on 10% grade
  - <= 4.6 METS = low workload
- Goal is 5 minutes on TM at any speed +/- grade
- Image patients
  - Can not exercise or exercise to 85% MPHR
  - Abnormal baseline ECG
  - Prior revascularization
- The optimal strategy for diagnosing CAD in women is not yet defined per guidelines

Tabular Summary

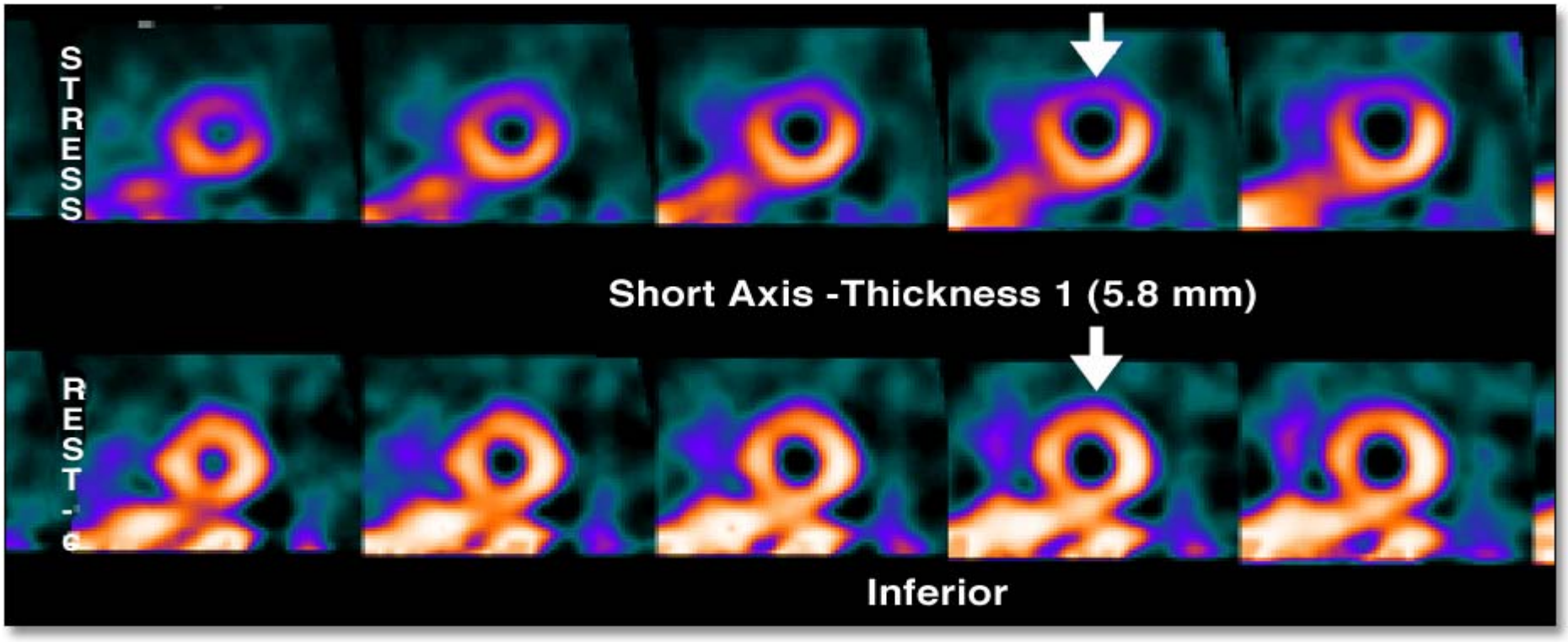
[redacted]

Stage	Total Stage Time	HR	Current ER	BP	HRxBP	TM Speed mph	TM Grade %	LVL II	LVL V2	LVL V5
REST	Protocol changed to Adenosine									
	15:05	69	0	142/ 90	9798	0.0	0.0	-0.3	0.2	-0.2
Stage 1	*01:00*	79	0	---/---	---	0.0	0.0	-0.1	0.2	-0.2
	Radionuclide Injected									
	02:00	82	0	140/ 90	11480	0.0	0.0	-0.3	0.0	-0.2
	03:00	86	0	140/ 90	12040	0.0	0.0	-0.4	0.1	-0.4
Stage 2	THROAT BURNING LIKE ANGINA									
	01:00	85	0	---/---	---	0.0	0.0	-0.8	0.2	-0.7
	01:03	87	0	132/ 70	11484	0.0	0.0	-0.8	0.2	-0.7
Stop exercise at 04:03										
RECOVERY	*01:00*	88	0	---/---	---	0.0	0.0	-0.9	0.3	-0.8
	02:00	72	0	---/---	---	0.0	0.0	-0.3	0.3	-0.3
	03:00	72	0	---/---	---	0.0	0.0	-0.4	0.2	-0.4
	STILLL WITH SOME THROAT TIGHTNESS									
	04:00	68	0	150/ 72	10200	0.0	0.0	-0.7	0.3	-0.4
	05:00	68	1	150/ 72	10200	0.0	0.0	-0.6	0.2	-0.5
	05:46	77	0	150/ 72	11550	0.0	0.0	-0.6	0.3	-0.4

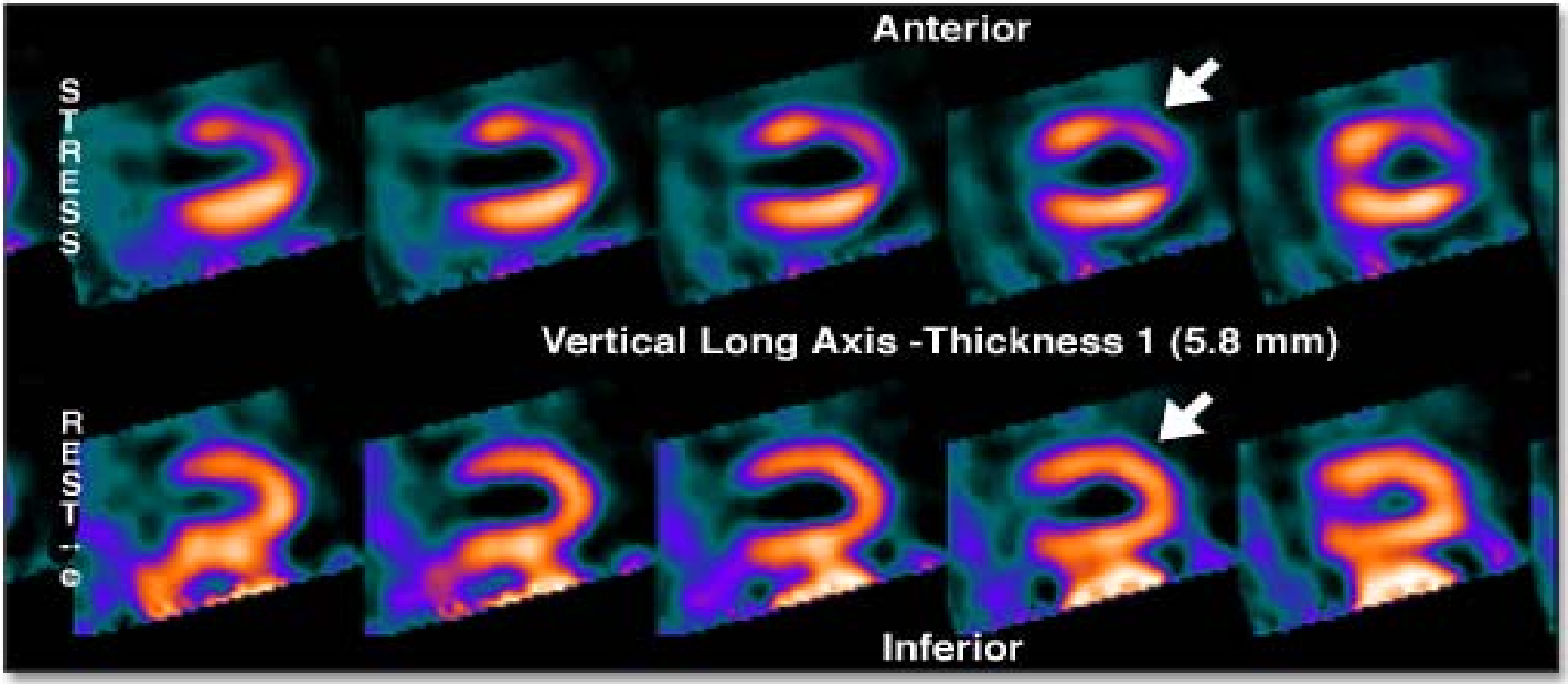
[redacted]

Rest	Worst	Rest	Worst	Rest	Worst	Rest	Worst
I		aVR		V1		V4	
LVL -0.1 SLP 0	LVL -0.4 SLP 0 Recovery 5:02	LVL 0.1 SLP 0	LVL 0.0 SLP -1 1 0:25	LVL 0.3 SLP 0	LVL 0.0 SLP -1 1 0:25	LVL -0.1 SLP 1	LVL -1.2 SLP -2 Recovery 0:32
II		aVL		V2		V5	
LVL -0.3 SLP -1	LVL -1.2 SLP -3 Recovery 0:32	LVL 0.0 SLP 1	LVL 0.0 SLP 1 Rest	LVL 0.2 SLP 1	LVL 0.0 SLP 0 1 1:05	LVL -0.2 SLP 0	LVL -1.0 SLP -2 Recovery 0:32
III		aVF		V3		V6	
LVL -0.2 SLP -1	LVL -1.0 SLP -3 Recovery 0:32	LVL -0.2 SLP -1	LVL -1.1 SLP -4 Recovery 0:32	LVL 0.1 SLP 4	LVL -0.8 SLP 0 Recovery 0:32	LVL -0.1 SLP 0	LVL -0.8 SLP -2 Recovery 0:32

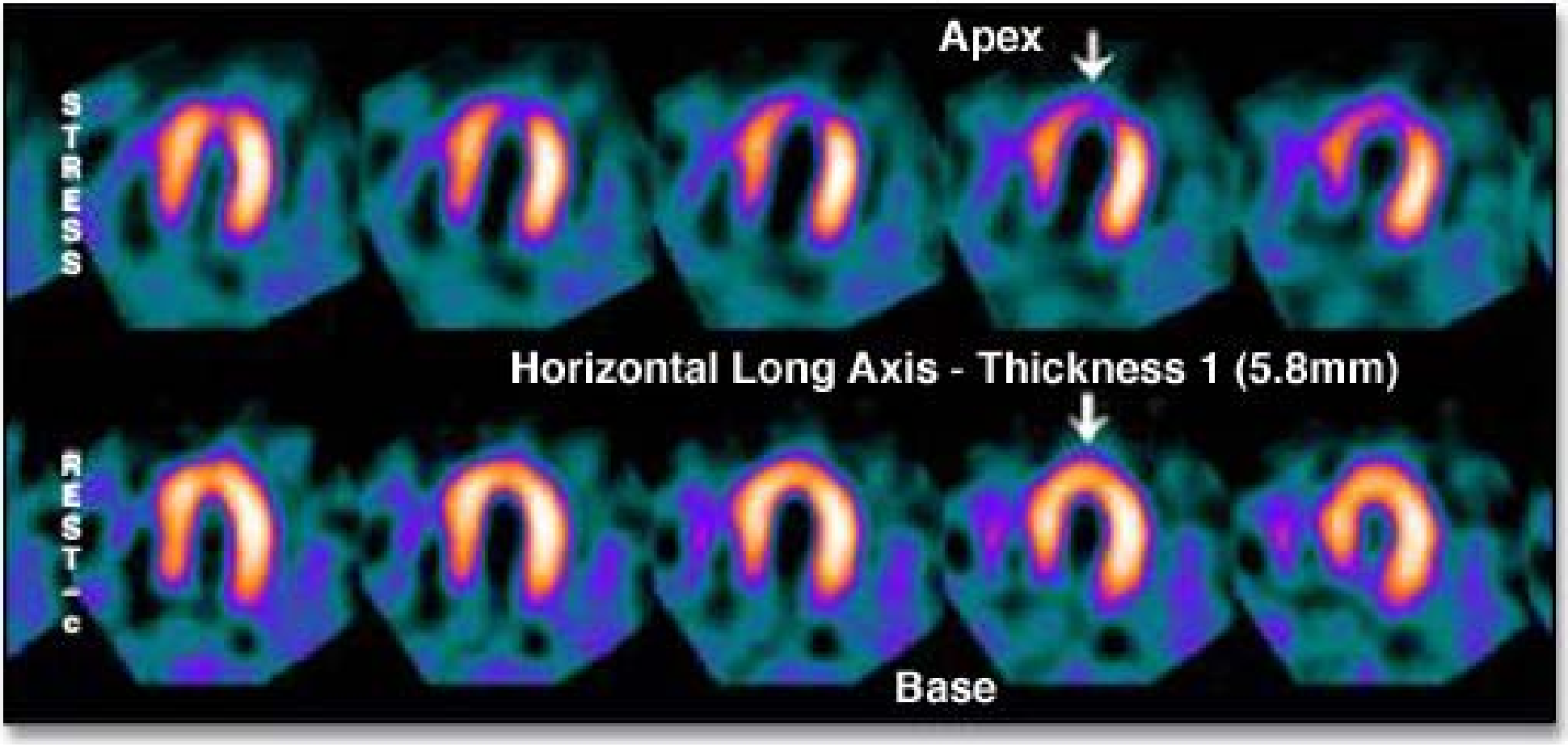
Anterior Ischemia



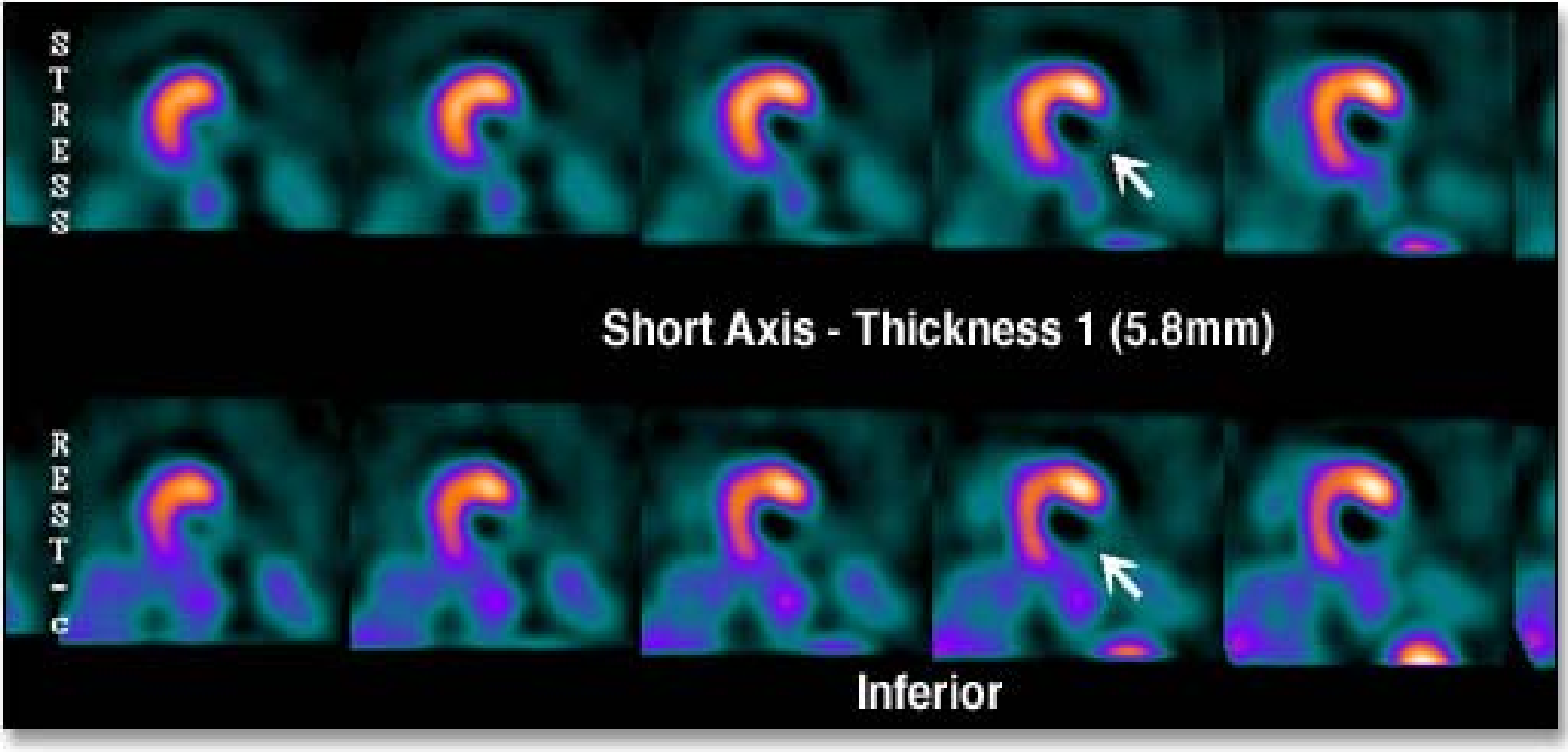
Anterior Ischemia



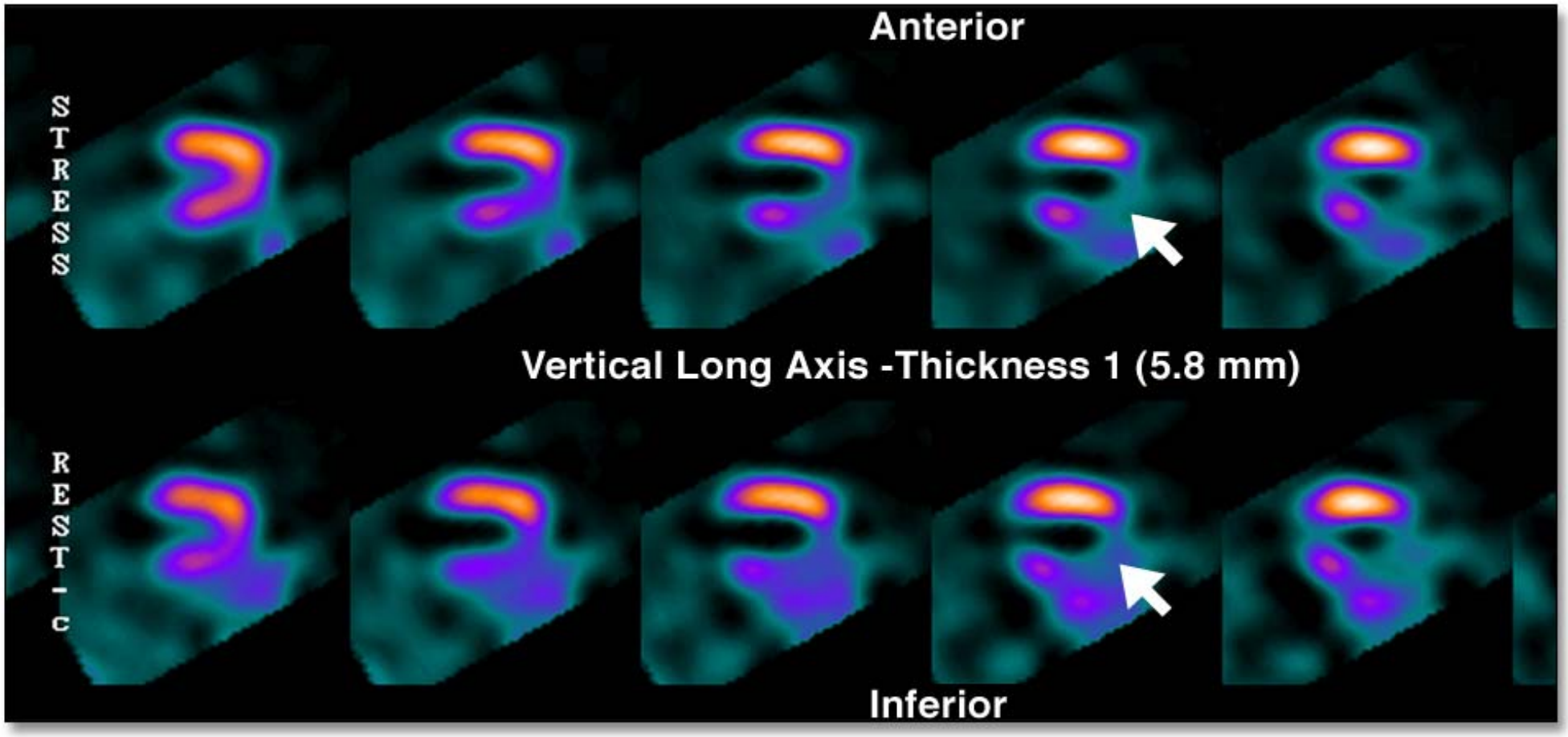
Anterior Ischemia



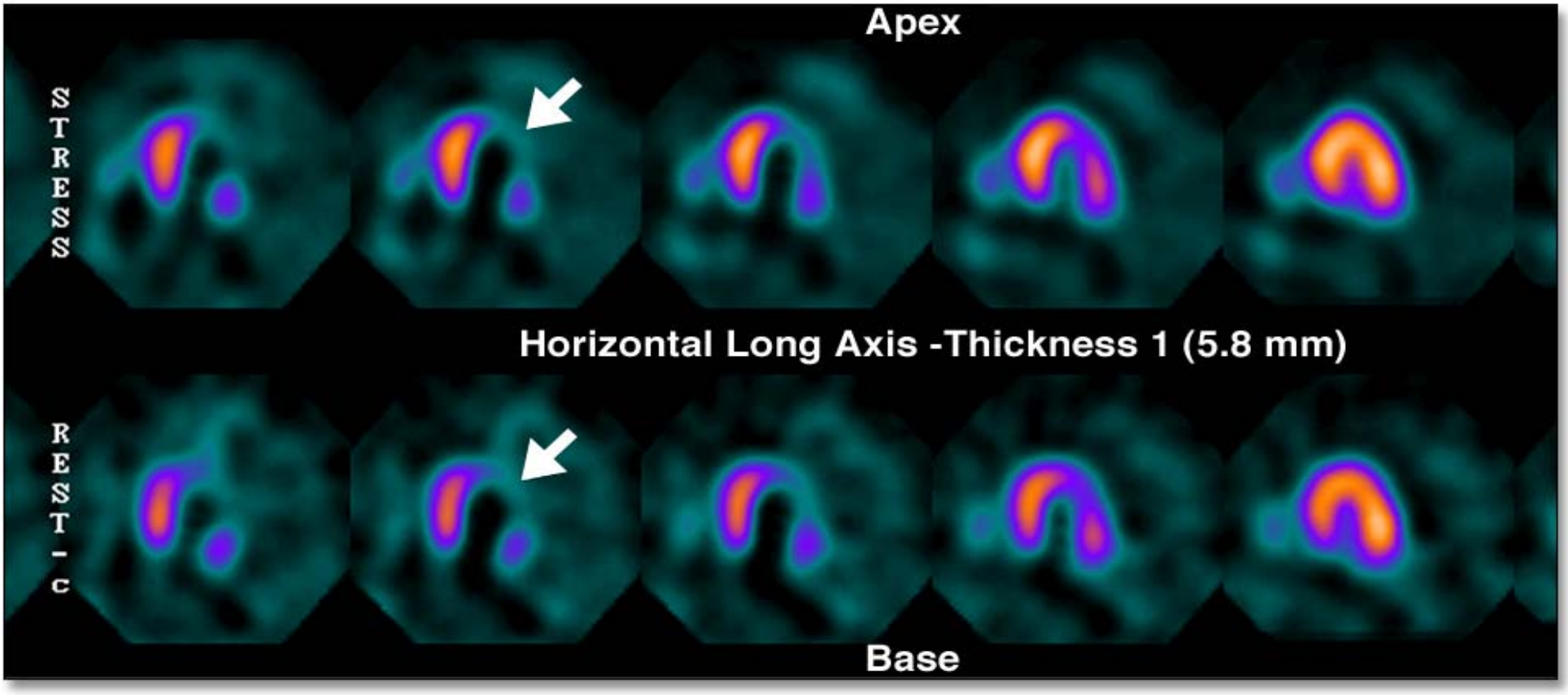
Fixed Inferolateral



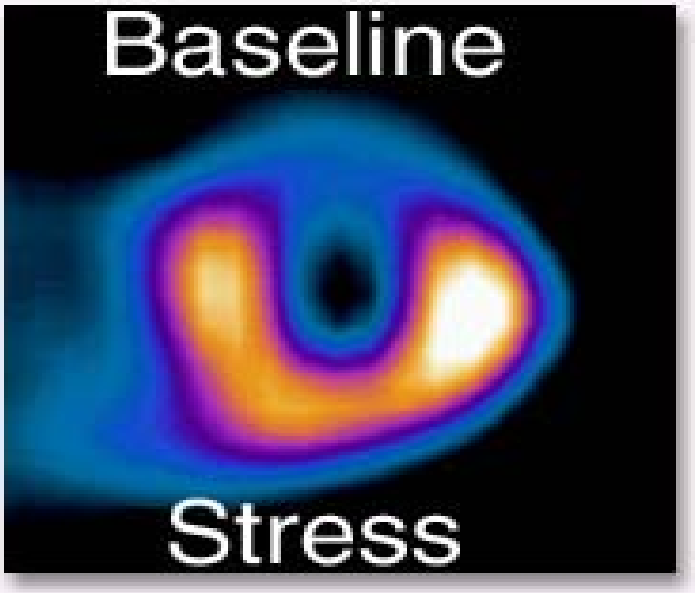
Fixed Inferolateral

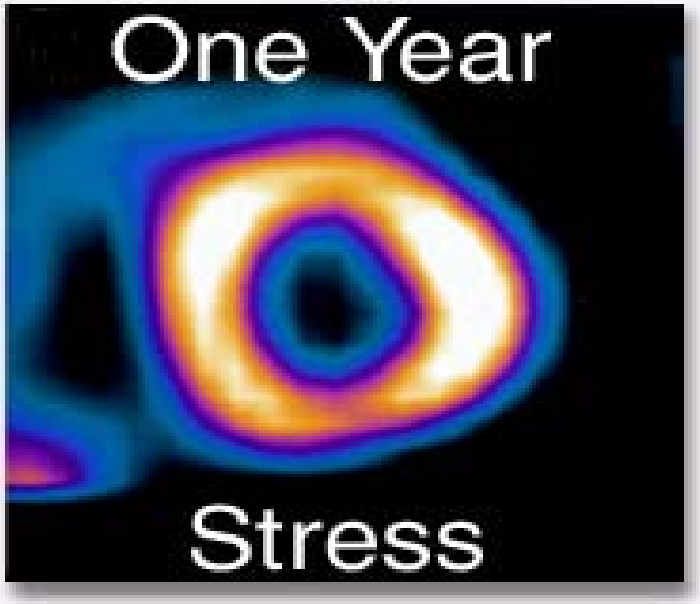


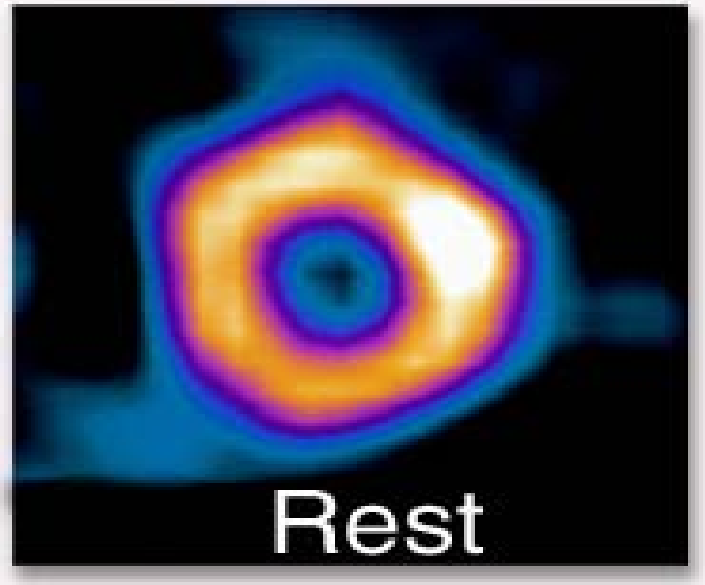
Fixed Inferolateral



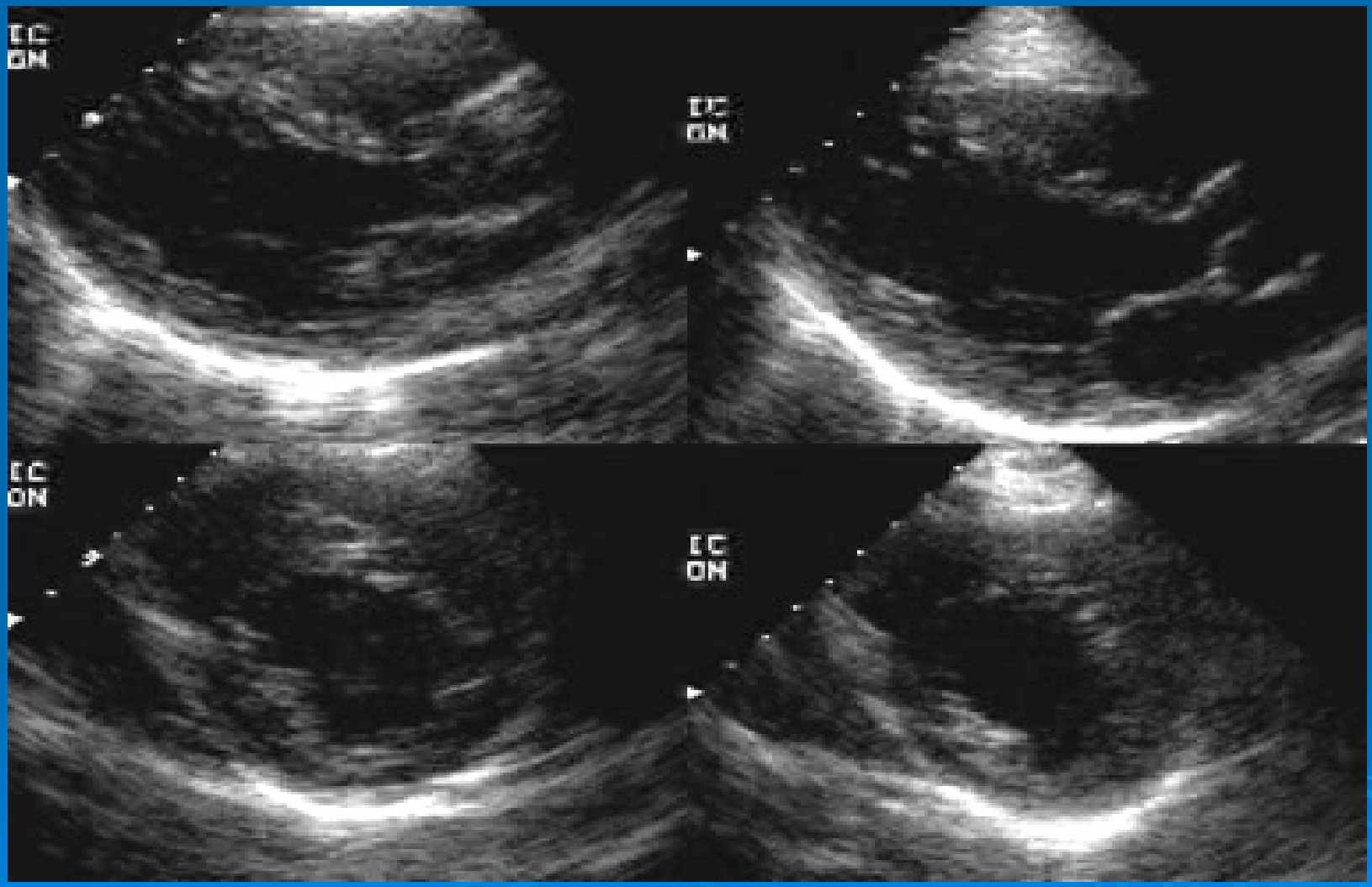
Optimal Medical Therapy - WOW!



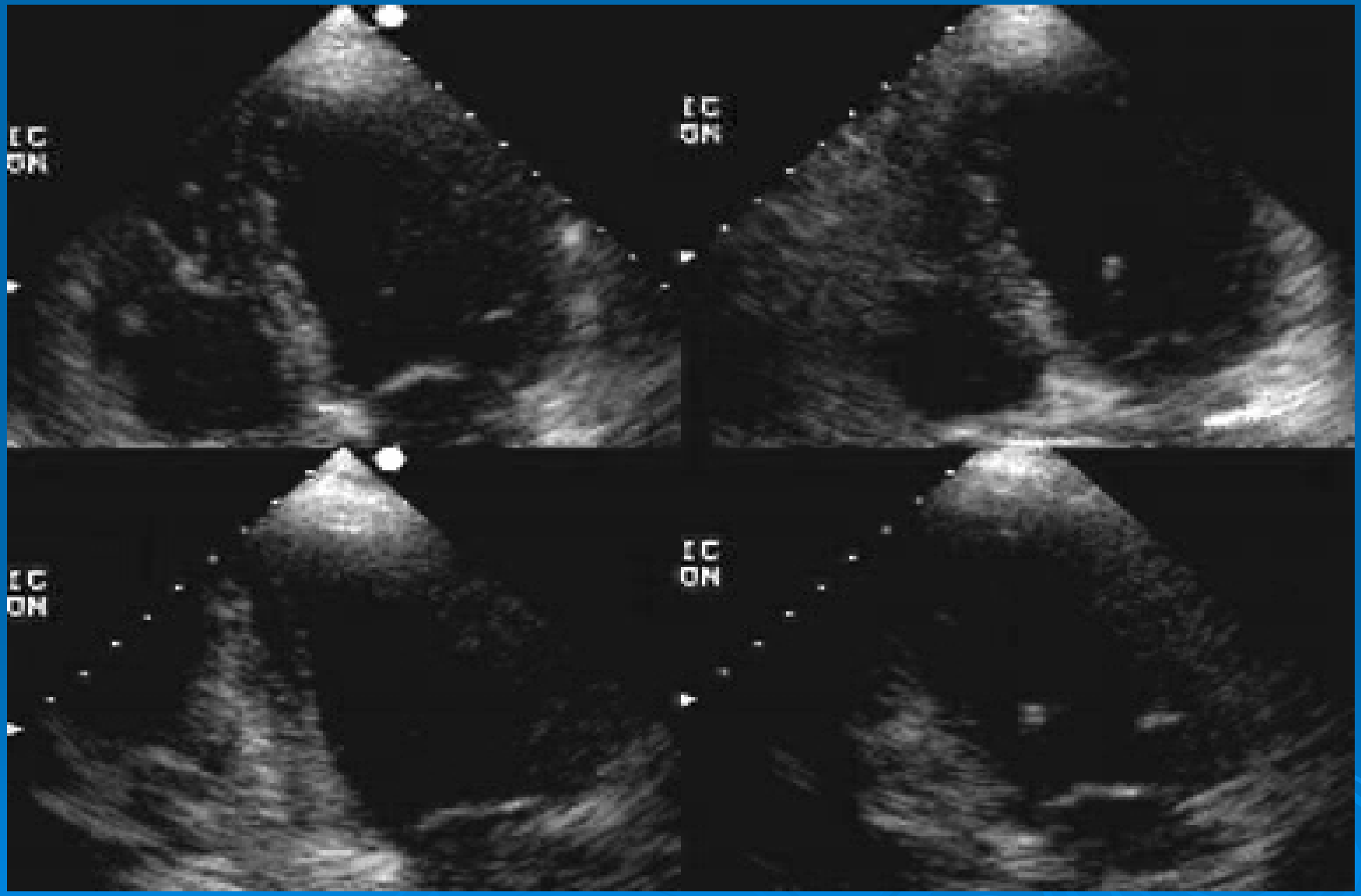




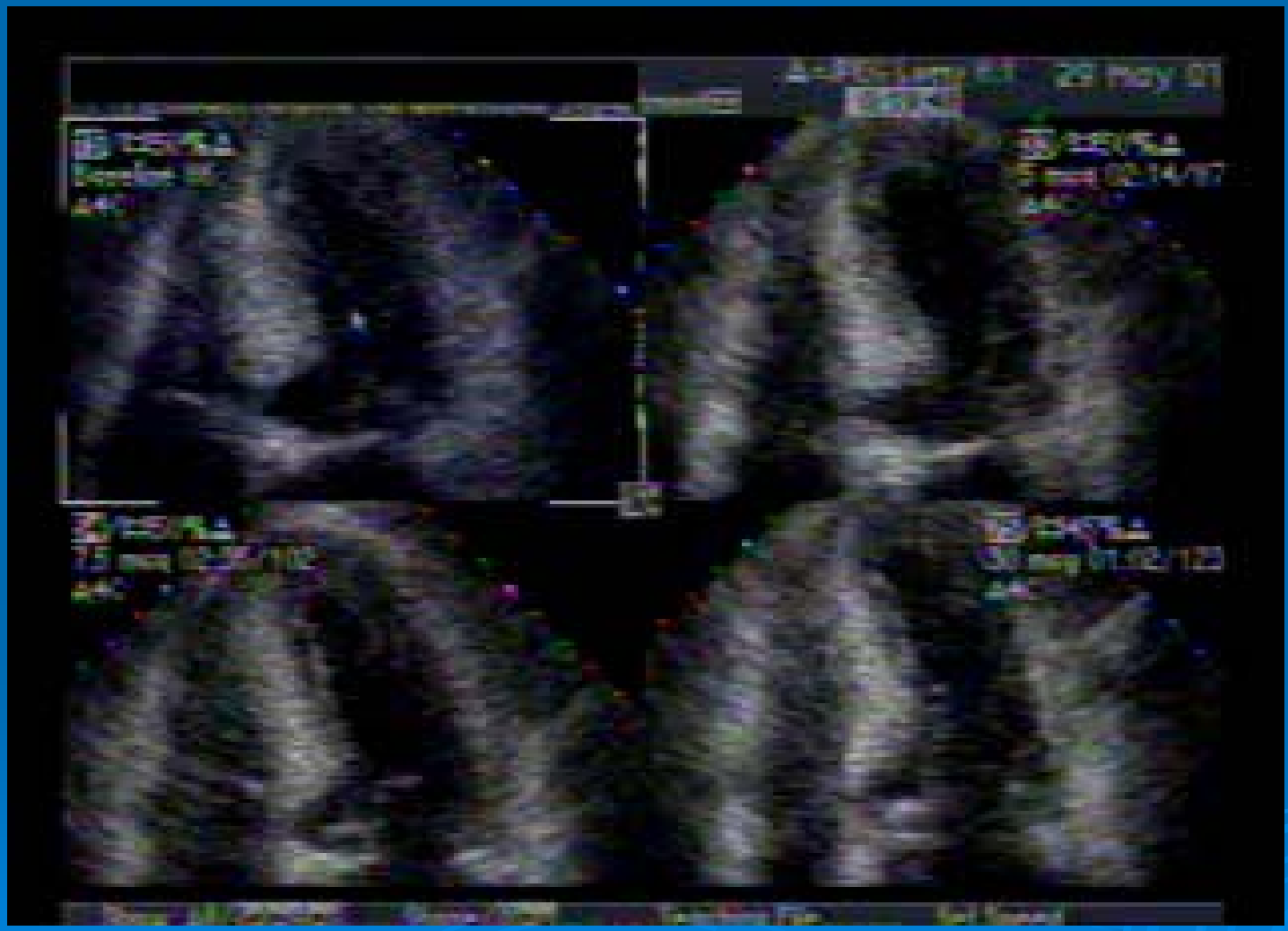
RCA Ischemia



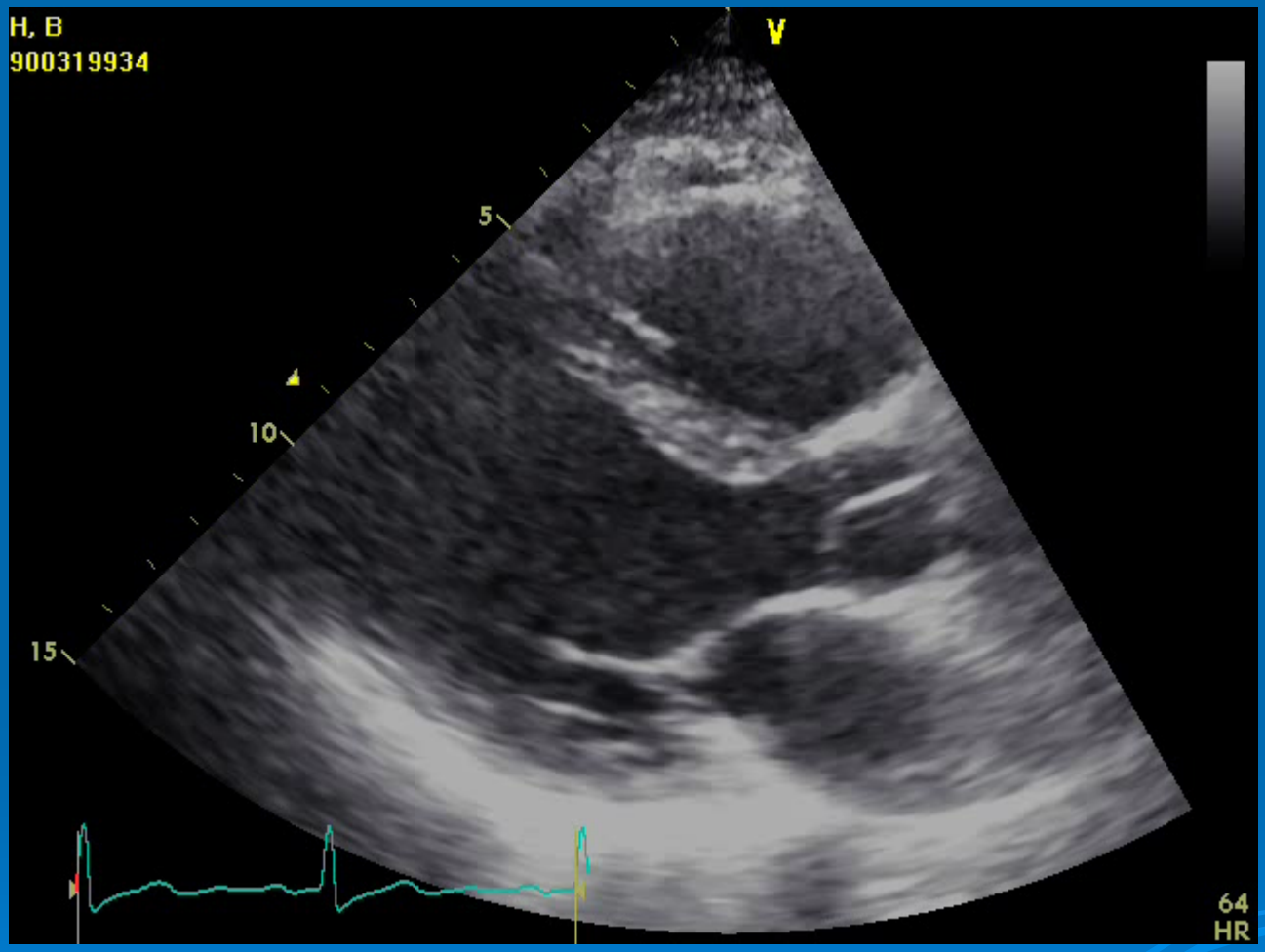
RCA Ischemia



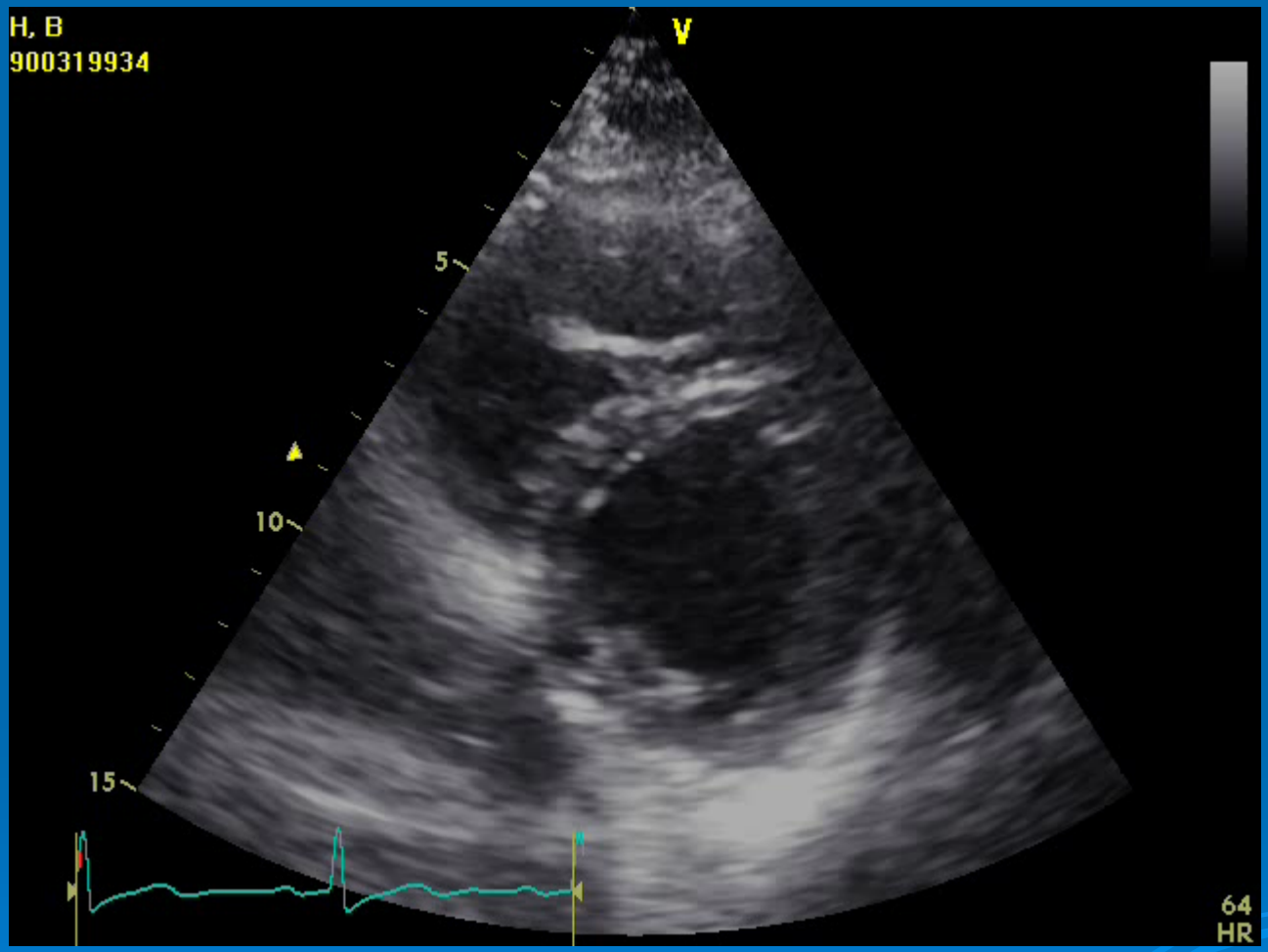
Normal Dobutamine



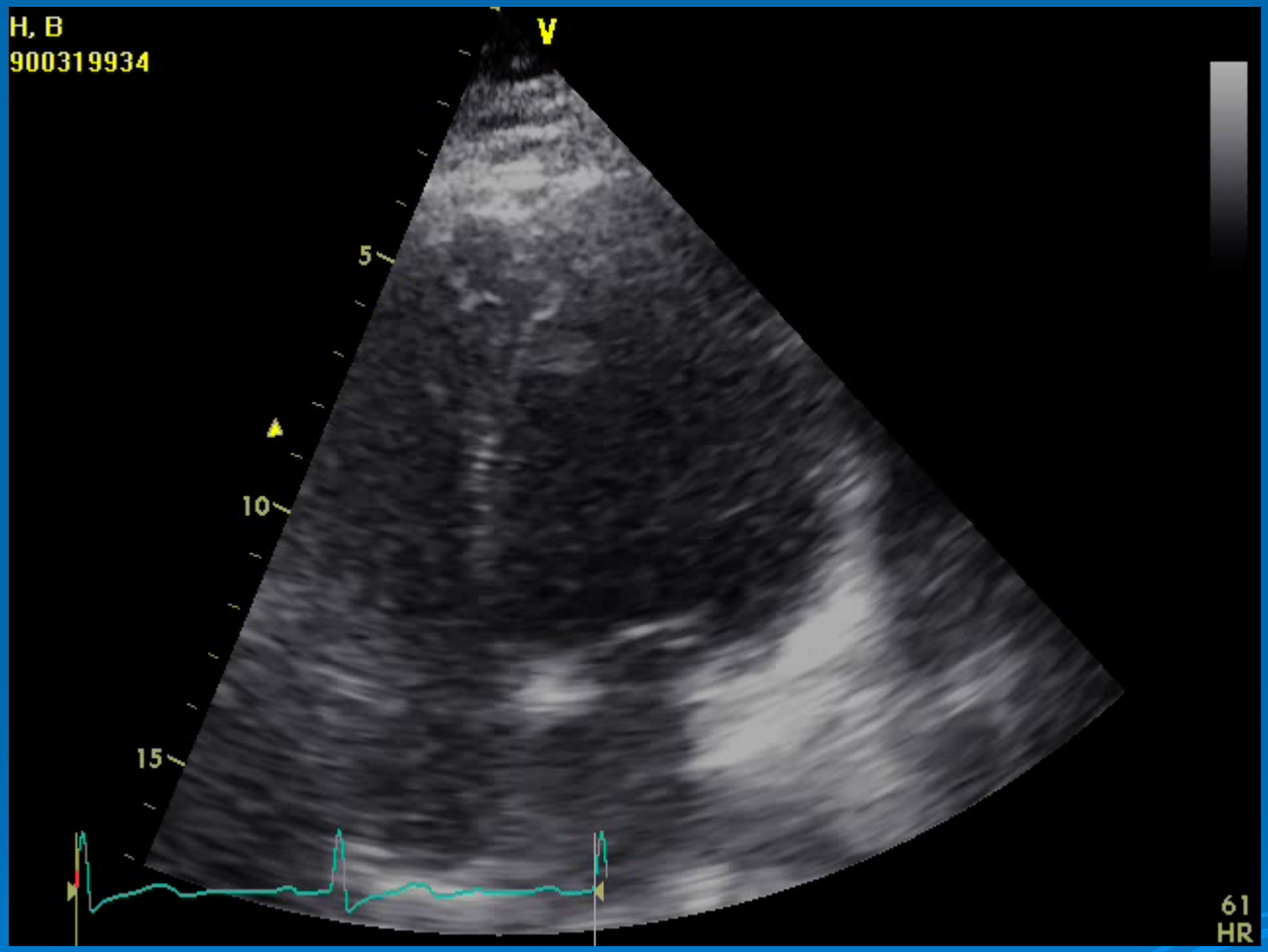
Parasternal Long Rest



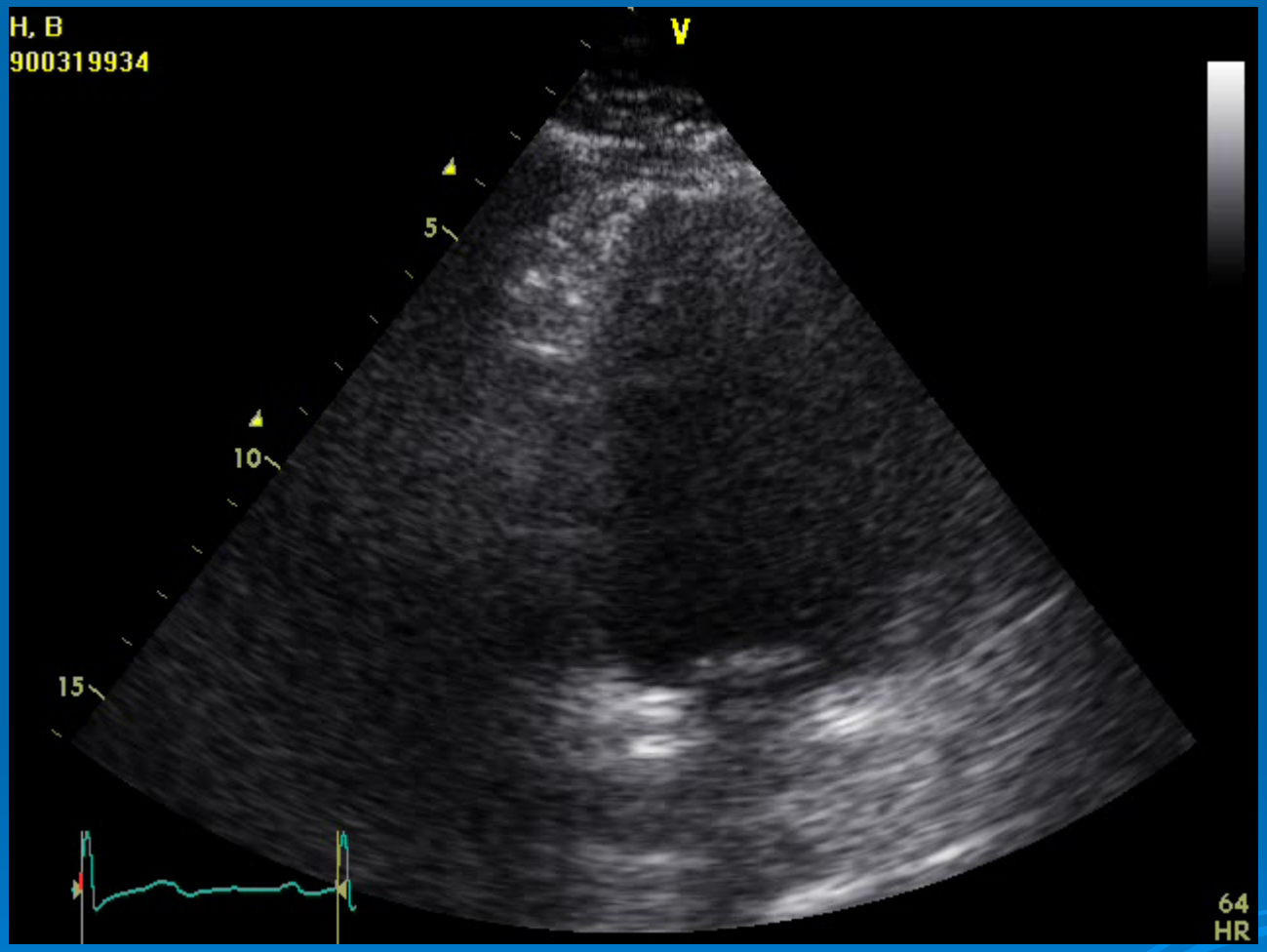
Parasternal Short Rest



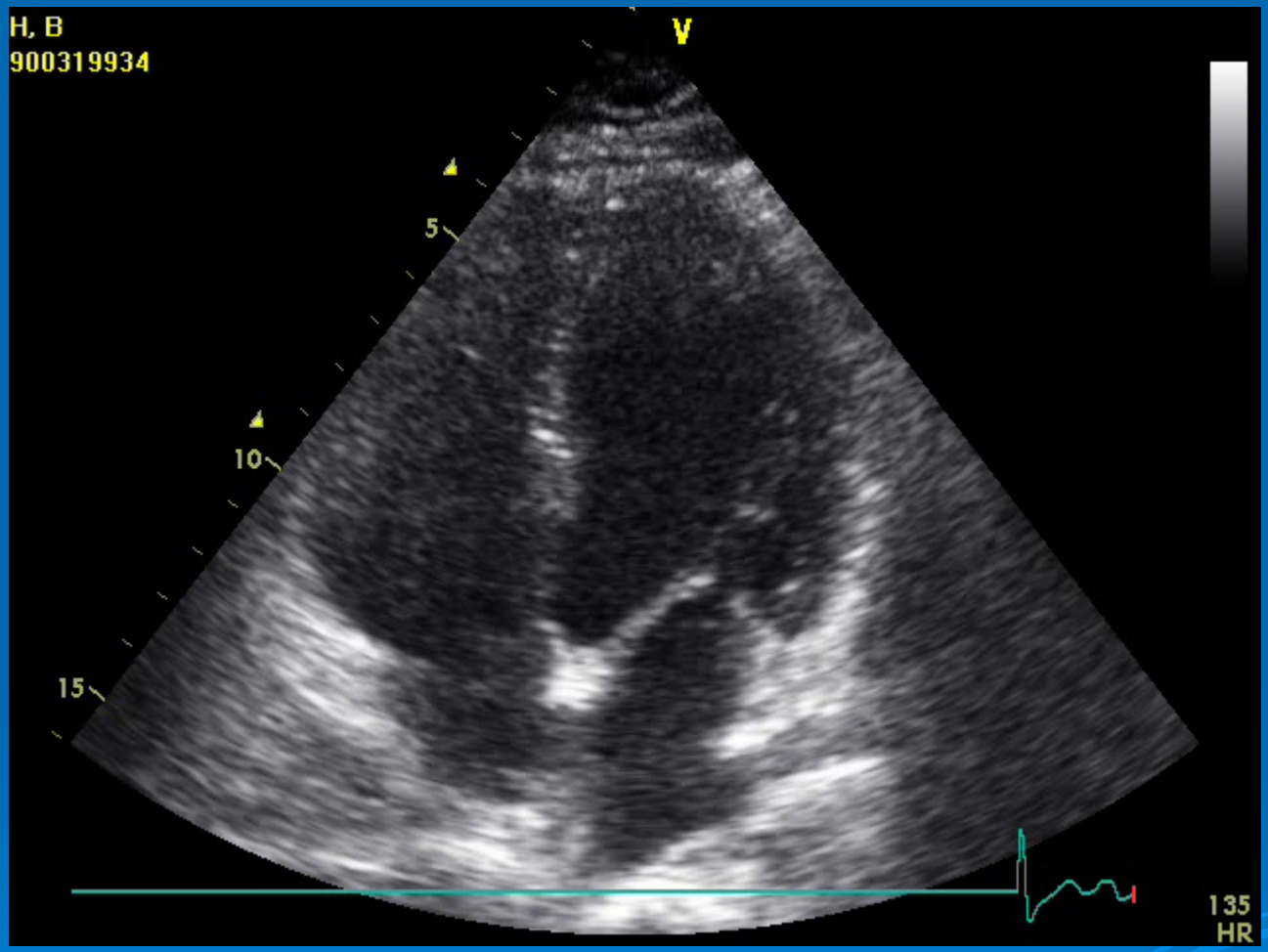
Apical 4 Rest



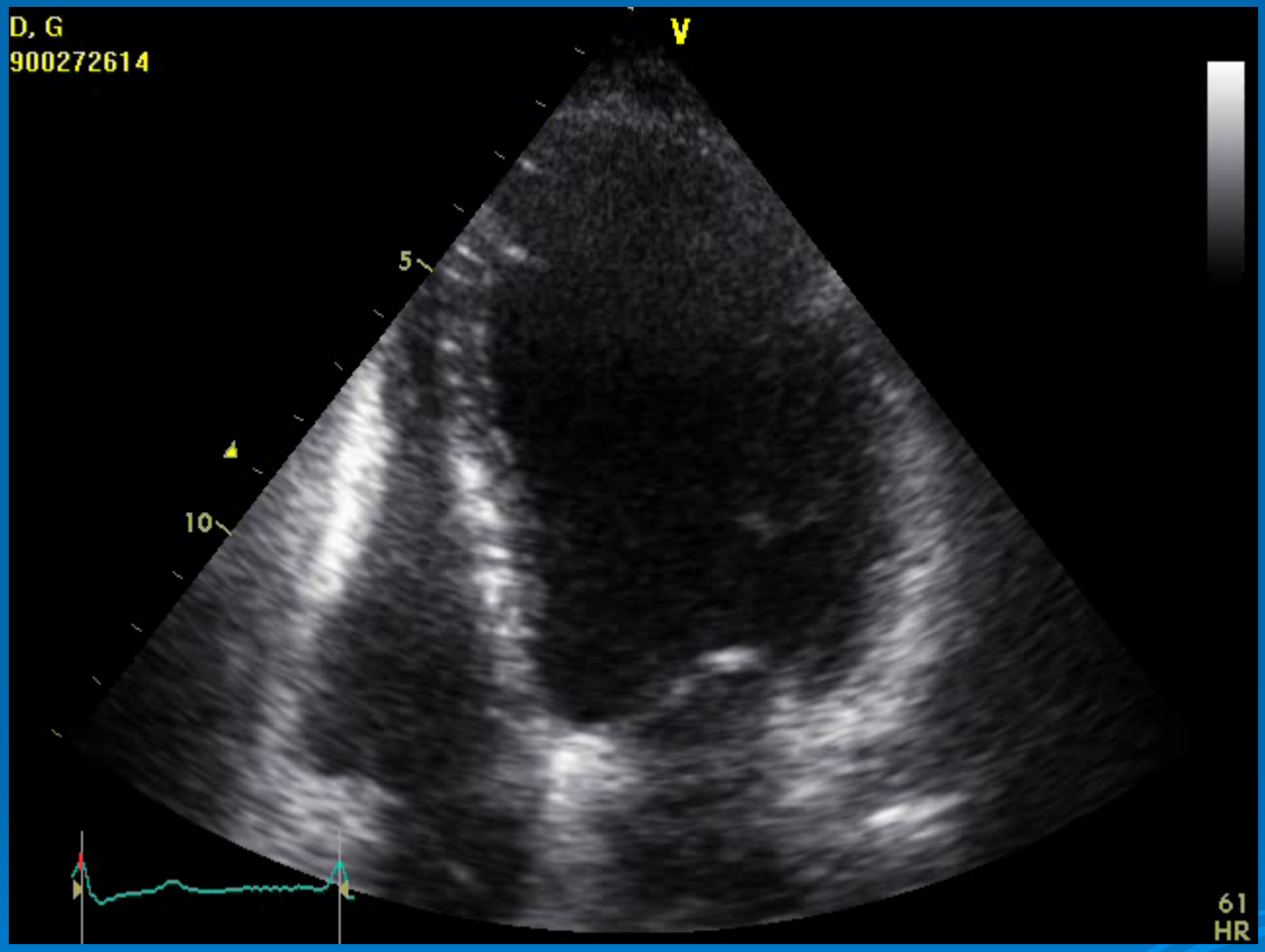
Apical 2 Rest



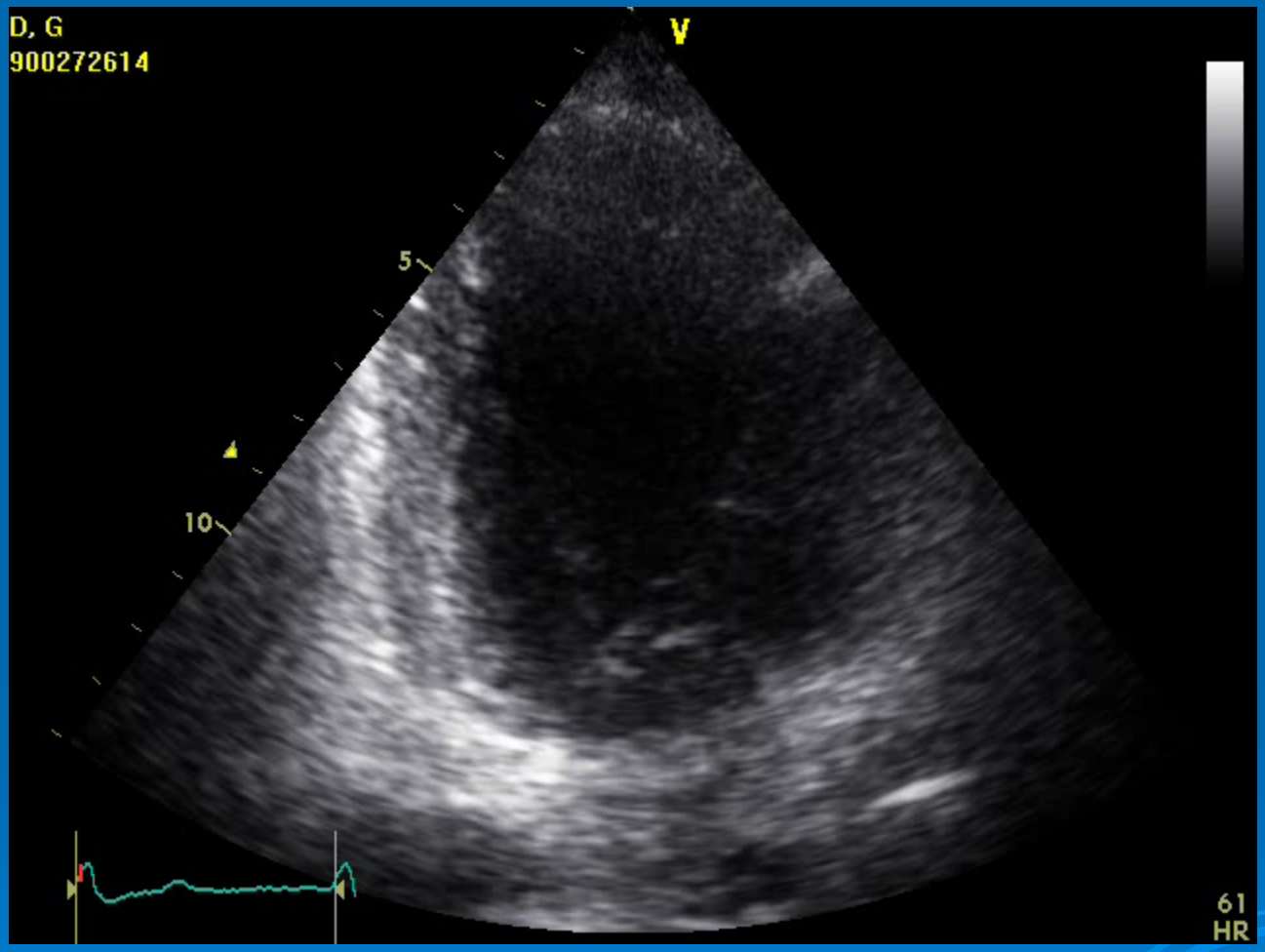
Stress Echo



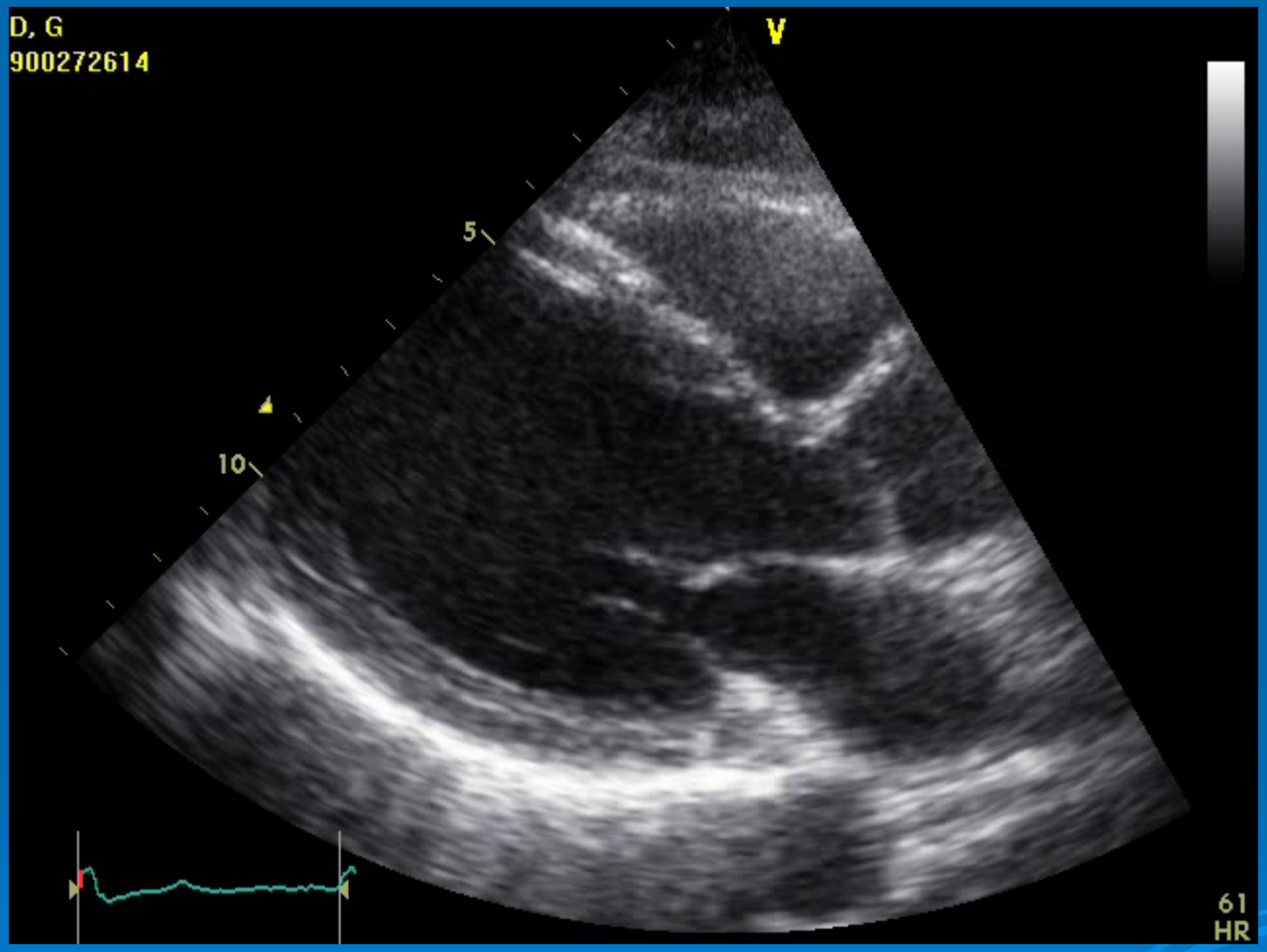
Do Not Stress



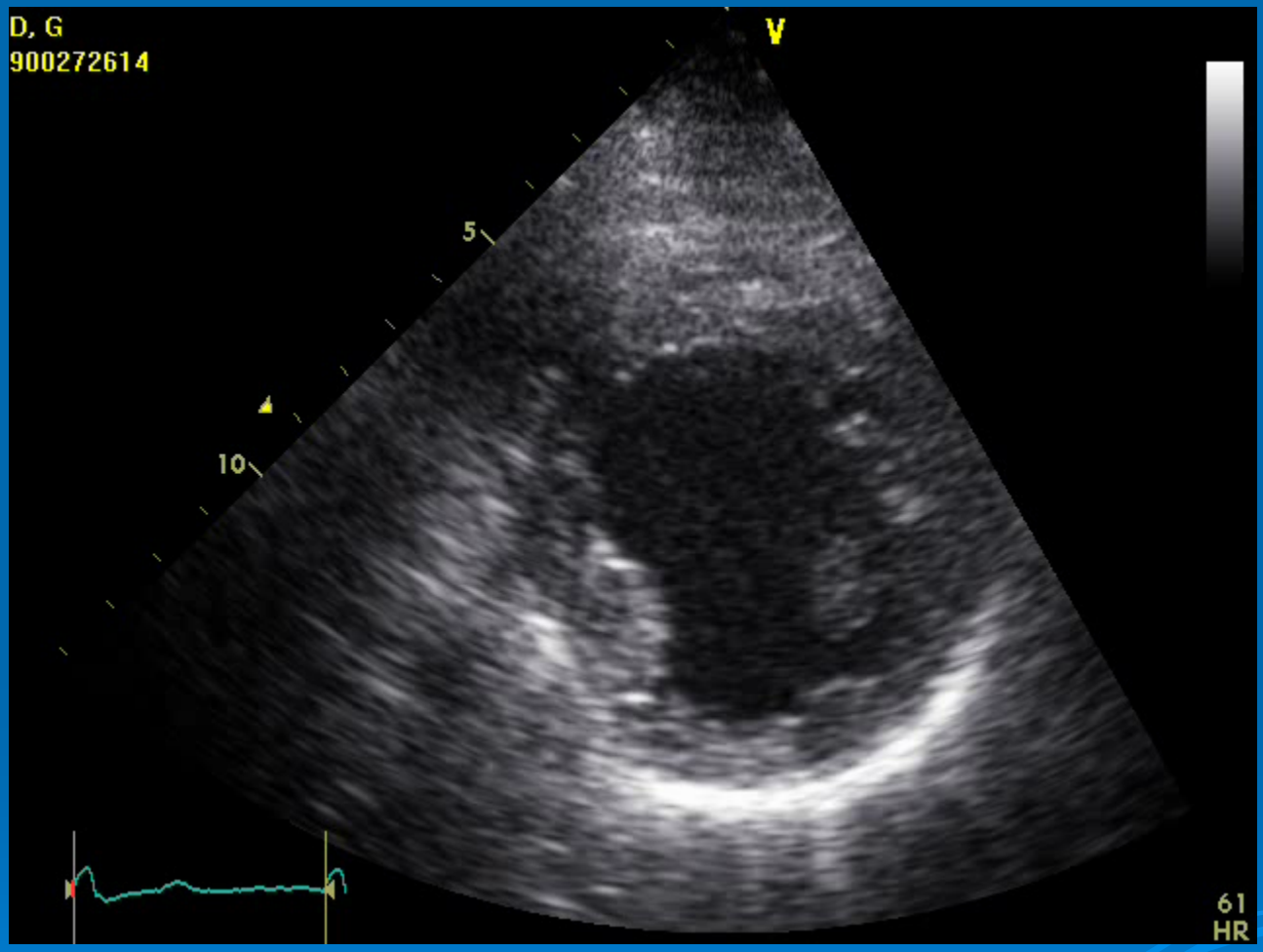
Do Not Stress



Do Not Stress



Do Not Stress



Exercise Test Endpoints

Patient-determined endpoints

- Patient wants to stop
- Significant chest discomfort
- Marked fatigue or severe dyspnea
- Other limiting symptoms (dizziness, leg cramps, joint discomfort, etc)

Physician-determined endpoints

- Patient does not look well (eg, ataxia, confusion, pallor, cyanosis, etc)
- Exertional hypotension (systolic BP below standing at rest systolic BP)
- Systolic BP >250 mmHg
- Diastolic BP >120 mmHg
- Equipment failure

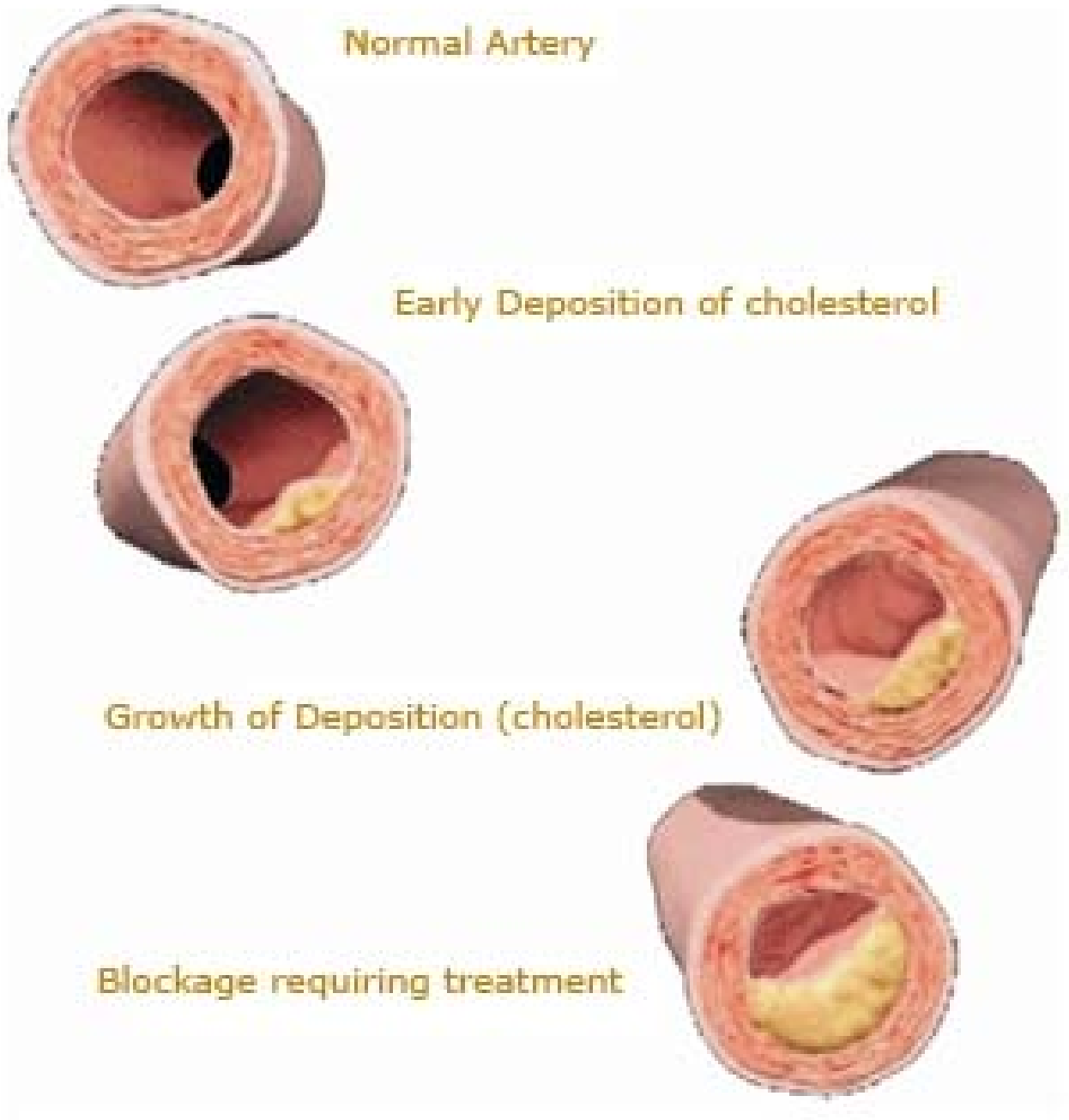
Exercise Test Endpoints (cont'd)

ECG endpoints

- Marked ST segment depression
- New bundle branch block or AV heart block
- Ventricular tachycardia or fibrillation
- Increasing frequency of ventricular arrhythmia (premature beats, couplets or nonsustained ventricular tachycardia), especially if ischemia present
- Onset of supraventricular tachyarrhythmias

Protocol-determined endpoints (submaximal tests)

- Heart rate determined (eg, 120 to 140 bpm)
- Workload determined (eg, 5 METs)


Normal Artery
Early Deposition of cholesterol
Growth of Deposition (cholesterol)
Blockage requiring treatment

THANK YOU!

Questions?