High Speed Myocardial Perfusion SPECT: Validation of Quantitative Analysis and use in Low-Dose Stress-only Protocol

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Conflict of interest

Tali Sharir – no conflict of interest

Marina Pinskiy – no conflict of interest

Vitaly Prochorov - no conflict of interest

Andrzej Bojko – no conflict of interest

Arik Rochman – no conflict of interest

Varda Gottfried – no conflict of interest

Boris Brodkin – no conflict of interest

Background

- Solid-state cardiac cameras provide high resolution myocardial perfusion SPECT (MPS) images.
- Quantitative analysis of these images using standard normal database is sub-optimal and suffers from high frequency of artifacts.

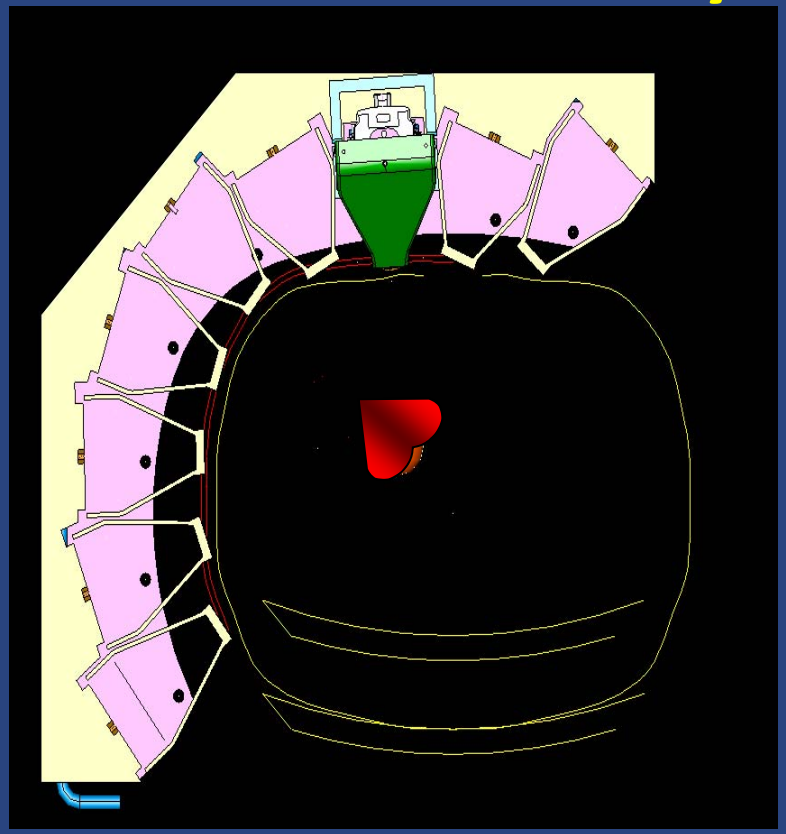
Purpose

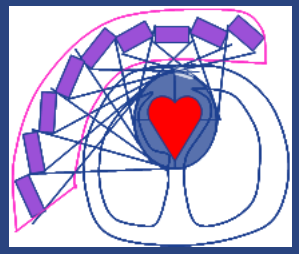
- To validate quantitative analysis of stress-rest MPS obtained by solid-state technology (Discovery 530c, GE Healthcare) using camera-specific normal limits
- Evaluate the usefulness of quantitative analysis in stress-only low dose tests using the stress-first protocol

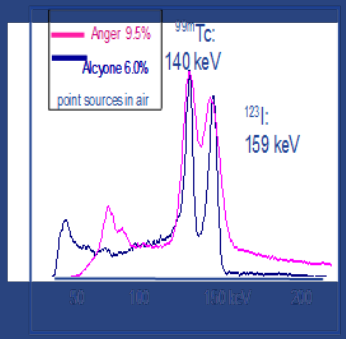
Patient Population

- Custom normal limits were developed from data of 30 females and 30 males with low CAD likelihood and normal perfusion
- Validation of Quantitative Analysis: 198 patients
  - Low likelihood of CAD (n=76) defined as: no CAD Hx, no DM, ≤2 risk factors, no typical angina
  - Intermediate-high likelihood (n=122) with abnormal perfusion

Solid-State Technology
Discovery NM System Design







4 cm

The concept

Multi "cameras"

Focus on the heart

No motion (like PET)

Enabling Technology

Multi pinhole

- ✓ Focus on heart
- ✓ High sensitivity
- ✓ Shielded for ^{201}Tl and ^{123}I

CZT detectors

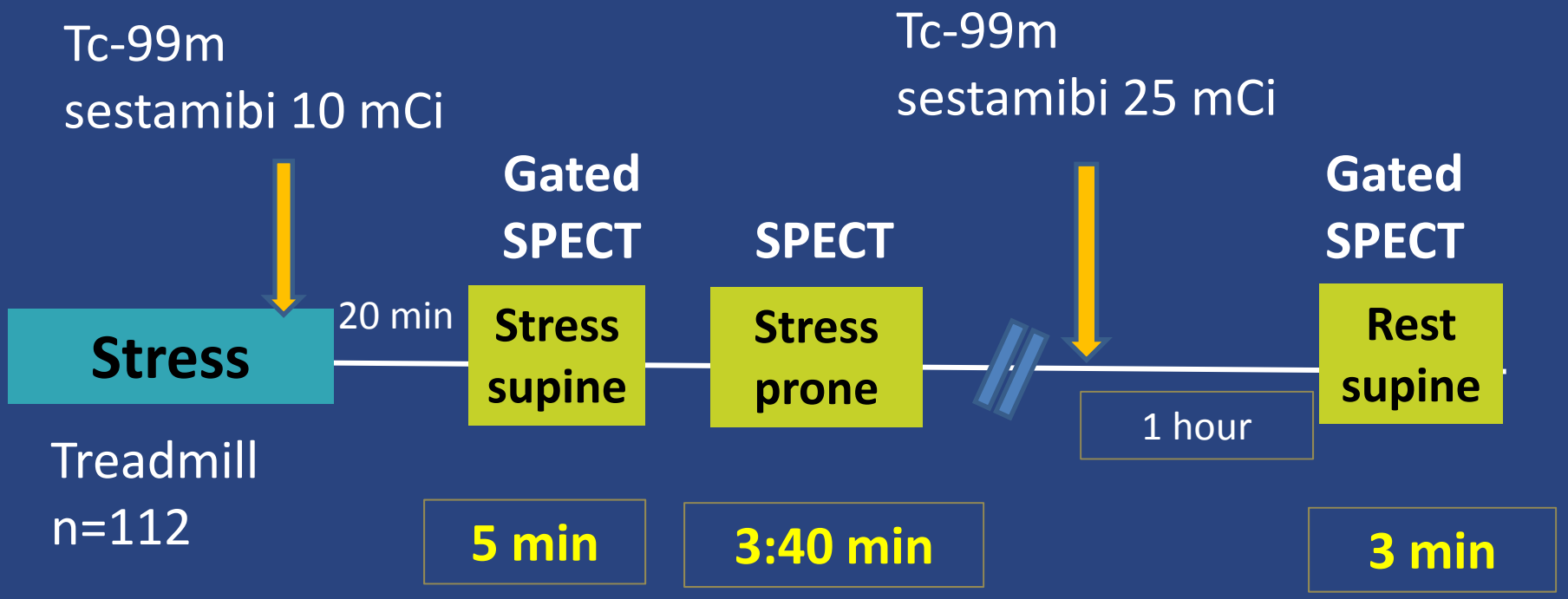
- ✓ Compact
- ✓ High resolution (at any energy)
- ✓ High energy resolution

3D Reconstruction

Automatic positioning

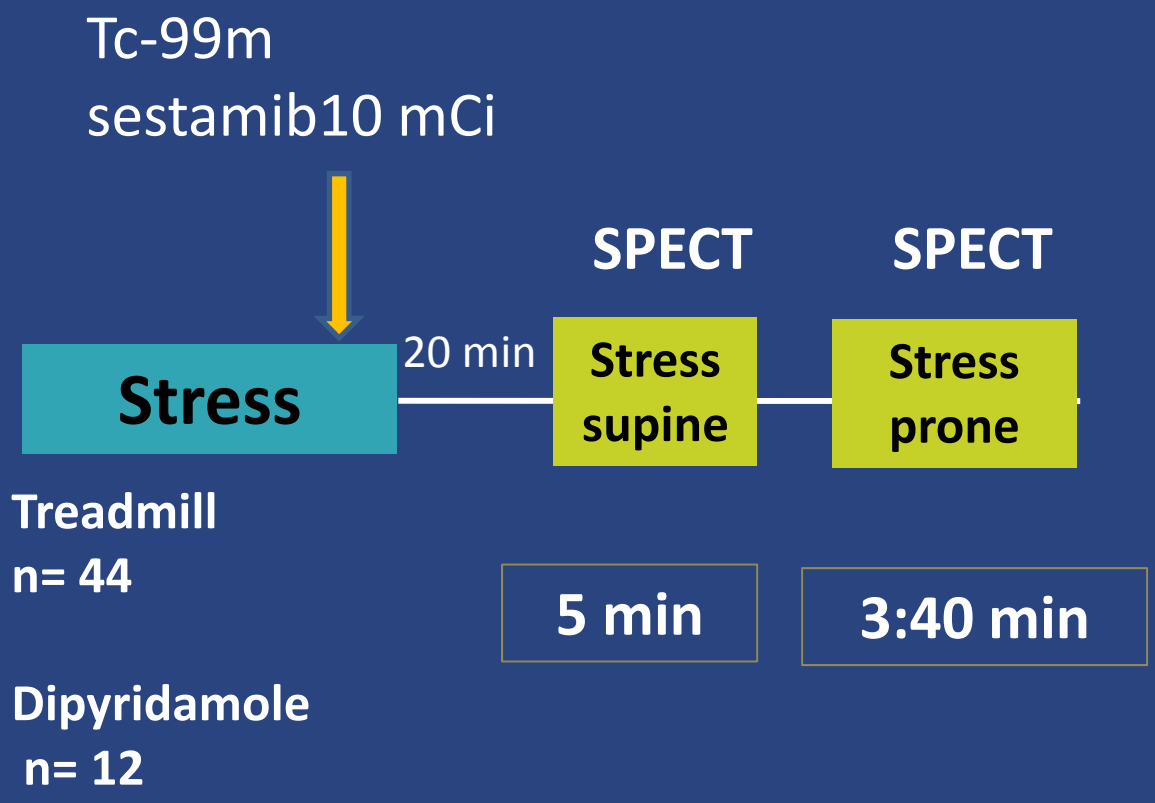
Courtesy GE Medical Systems

Stress First Protocol



Stress only (3 mSv)

Performed in patients with low CAD likelihood when stress images (supine and prone) were visually normal (visual SSS<5%)



Analysis of Perfusion Images

- Semi-quantitative visual analysis utilized 17 segment model, 0-4 score.
- Visual SSS was converted to % myo by dividing to 68.
- Quantitative analysis utilizing QPS (CSMC) employed standard (commercial) normal limits and new (custom) normal limits.
- Automatic SSS and stress TPD were derived using the new normal limits and standard limits.

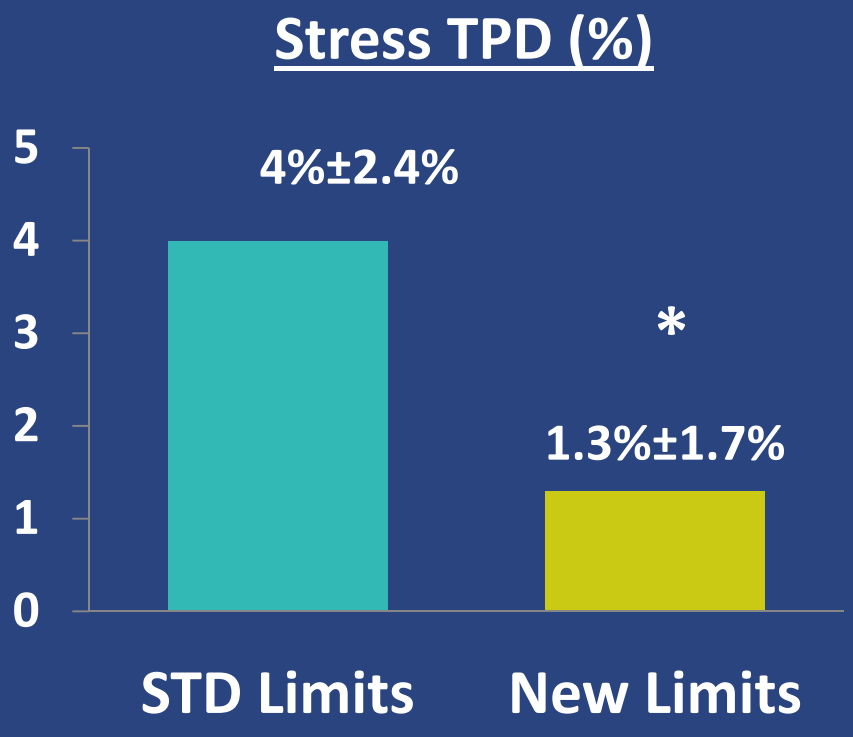
Clinical Characretistics

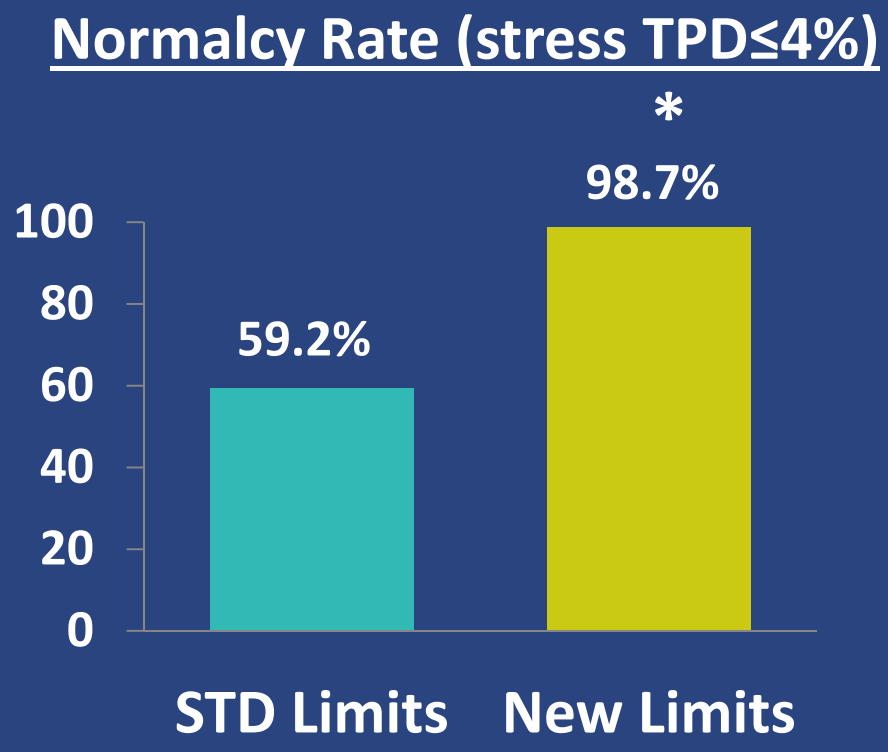
Pretest Likelihood	Low	Intermediate-High	p
	n=76	**n=122**	
• Age	57.4±9.5	66.3±10.6	<0.0001
• Males	33 (43.4%)	107 (87.7%)	<0.0001
• BMI	26.2±3.8	27.6±4.7	0.04
• Hx MI	0	35 (28.7%)	<0.0001
• Hx PCI	0	61 (50%)	<0.0001
• Hx CABG	0	20 (16.4%)	<0.0001
• Typical/atypical Angina	3 (3.9%)	30 (24.6%)	0.0002
• HTN	18 (23.7%)	77 (63.1%)	<0.0001
• DM	0	38 (31.1%)	<0.0001
• Dyslipidemia	39 (51.3%)	86 (70.5%)	0.007
• Positive ETT	7 (9.2%)	63 (51.6%)	<0.0001

MPS Characteristics

Pretest Likelihood	Low	Intermediate-High	p
	n=76	n=122	
Visual SSS %	0.9±1.1	20±8.7	<0.000001
Visual SRS %	0.5±1	6.3±7.1	0.0004
Visual SDS %	0.5±0.9	14.2±6.3	<0.000001
Resting EF %	63.5±8	56.8±12.4	0.02
Post-stress EF %	65.4±6.7	51.2±11.8	<0.000001

Quantitative Analysis of Perfusion in Patients with Low Likelihood (n=76): Normalcy Rate



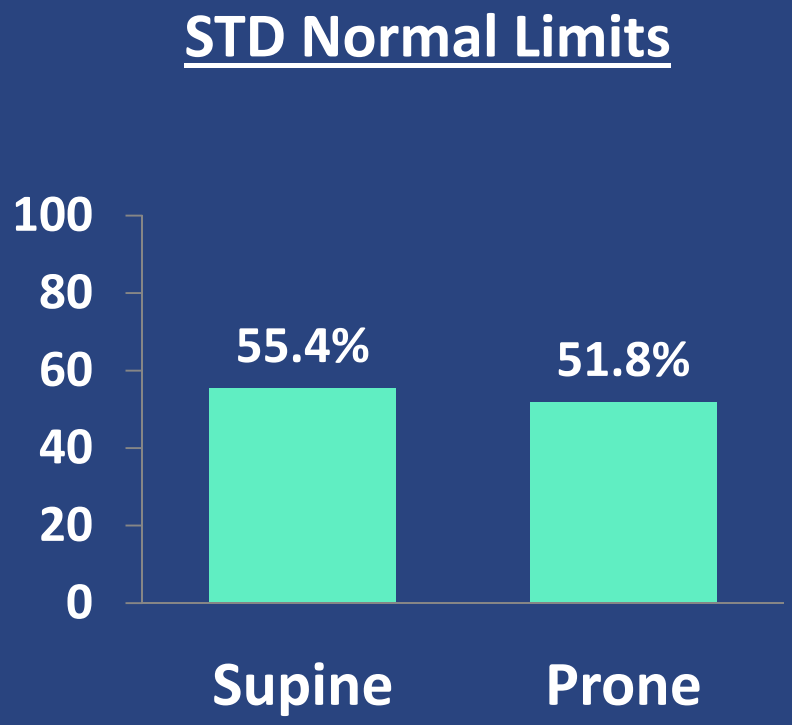


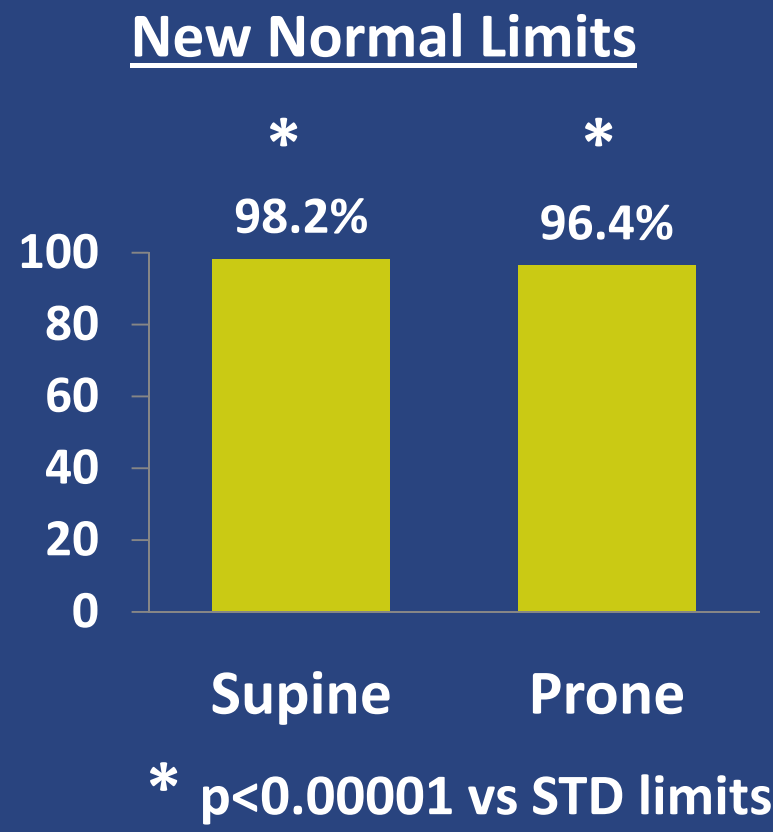
* p<0.00001 vs STD limits

Quantitative analysis with new normal limits provided very low stress TPD and high normalcy rate.

Stress-only Protocol (n=56)

Rate of Normal Scans by Quantitative Analysis (TPD<5%)



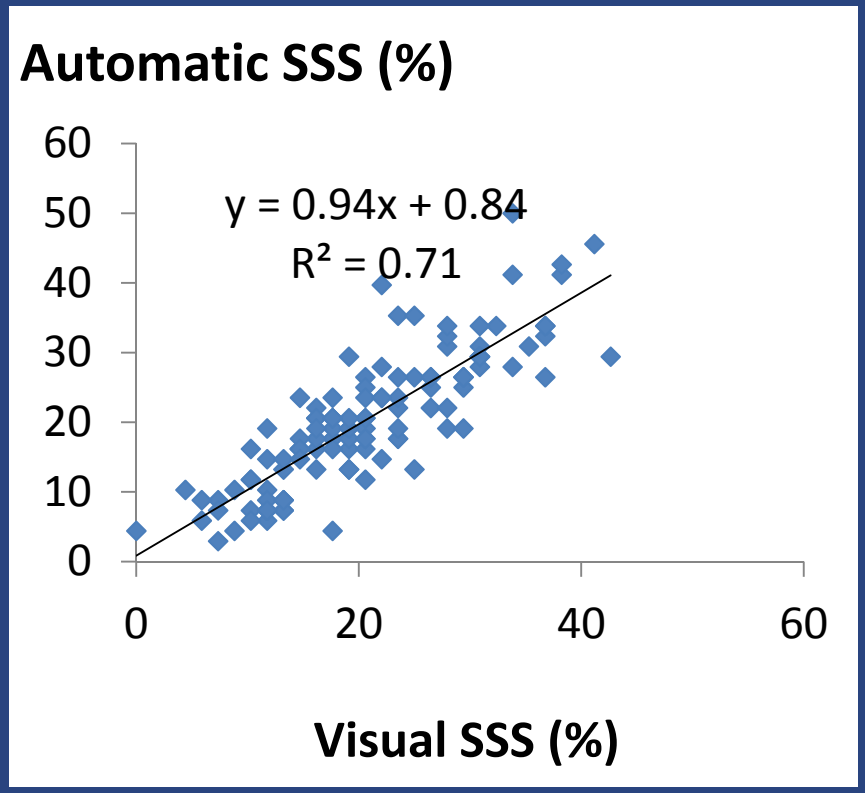


Quantitative analysis with new normal limits provided very high normalcy rate in patients undergoing stress-only protocol.

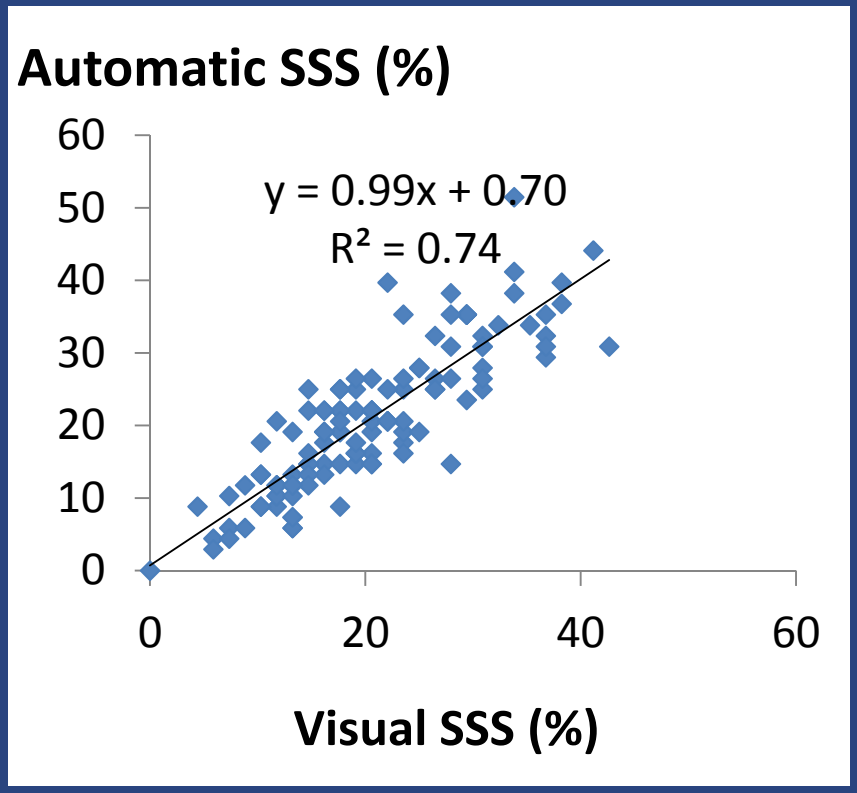
Quantitative Analysis of Stress Perfusion in Patients with Intermediate-High Likelihood (n=122)

Correlation to Visual Analysis

Standard Normal Limits



New Normal Limits



Excellent correlation between Automatic SSS and visual SSS for both standard and new normal limits.

Case Example: Low Likelihood, Stress only

Male 46y, heavy smoker, non-anginal CP, Inconclusive stress test

Normal visual analysis

Standard normal limits

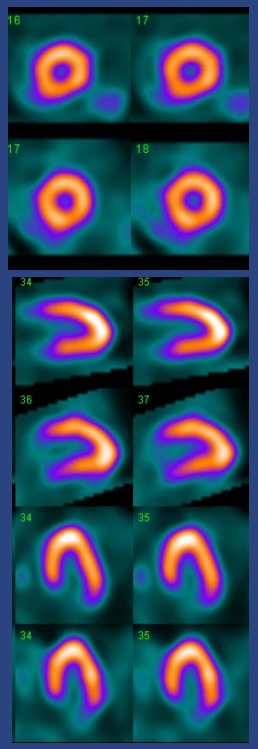
Stress supine + prone

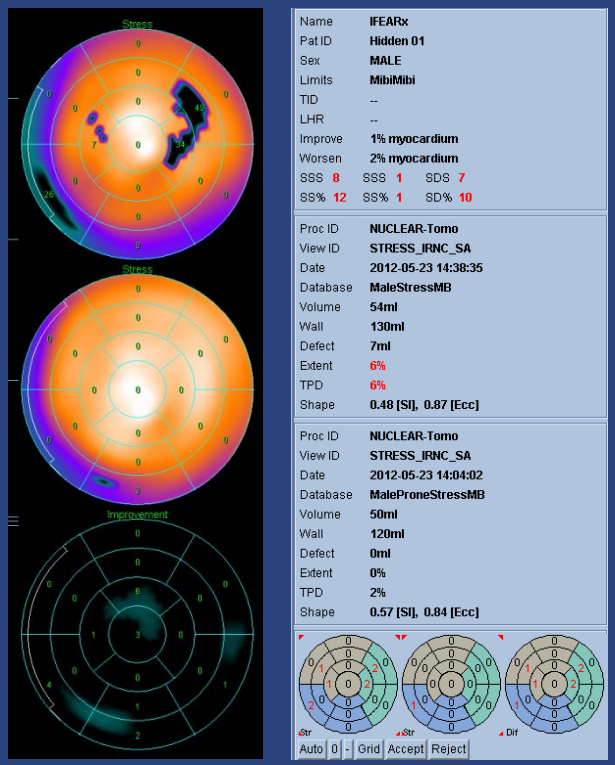
New normal limits

Stress supine + prone

Stress supine

Stress prone





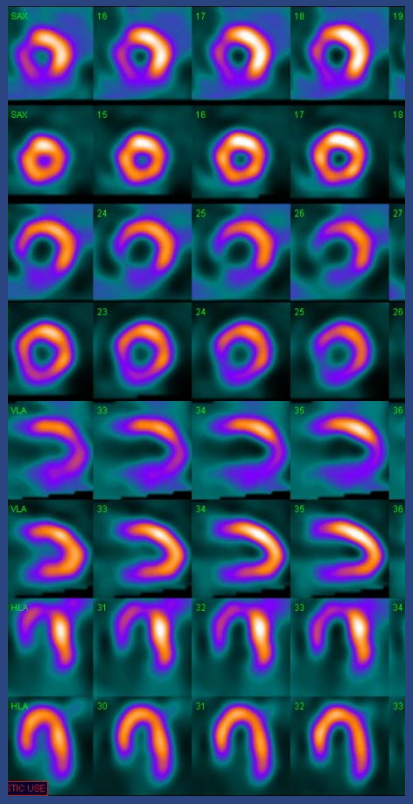
Quantitative analysis using new normal limits provided normal stress perfusion

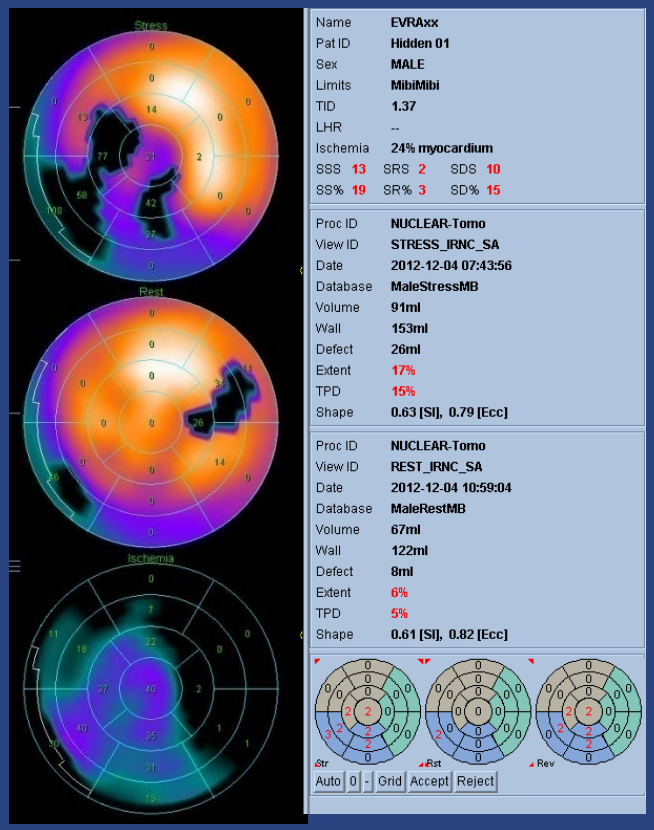
Case Example: High Likelihood of Ischemia

Male, 67y, HTN, high cholesterol, typical angina, Inconclusive stress test

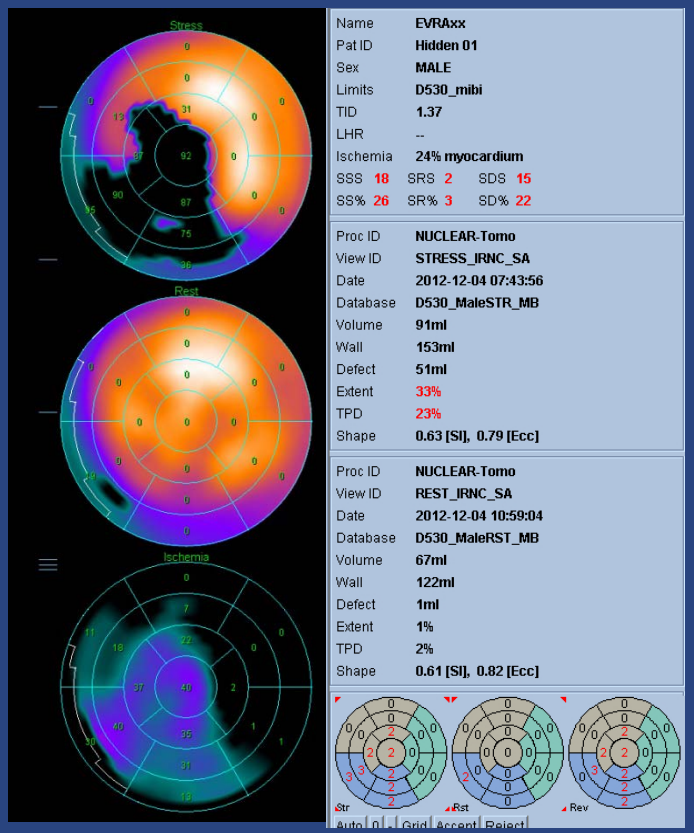
Coronary angio: mid LAD 90%, LCX 80%, RCA 95% → CABG

STD normal limits





New normal limits



Quantitative analysis using new normal limits demonstrated large ischemia

Conclusions

- Quantitative analysis of solid-state MPS using custom normal limits and commercial software provided very high normalcy rate among patients with low CAD likelihood, and correctly detected the amount of perfusion abnormality among patients with intermediate-high likelihood.
- This standardized analysis may facilitate the use of low-dose, stress-only protocol with very low patient radiation exposure (<3mSv).