Cardiac Magnetic Resonance Imaging & Echocardiography in Severely Obese Patients:
An Assessment of Image Quality

Akash Goyal, MD[1], Christopher D. Crabtree, MS[1,2], Bryan C. Lee, MD[1], Thura T. Harfi, MD[1], Saurabh Rajpal, MBBS[1], Vedat O. Yildiz, MS[3], Haikady N. Nagaraja, PhD[3], Orlando P. Simonetti, PhD[1], Matthew S. Tong, DO[1]

[1]*Division of Cardiology, The Ohio State University Wexner Medical Center, Columbus, OH*

[2]*Department of Human Sciences, The Ohio State University, Columbus, OH*

[3]*Center for Biostatistics, Department of Biomedical Informatics, The Ohio State University, Columbus, OH*

THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

AMERICAN COLLEGE OF CARDIOLOGY | Ohio CHAPTER

BACKGROUND

- Severe obesity is highly prevalent and an independent risk factor for cardiovascular disease.

- Cardiac magnetic resonance imaging (CMR) and transthoracic echocardiography (TTE) are used to image severely obese patients, but the impact of high body mass index (BMI) on image quality is not well described.
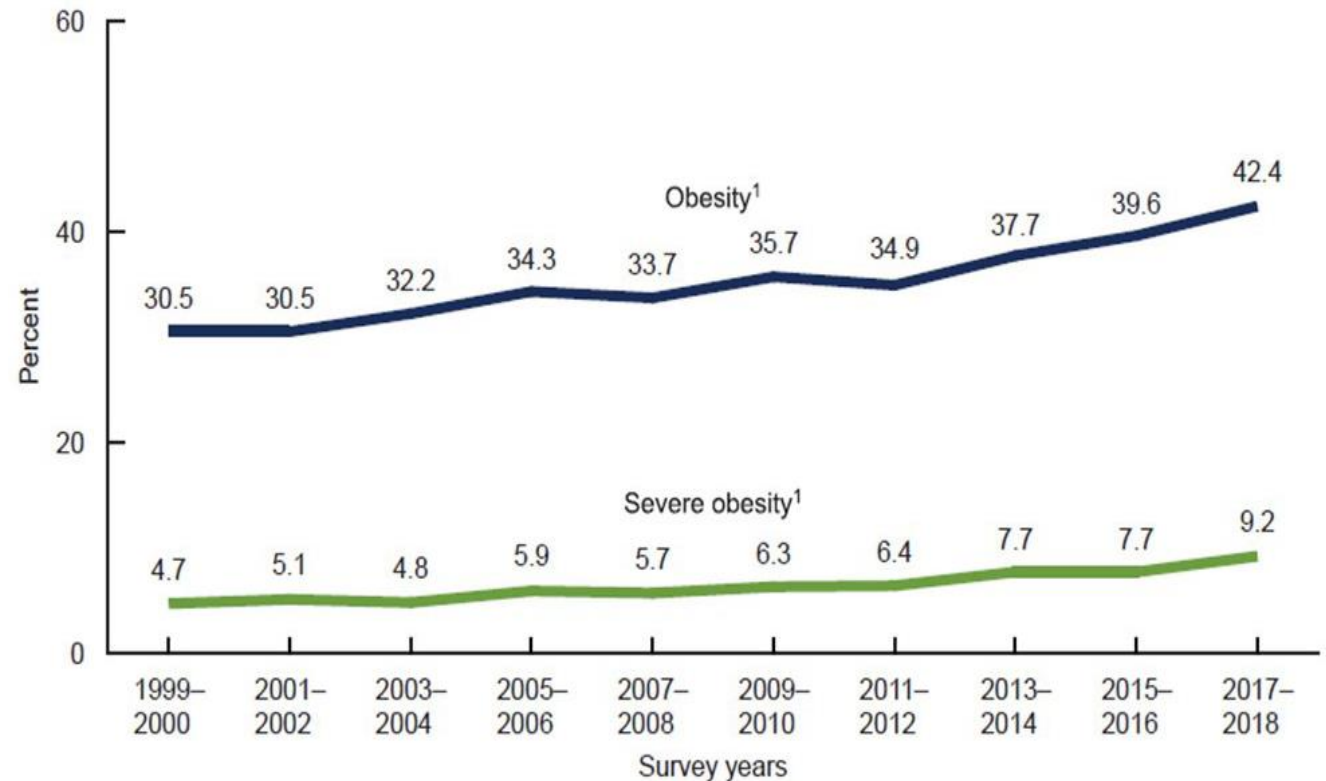
Overweight and Obesity Statistics.
National Institutes of Health NIDDK, 2022

OBJECTIVES

1. To assess the image quality of CMR and TTE in severely obese and normal weight cohorts

2. To investigate the effect of image quality (IQ) on ventricular function assessment

METHODS

- We developed a 31-part, 93-point IQ score of routine cardiac and valve parameters, assessed visually or quantitatively for both CMR and TTE where higher scores denoted higher quality.

- We retrospectively studied 50 normal BMI (18.5-25 kg/m2) and 50 severely obese (BMI ≥40 kg/m2) patients who had both CMR and TTE within 12 months.

- Four level III readers, blinded to BMI and alternate modality, independently assigned CMR and TTE IQ scores.

- Mean CMR and TTE IQ scores were compared within and across cohorts using paired and two-sample t-tests.

- Left (LVEF) and right (RVF) ventricular function were compared using descriptive and Cohen's kappa statistics, with disagreement defined as ΔLVEF ≥10% or an RVF categorical (e.g. normal, mild, moderate, or severe) difference.

METHODS

0 – Parameter cannot be visualized/evaluated
1 – Parameter can be visualized/evaluated; confidence is low.
2 – Parameter can be visualized/evaluated, confidence is average.
3 – Parameter can be visualized/evaluated; confidence is high.

Chambers	
Left Ventricle	
Morphology	Score
• Size	_____
• Mass	_____
• Wall Thickness	_____
Global Function	
• Qualitative Assessment	_____
• Quantitative Assessment	_____
Regional Wall Motion	
• Qualitative Assessment	_____
• Semi-quantitative assessment	_____
Right Ventricle	
Morphology	
• Size	_____
• Wall Thickness	_____
Global Function	
• Qualitative Assessment	_____
• Quantitative Assessment	_____
Regional Wall Motion	
• Qualitative Assessment	_____
• Semi-quantitative assessment	_____
Left Atrium	
Morphology	
• Size	_____
Right Atrium	
Morphology	
• Size	_____
Pericardium	
• Effusion	_____
• Features (thickness, calcification)	_____

Valves	
Aortic	
Visual Assessment	
• Leaflets	_____
• Function	_____
Quantitative Assessment	
• Stenosis	_____
• Regurgitation	_____
Mitral	
Visual Assessment	
• Leaflets	_____
• Function	_____
Quantitative Assessment	
• Regurgitation	_____
Tricuspid	
Visual Assessment	
• Leaflets	_____
• Function	_____
Quantitative Assessment	
• Regurgitation	_____

| Vessels	
Aorta- Root	
• Size	_____
• Features (calcification, mass)	_____
Aorta- Ascending	
• Size	_____
• Features (calcification, mass)	_____

RESULTS

- Mean ± SD BMI of the normal BMI and severely obese cohorts was 22.2 ± 1.7 kg/m2 and 50.3 ± 5.9 kg/m2, respectively (p<0.001)

- Median time between CMR and TTE was 83 days

- **For CMR**, mean IQ score was 91.5±2.5 for normal BMI and 88.4±5.5 for severely obese patients, LS difference 3.1, p=0.46

- **For TTE,** mean IQ score was 64.2±13.6 for normal BMI and 46.0±12.9 for severely obese patients, LS difference 18.2, p<0.001

- There was **LVEF disagreement** between CMR and TTE in 20% of studies for normal BMI patients vs 28% of studies for severely obese patients vs (kappa 0.70 [substantial agreement] vs 0.53 [moderate agreement], respectively)

- There was **RVF disagreement** between CMR and TTE in 28% of studies for normal BMI patients vs 42% of studies for severely obese patients (kappa 0.34 [fair agreement] vs 0.18 [no agreement], respectively)

Image Quality Score by Imaging Modality and BMI Category
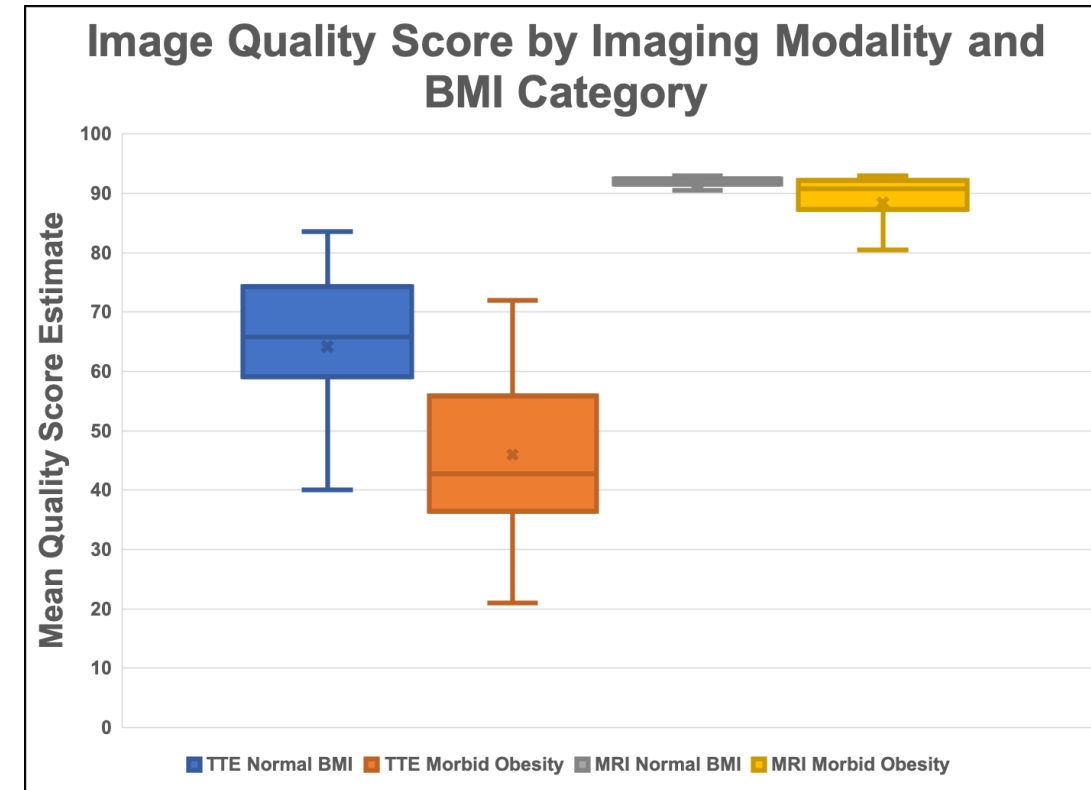
RESULTS

Example of Low Overall Echocardiography Image Quality Score
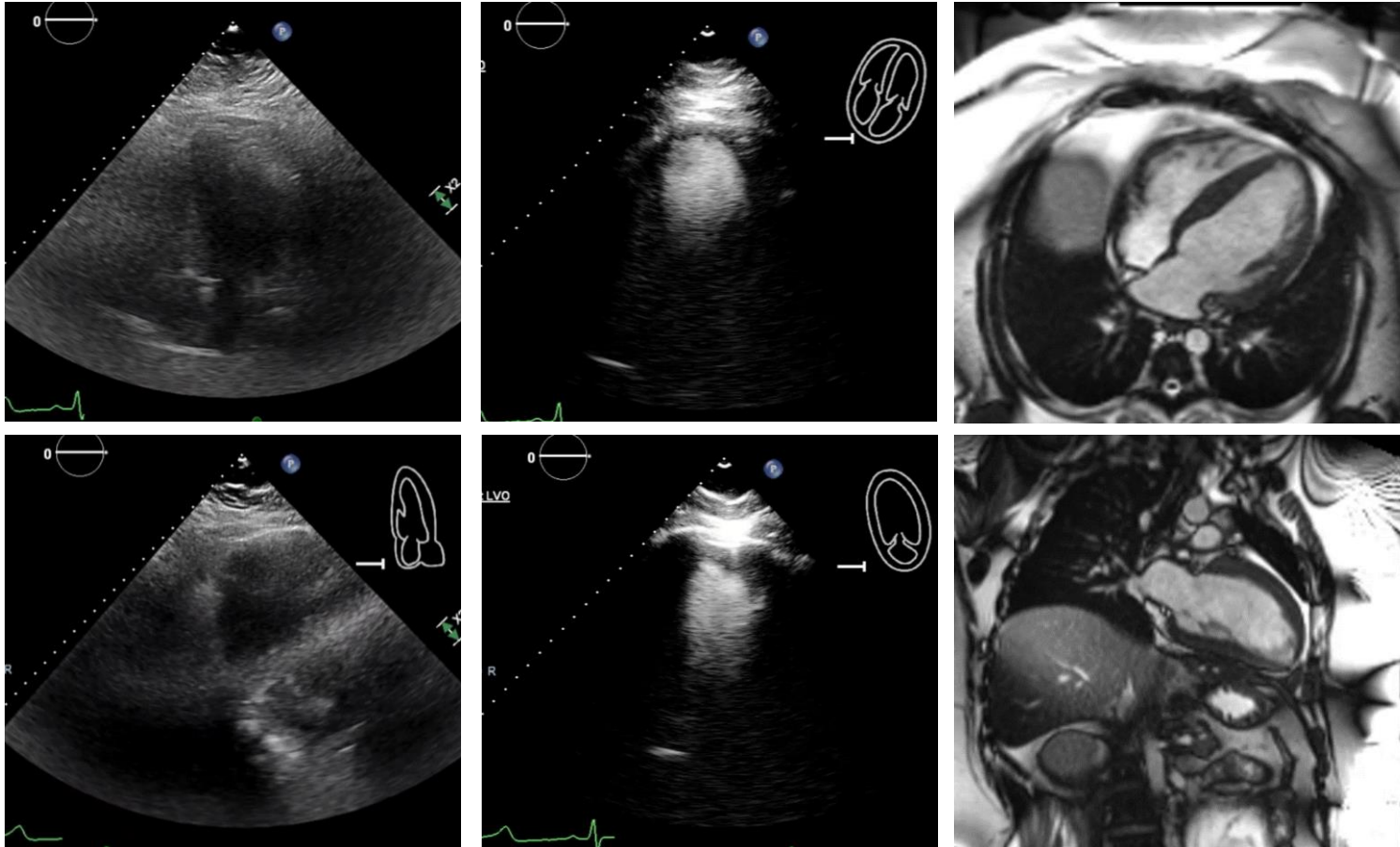
Top (left to right)
4-chamber TTE views without, with Definity contrast; CMR steady state free precession cine.

Bottom (left to right)
2-chamber TTE views without, with Definity contrast; CMR steady state free precession cine.
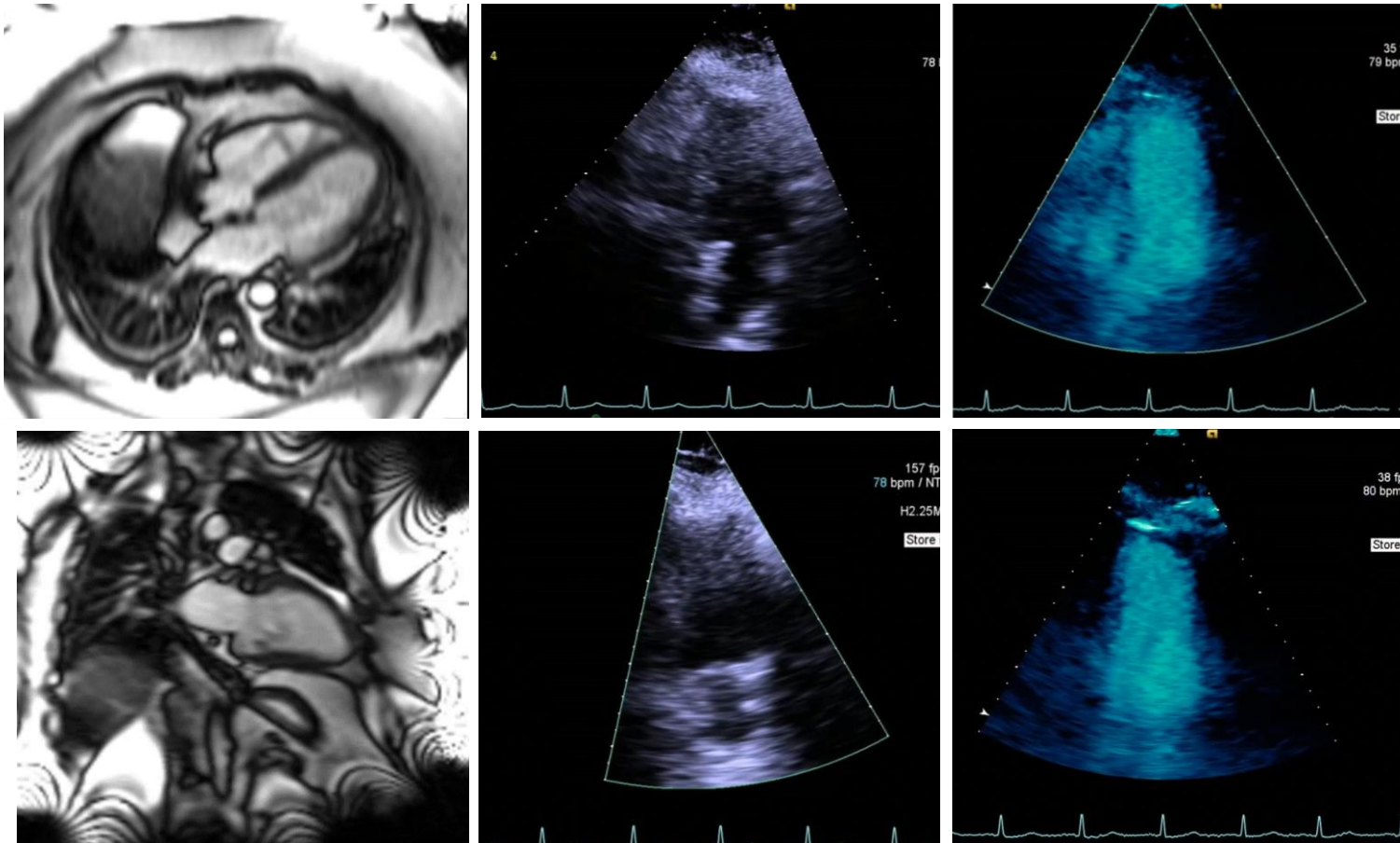
Overall image quality score:
TTE – 21; CMR – 91
Patient BMI: 49.2 kg/m^2
CMR Scanner: Siemens Aera 1.5T

RESULTS

Example of Low Overall CMR Image Quality Score

Top (left to right)
4-chamber CMR steady state free precession cine; TTE view without, with Definity contrast.

Bottom (left to right)
2-chamber CMR steady state free precession cine; TTE view without, with Definity contrast.

Overall image quality score:
CMR – 71; TTE – 43.5
Patient BMI: 56.5 kg/m^2
CMR Scanner: Siemens Espree 1.5T

CONCLUSIONS

- CMR image quality is relatively preserved with severe obesity when compared to that of a normal BMI cohort, whereas TTE has incremental quality degradation.
- This TTE image quality degradation contributes to less agreement between CMR and TTE derived LVEF and RVF in patients with severe obesity compared with those with normal BMI.
- CMR provides higher image quality and may provide better diagnostic ventricular, especially right ventricular assessment than TTE in severely obese patients.
- These results may inform imaging modality selection in severely obese patients.
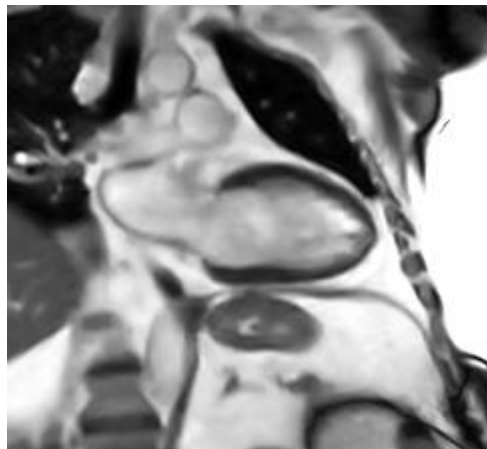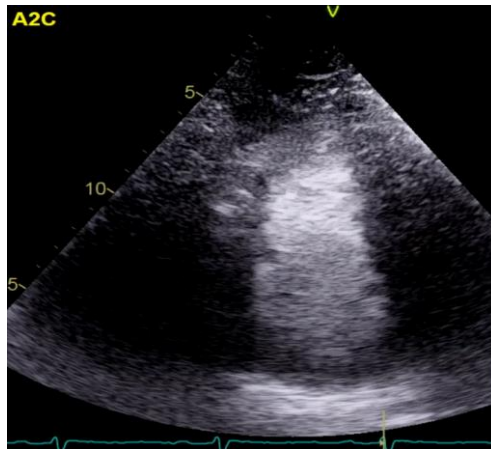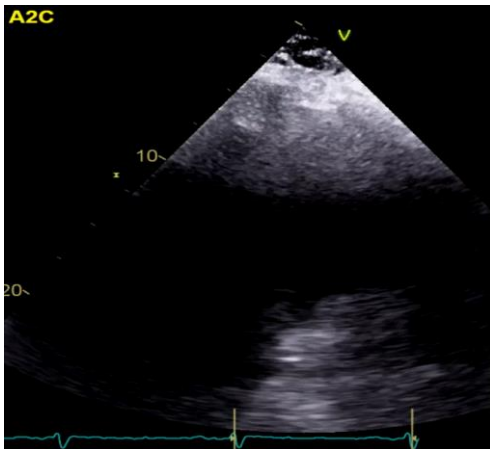
FUTURE DIRECTIONS

Example of Our First Patient in New 0.55T Scanner
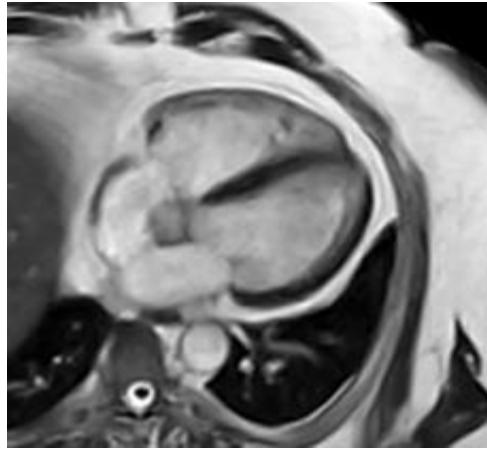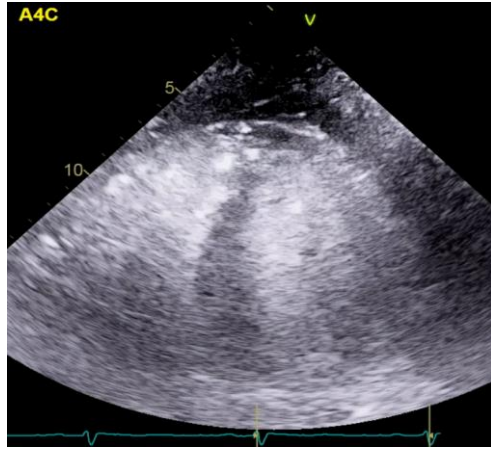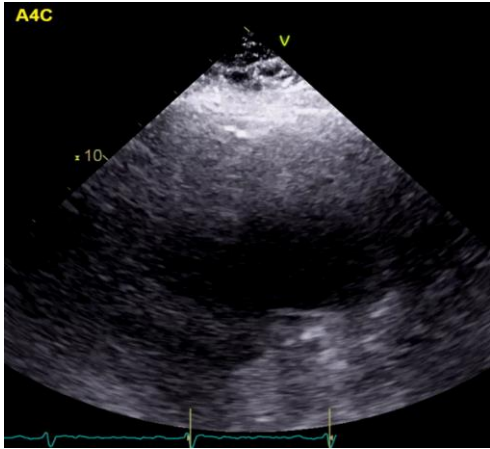
Top (left to right)
4-chamber TTE views without, with Definity contrast; CMR steady state free precession cine.

Bottom (left to right)
2-chamber TTE views without, with Definity contrast; CMR steady state free precession cine.

Scan Characteristics:
Patient BMI: 48.2 kg/m^2
CMR Scanner: Siemens Free.Max 0.55T

CONTACT

Akash Goyal, M.D.

234 Davis Heart & Lung Research Institute,
473 W. 12th Avenue, Columbus, Ohio 43210

akash.goyal@osumc.edu

Twitter: @agoyalMD