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CASE REPORT

# Gd-enhanced cardiovascular MR imaging to identify left ventricular pseudoaneurysm

THAO TRAN,[1,*] BRIAN D. ROSS,[1] PATRICK COLLETTI,[2] and RUSSELL E. CHING[3]

[1]*Huntington Medical Research Institutes, Pasadena, California, USA*
[2]*LAC/USC Imaging Science Center, Los Angeles, California, USA*
[3]*Foothill Cardiology/California Heart Medical Group, Inc., Pasadena, California, USA*

A pseudoaneurysm occurs when incomplete rupture of the heart seals within organizing thrombus, hematoma, and pericardium and maintains communication with the left ventricle. A pseudoaneurysm may cause arterial emboli and drain off a considerable portion of ventricular stroke volume. Cardiovascular magnetic resonance imaging proves to be an adequate technique to not only identify pseudoaneurysms but also quantify function measurements of the left ventricle and allow for projections of post-surgical function. When complemented with myocardial delayed enhancement, it is the best technique for identifying the viability of myocardial tissue, an important aspect in surgical planning.

*Key Words:* Aneursym; Ejection fraction; Myocardium; Delayed enhancement

## 1. Introduction

A true aneurysm has a wide base with walls composing of myocardial elements and is at low risk of free rupture (1). It is usually the result of myocardial scar from an acute myocardial infarction. A pseudoaneurysm (1) occurs when there is an incomplete rupture of the heart which has sealed within organizing thrombus, hematoma, and pericardium. A pseudoaneurysm of the left ventricle maintains communication (1) with the left ventricular (LV) cavity through a narrow neck lacking any element of the original myocardial wall. It can become quite large, draining off a significant portion of ventricular stroke volume. Another problem is the mural thrombus may cause arterial emboli; therefore, treatments for left ventricular pseudoaneurysms usually involve surgical repair (2), resection (3), venting (4) or ultrasound-guided compression.

## 2. Case report

A 66-year-old female presented to the hospital with episodes of shortness of breath and heart failure. Coronary artery stents were placed a year ago at the time of an acute myocardial infarction. An echocardiogram demonstrated a dilated left ventricle with severe mitral valve regurgitation and pseudoaneurysm. Because of the patient's history of myocardial infarction with progression of heart failure and cardiogenic shock, left and right heart catheterizations were performed with left ventriculography and selectively coronary arteriography. These revealed a dilated LV with formation of a large mass in the lateral portion of the LV and mitral regurgitation. Pulmonary artery systolic pressures were also elevated to 30 mmHg. A single proton emission computed tomography (SPECT) exam, with gating, was also performed for functional analysis. The left ventricle was visualized using an injection of 3mCi of TI201 thallium chloride. The exam was then repeated with intravenous administration of 26mCi of 99m-Tc Myoview and infusion of adenosine. These tests indicated high posterolateral/mid-lateral activity at stress and at rest which is attributed to the large transmural myocardial infarct. There was also decreased apicoseptal abnormal myocardial activity which is more pronounced at rest than at stress associated with inferoposterior hypokinesis.

### 2.1. *Cardiovascular magnetic resonance (CVMR) imaging*

Patient was referred for CVMR exam in order to plan surgery. The CVMR exam was performed on a 1.5 Tesla clinical scanner (General Electric LX, Milwalkee, WI) using a 4-element phased array cardiac coil and gated by a 4-lead

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*Address correspondence to Thao Tran, Huntington Medical Research Institutes, 10 Pico St., Pasadena, CA 91105, USA; Fax: (626) 397-5846; E-mail: mrs@hmri.org

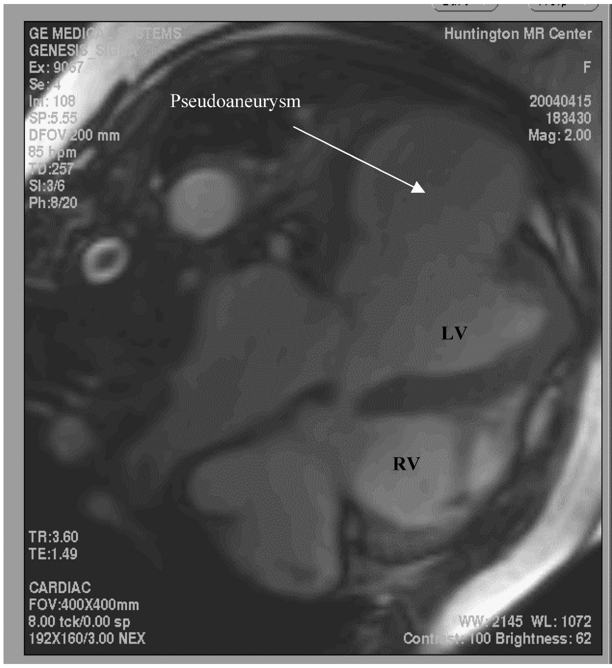


**Figure 1.** Radial 3 chamber view. Pseudoaneurysm can be seen in the radial view as well.

electrocardiogram (ECG). Two doses of gadopentetate dimeglumine (Magnevist, Berlex, Wayne, NJ) were injected (the first, 0.05 mL/kg at 2 mL/second for perfusion imaging and the second, 0.1 mL/kg for delayed enhancement) using a Spectrus power injector (Medrad, Indianola, PA). The

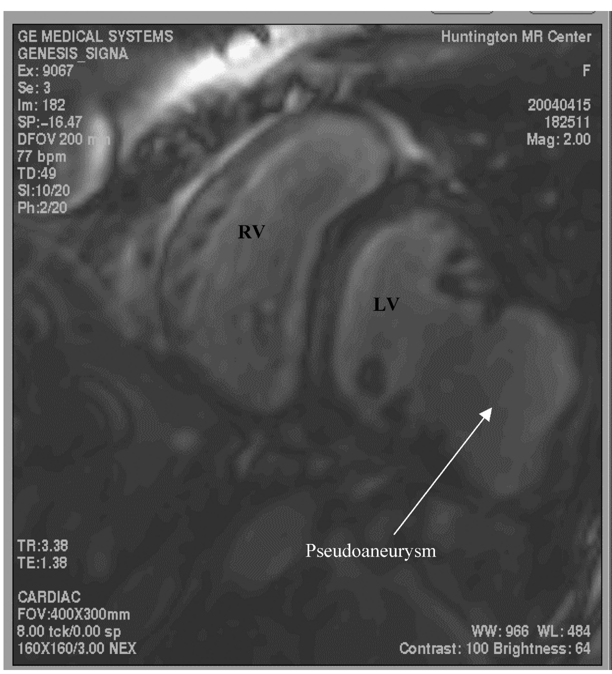


**Figure 2.** Short axis view. The short axis view clearly demonstrates the communication between the LV and the pseudoaneurysm.

**Table 1.** Pre-surgical left ventricular measurements

| | Patient | Normal |
|---|---|---|
| Ant. sep. wall thickness | 0.9 cm | 0.6–0.8 cm |
| Post. lat. wall thickness | 0.7 cm | 0.6–0.8 cm |
| Mean wall thickness | 0.9 cm | 0.6–0.8 cm |
| End diastolic dimension | 7.9 cm | 4.0–4.9 cm |
| End systolic dimension | 7.8 cm | 2.6–3.6 cm |
| Fractional shortening | 1.3% | 26–40% |
| End-diastolic volume (EDV) | 256.0 mL | 98–127 mL |
| End-systolic volume (ESV) | 179.0 mL | 27–55 mL |
| End-diastolic volume index | 148.4 mL/m$^2$ | 53–73 mL/m$^2$ |
| End-systolic volume index | 103.8 mL/m$^2$ | 18–31 mL/m$^2$ |
| Ejection fraction | 30.3% | 51–72% |
| Stroke volume | 77.9 mL | |
| Stroke volume index | 45.2 mL/m$^2$ | 27–48 mL/m$^2$ |
| Cardiac index | 3.5 L/min/m$^2$ | 1.7–4.1 L/min/m$^2$ |
| Left atrial dimension | 4.6 cm | 2.4–3.2 cm |
| Aortic root diameter | 2.4 cm | 2.0–2.6 cm |
| Ascending aorta diameter | 3.7 cm | 2.6–3.2 cm |

This table displays the left ventricular (with pseudoaneurysm) function measurements (acquired by CVMR and analyzed in MASS Analysis).

protocol used is as follows: 1) fast spoiled grass (fSPGR) sagittal localizer; 2) fSPGR long axis localizer; 3) Fast Imaging Employing Steady State Acquisition (FIESTA); 4) perfusion fast gradient echo-echo train (FGRE-ET); 5) FIESTA cine radial views; 6) myocardial delayed enhancement (MDE)

A


**Figure 3.** (A) Non-stressed perfusion study in short axis view. Perfusion study demonstrates contrast agent in the RV and filling up the LV as well as the pseudoaneurysm, which displays hypoperfusion at rest. (B–C) Myocardial Delayed Enhancement (MDE) study. The MDE study demonstrates enhancement of pseudoaneurysm wall, indicating that it is indeed non-viable.

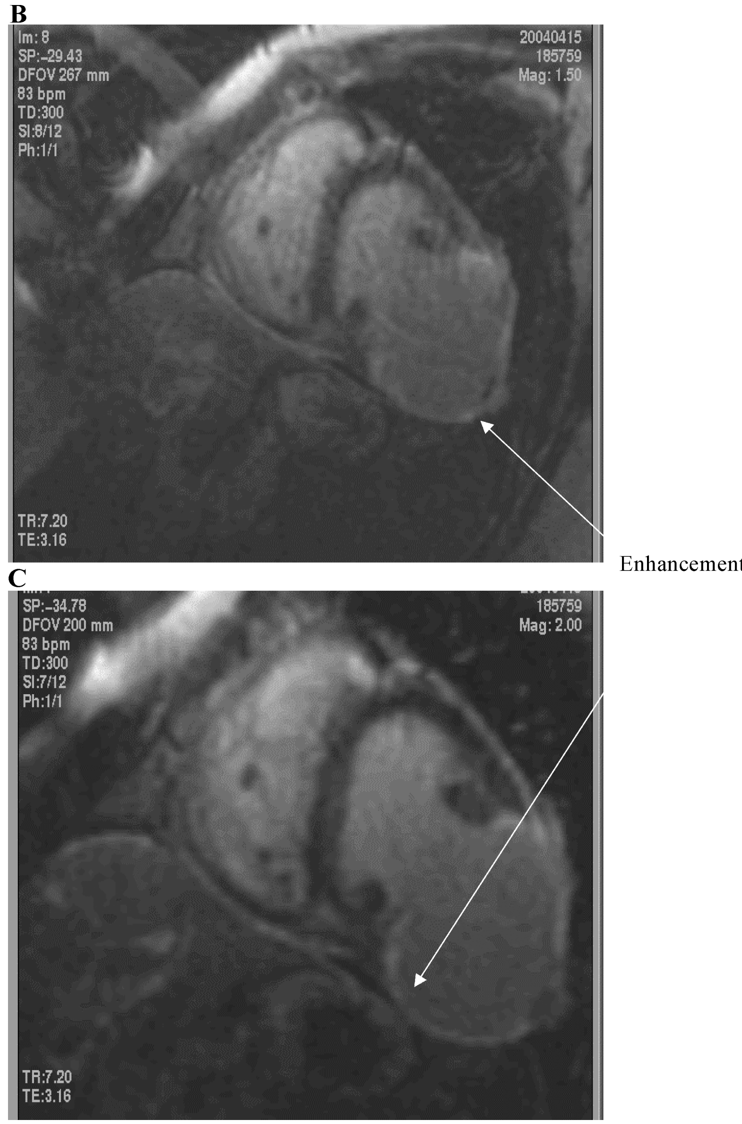


**Figure 3.** Continued.

approximately 10 minutes post-intravenous injection. All acquisitions, except for the perfusion study, were performed with breath-holding and the entire exam was accomplished in 45 minutes. The data was analyzed and quantified using Advantage Workstation (GE LX, Milwaukee, WI) and MASS Analysis Plus (5) software (MEDIS, Netherlands).

A large pseudoaneurysm, measuring 4.3 centimeters in diameter, was identified (Figs. 1 and 2) at the inferior apical level of the left ventricle. The radial (Fig. 1) and short axis (2) views demonstrate that there is communication between the pseudoaneurysm and the left ventricle. Also noted were tricuspid incompetence mitral regurgitation and bi-directional flow in the pseudoaneurysm.

Cardiac measurements by CVMR (Table 1) of the left ventricle show that function is noticeably abnormal with increased end-diastolic (ED) and end-systolic (ES) dimensions and much reduced fractional shortening (FS). This indicates that there is very little wall motion in the LV. Her ED volume (256 mL) is twice the normal range (98–127 mL for females) and her ES volume (179 mL) is almost quadruple the normal range (27–55 mL for females). The perfusion (Fig. 3a) and delayed enhancement (DE) (Fig. 3b–c) studies show that the wall of the aneurysm is largely non-perfused and non-viable, presumably due to earlier coronary occlusion and myocardial infarct. Table 2 demonstrates hypothetical LV measurements if the pseudoaneurysm were surgically resected, predicting an increase in the ejection fraction to 38.8%. The actual ejection fraction measured seven months after surgery is 35.3%.

While pseudoaneurysms can be detected through such modalities as echocardiography (6, 7), chest computed tomography (CT) (4), and chest x-ray (8), CVMR is valuable for demonstrating morphology, quantifying cardiac function such as ejection fraction (EF), stroke volume (SV), cardiac output (CO), and identifying mural non-viability of pseudoaneurysms.

**Table 2.** Projected LV function measurements without pseudoaneurysm

| | Patient | Normal |
|---|---|---|
| End-diastolic volume (EDV) | 167.94 mL | 98–127 mL |
| End-systolic volume (ESV) | 102.82 mL | 27–55 mL |
| End-diastolic volume index | 148.4 mL/m$^2$ | 53–73 mL/m$^2$ |
| End-systolic volume index | 103.8 mL/m$^2$ | 18–31 mL/m$^2$ |
| Ejection fraction | 38.8% | 51–72% |
| Stroke volume | 65.12 mL | |
| Stroke volume index | 45.2 mL/m$^2$ | 27–48 mL/m$^2$ |
| Cardiac index | 2.9 L/min/m$^2$ | 1.7–4.1 L/min/m$^2$ |

This table shows the projected left ventricular function measurements (acquired by CVMR and analyzed in MASS Analysis) if the pseudoaneurysm were surgically corrected.

## 3. Discussion and follow-up

Following these studies, the patient had two vessel coronary artery bypass grafts, resection of the LV aneurysm and placation of the ventricle as well as mitral valvoplasty utilizing a 26 mm Medtronic ring (Shoreview, Minnesota, USA). The CVMR exam (standard exam without delayed enhancement) acquired seven months post-surgery revealed an ejection fraction of 35.3%, a relatively small but still significant improvement. Morphologically, there is a significant difference between pre-surgery and post-surgery (Fig. 4) images. There is also overall improvement in other areas of the heart as shown in Table 3.

This case is analogous to the Surgical Treatment for Ischemic Heart Failure (STICH) Trial (National Institutes of Health), and further analyses (9, 10) are needed to determine whether the procedure was successful.

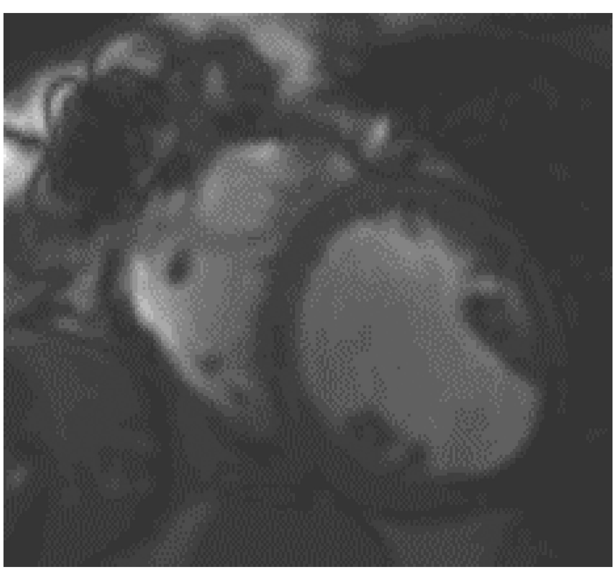

**Figure 4.** Follow-up CVMR exam post-surgical correction. Post-surgical short axis view of the left and right ventricles after surgical correction.

**Table 3.** Post-surgical left ventricular function measurements

| | Patient | Normal |
|---|---|---|
| Ant. sep. wall thickness | 1.2 cm | 0.6–0.8 cm |
| Post. lat. wall thickness | 0.7 cm | 0.6–0.8 cm |
| Mean wall thickness | 0.9 cm | 0.6–0.8 cm |
| End diastolic dimension | 5.9 cm | 4.0–4.9 cm |
| End systolic dimension | 5.2 cm | 2.6–3.6 cm |
| Fractional shortening | 11.9% | 26–40% |
| End-diastolic volume (EDV) | 151.0 mL | 98–127 mL |
| End-systolic volume (ESV) | 98.0 mL | 27–55 mL |
| End-diastolic volume index | 85.2 mL/m$^2$ | 53–73 mL/m$^2$ |
| End-systolic volume index | 55.3 mL/m$^2$ | 18–31 mL/m$^2$ |
| Ejection fraction | 35.3% | 51–72% |
| Stroke volume | 53.0 mL | |
| Stroke volume Index | 29.9 mL/m$^2$ | 27–48 mL/m$^2$ |
| Cardiac index | 1.7 L/min/m$^2$ | 1.7–4.1 L/min/m$^2$ |
| Left atrial dimension | 4.0 cm | 2.4–3.2 cm |
| Aortic root diameter | 2.2 cm | 2.0–2.6 cm |
| Ascending aorta diameter | 2.7 cm | 2.6–3.2 cm |

This table displays the left ventricular function measurements (acquired by CVMR and analyzed by MASS Analysis) 7 months post-surgery.

## Abbreviations

| | |
|---|---|
| LV | Left Ventricle |
| CVMR | Cardiac Magnetic Resonance |
| EF | Ejection Fraction |
| ECG | Electrocardiogram |
| fSPGR | Fast Spoiled Grass |
| FIESTA | Fast Imaging Employing Steady State |
| FGRE_ET | Fast gradient echo-echo train |
| MDE | Myocardial Delayed Enhancement |
| ED | End-Diastole/Diastolic |
| ES | End-Systole/Systolic |
| FS | Fractional Shortening |
| SV | Stroke Volume |
| CO | Cardiac Output |

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