

Anatomical and Functional Evaluation of Myocardial Bridging on the Left Anterior Descending Artery by Cardiovascular Magnetic Resonance Imaging

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ABSTRACT

A myocardial muscle bridge spans a segment of a major epicardial coronary artery that is located in the myocardium. This anatomic configuration can be responsible for angina pectoris, arrhythmias or even death. The current reference standard for diagnosis is conventional x-ray coronary angiography showing systolic compression of an epicardial vessel and the typical angiographic “milking effect.” We report the case of a patient with myocardial bridging on the left anterior descending artery, in whom a combination of noninvasive high resolution display of the coronary artery lumen, visualization of the myocardium and functional assessment of blood flow during dobutamine stimulation by cardiovascular magnetic resonance imaging was performed.

In myocardial bridging, a segment of a major epicardial coronary artery, the “tunnelled artery,” is located intramurally in the myocardium (1). Usually this does not give rise to overt symptoms, and patients are rarely referred for coronary angiography. Therefore, the incidence of myocardial bridging found varies consistently between angiographic (0.5–2.5%) and pathological (15–85%) series (2). In some cases, myocardial bridging is responsible for angina pectoris, myocardial infarction, life-threatening arrhythmias or even death (3). Combined assessment of morphology and function may, therefore, be important.

We report the case of a patient with myocardial bridging of the left anterior descending artery (LAD), who underwent mor-

phological and functional evaluation by cardiovascular magnetic resonance imaging (CMR).

A 49-year-old man was admitted to our institution with atypical chest pain. He was a previous smoker and had a history of hyperlipoproteinemia. ECG at rest and myocardial enzymes were normal. Coronary angiography showed left ventricular ejection fraction to be normal, and no atherosclerotic lesions of the coronary arteries were found. However, a “milking effect” was observed in the mid-LAD with systolic lumen compression of around 75%, which is highly specific for myocardial bridging (Fig. 1). Exercise testing to establish the clinical and functional relevance of the bridge was done by dobutamine stress CMR. Examination was performed in the supine position using a 1.5 Tesla MR system (Philips Intera 1.5 Tesla, Best, The Netherlands). The patient was in sinus rhythm and reached maximum heart rate without clinical symptoms, wall motion abnormalities or arrhythmias at 40 mcg dobutamine/kg body weight (Fig. 2). Free-breathing, navigator-gated magnetic resonance coronary angiography (MRCOA) without contrast agent was performed, using a single three dimensional volume with transversal slice orientation and spatial resolution ($1.18 \times 1.18 \times 1.8$ mm, reconstructed: $0.7 \times 0.7 \times 0.9$ mm) with coverage of the whole coronary artery tree [steady-state free precession (SSFP); TR/TE/flip angle: 4.6 ms/2.3 ms/100 degrees] (4). The acquisition duration per heart beat was individually adapted to the cardiac rest period. Correction of respiratory motion was done using a patient-specific navigator technique (one

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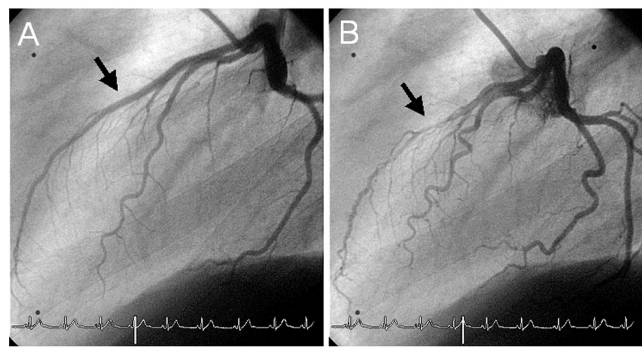


Figure 1. Conventional x-ray coronary angiography showing no signs of coronary atherosclerosis. (A) Normal diastolic lumen. (B) Severe systolic compression (arrows) of the mid left anterior descending coronary (AD).

navigator in cranio-caudal position on the dome of the right hemidiaphragm). Original dataset, curved multiplanar and three dimensional reconstruction of the LAD confirmed its intramyocardial course, corresponding to the region of the angiographi-

cally assessed myocardial bridging (Fig. 3). However, in images acquired in mid-diastole, no stenosis of the mid-LAD was found.

The current reference standard for diagnosing myocardial bridges is conventional x-ray coronary angiography with the typical “milking effect” and a “step down—step up” phenomenon induced by systolic compression of the tunneled segment. However, these signs provide little information on the functional impact at the myocardial level (2). Other suitable imaging techniques are intravascular ultrasound (IVUS), intracoronary Doppler ultrasound (ICD) and intracoronary pressure devices (5). With these methods, morphological and functional features of myocardial bridging can be visualized and quantified; however, they require invasive procedures. Multidetector computed tomography (MDCT) enables non-invasive diagnosis of coronary stenosis and abnormalities (6, 7), but it uses ionizing radiation and potentially nephrotoxic and allergenic contrast agents. It cannot be used for functional evaluation, and results in non-selected patients are poor.

Currently, by MRCA alone, the visualization of distal coronary vessels and small side branches is not yet adequate,

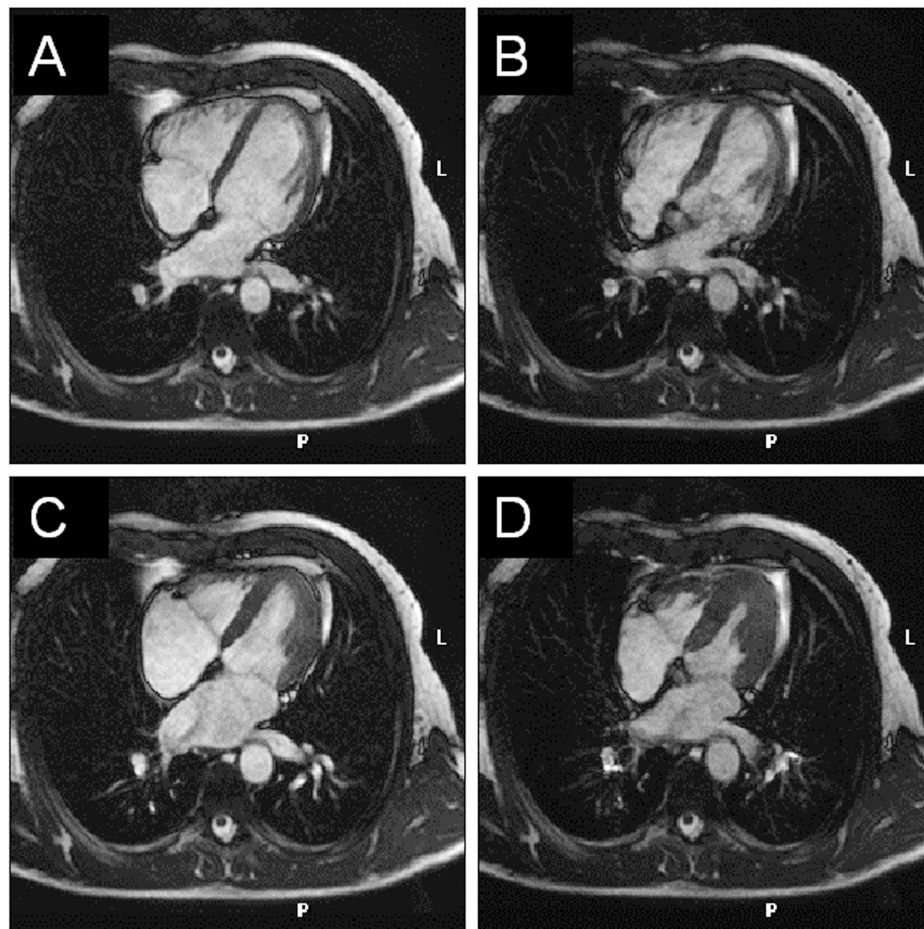


Figure 2. Dobutamine stress CMR. All images were acquired with a steady-state free precession technique at 1.5 Tesla. Top row: end-diastole (A, B); bottom row: end systole (C, D). Left: rest, right: 40 mcg dobutamine. There are no wall motion abnormalities at rest or under stress. Supplemental materials are available for this figure. Go to the publisher's online edition of the *Journal of Cardiovascular Magnetic Resonance* for these images as movie clips.

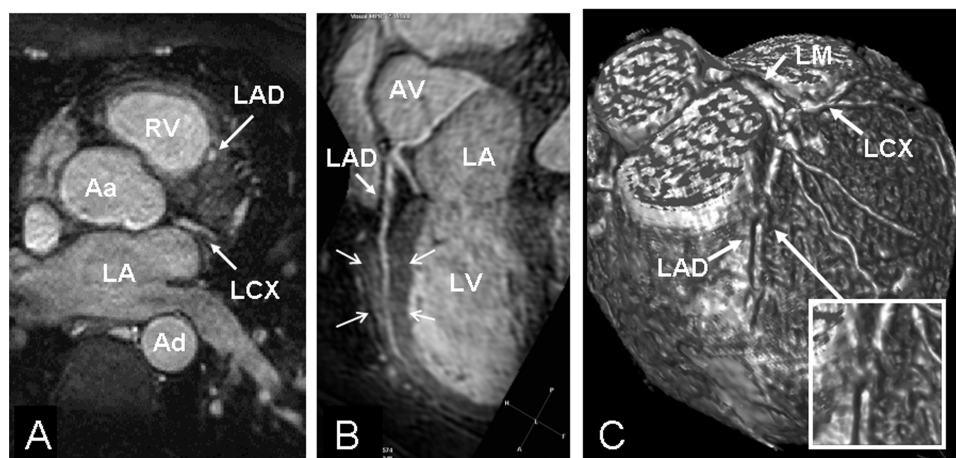


Figure 3. Original transversal slice (A), curved multiplanar (B) and three-dimensional reconstruction (C) of the left anterior descending coronary (LAD). (C) Mid-LAD shows an intramyocardial course (B: thin white arrows), closely corresponding to the region of angiographically assessed myocardial bridging. LCX: left circumflex artery; LM: left main stem; Aa: aorta ascendence; Ad: aorta descendence; AV: aortic valve; LA: left atrium; LV: left ventricle; RV: right ventricle.

so that complete replacement of invasive coronary angiography is not possible. However, the currently available non-invasive technique allow the detection of relevant stenosis in 95% of the patients with suspected coronary artery disease (CAD) to prepare for further invasive diagnostic and therapeutic planning (8).

The potentials of CMR may overcome these limitations, since it combines non-invasive high resolution display of the coronary artery lumen (which is normal in muscle bridging due to the mid-diastolic data acquisition), visualization of the myocardium and functional assessment of blood flow, for example during dobutamine stimulation (9).

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