MRI as Diagnostic Modality for Myocarditis in Patients with Unexplained Chest Pain

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ABSTRACT

Myocarditis is the inflammation of the cardiac muscle. Diagnosis can be challenging as the symptoms are not typical. Cardiac magnetic resonance imaging (MRI) can be used to diagnose myocarditis, allows more reliable quantitative measurements, and a clear discrimination from other mimicking conditions. We include 3 patients with myocarditis.

Keywords: Chest pain, heart failure, MRI, myocarditis.

ABSTRAK

Miokarditis adalah radang otot jantung. Diagnosis dapat menjadi tantangan karena gejalanya tidak khas. Pemeriksaan jantung dengan *magnetic resonance imaging* (MRI) dapat mendiagnosis miokarditis, memungkinkan pengukuran kuantitatif yang lebih andal, dan membedakan dengan jelas dari kondisi serupa lainnya. Kami menyajikan 3 pasien miokarditis. **Prasetyo Andriono, Armand Achmadsyah. MRI sebagai Alat Diagnostik Miokarditis pada Keluhan Nyeri Dada Tidak Spesifik.**

Kata Kunci: Nyeri dada, gagal jantung, MRI, miokarditis.

INTRODUCTION

Myocarditis is a medical condition characterized by inflammation in the cardiac muscle (myocardium). It is commonly linked to previous infection, such as Parvovirus B19 or COVID-19.[1]

Myocarditis may result in sudden cardiac death caused by non-ischemic dilated cardiomyopathy or cardiogenic shock due to severe heart failure. Despite its risk of mortality and morbidity, the exact prevalence of myocarditis remains unknown due to the difficulties in diagnosing the condition, which presents with varied symptoms (e.g. unexplained chest pain, dyspnea, fatigue, syncope).[2-4]

Various diagnostic tests such as electrocardiogram (ECG), echocardiography, and laboratory measures including serum troponin and B-type natriuretic peptide can be used to evaluate myocarditis. Radiology, including x-ray, CT angiography, and cardiac magnetic resonance imaging (MRI), is also an important tool for diagnosis.[3]

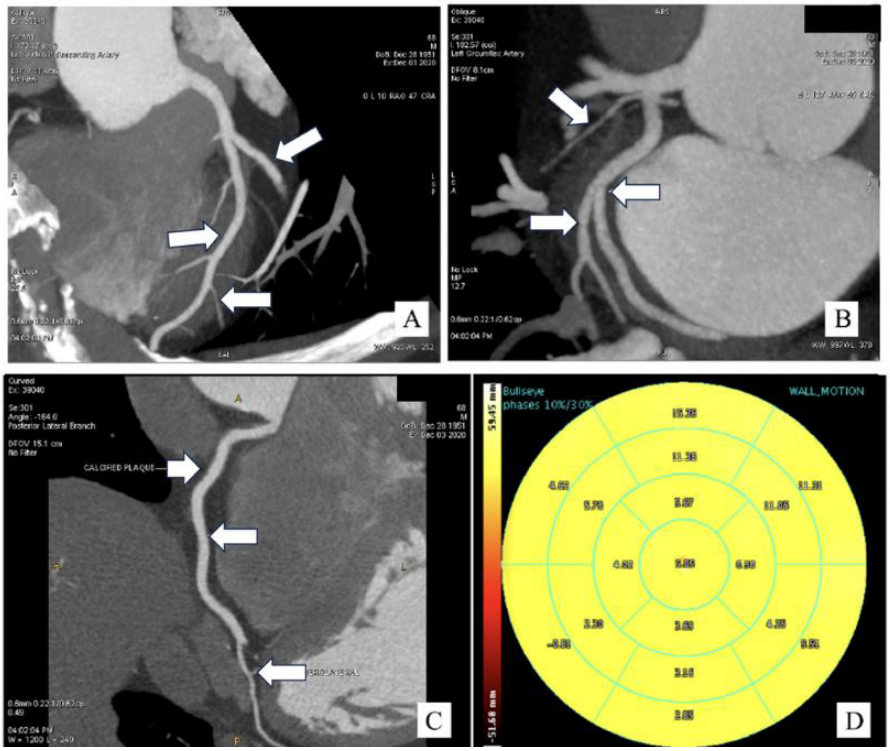

Figure 1. CT angiography showing mild calcified plaque in the middle segment of right coronary artery (RCA) (white arrow).

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Diagnosing myocarditis can be challenging especially in patients with underlying heart failure. This is due to the fact that the pathological conditions associated with heart failure may mimic the imaging characteristics of myocarditis. Patients with unexplained chest pain are often misdiagnosed with myocardial infarction which can lead to delayed diagnosis and treatment. MRI has been shown to be a promising modality for accurately diagnosing myocarditis as it can distinguish between inflammatory and non-inflammatory etiologies of cardiac pathology.[5] This is particularly important in the diagnosis of myocarditis. In this report, we present three patients with unexplained chest pain diagnosed with myocarditis using MRI.

CASE SERIES

Case 1

A 68-year-old male with chief complaint of chest pain with intermittent palpitations. There was no dyspnea, fever, or cough. ECG examination revealed occasional premature ventricular contraction (PVC). A cardiac treadmill test showed a negative ischemic response.

The patient then underwent radiologic examinations. CT angiography showed a mild calcified plaque in the middle segment of right coronary artery (RCA) (**Figure 1**). MRI examination was then performed to determine the etiology. MRI revealed global hypokinesia in the left ventricle with an ejection fraction (EF) of 42.45%. T2-weighted MRI showed hyperintensity in areas involving the inferior, anterior, and anteroseptal walls. Late gadolinium enhancement (LGE) revealed non-ischemic pattern of hyperenhancement involving the mid myocardium of inferoseptal, anteroseptal, anterior, and lateral walls indicating the presence of myocardial fibrosis. T1-T2 mapping also showed an increase in T1 and T2 values in the inferoseptal, anteroseptal, and lateral walls of the left ventricle. MRI results are shown in **Figure 2**. The patient was diagnosed with myocarditis with underlying heart failure with reduced ejection fraction (HFrEF).

Case 2

A 74-year-old female with chief complaint of right intermittent chest pain. There was no dyspnea, cough, fever, nor palpitations. No history of herpes infection. ECG and laboratory results were unremarkable. Chest x-ray revealed fibrosis in the 10th pulmonary segment with intimal aorta calcification. Initially, patient was suspected with coronary artery disease. However, CT angiography revealed absent or no identifiable atherosclerotic plaque in the coronary arteries as shown in **Figure 3.** Cardiac MRI was then performed to confirm the diagnosis. LGE showed a non-ischemic pattern of hyperenhancement involving the mid-myocardium in the lateral wall extending to the anterior wall. There was also hyperenhancement of the pericardium in the anterolateral wall of the left ventricle. Native T1 and T2 values were also increased in the area corresponding to LGE examination. Left EF of the patient was 69.98%. MRI results are shown in **Figure 4**. Patient was then diagnosed with acute perimyocarditis.

Case 3

A 38-year-old female arrived at our setting with shortness of breath. The patient also complained of a non-specific, dull, intermittent chest pain accompanied by restlessness and sweating. There was no fever and cough. ECG and thorax x-ray were unremarkable. Laboratory examination was also unremarkable. CT scan could not be performed due to contrast allergy. Cardiac MRI was then performed. T1-T2 mapping showed an increase in native T1 and T2 values

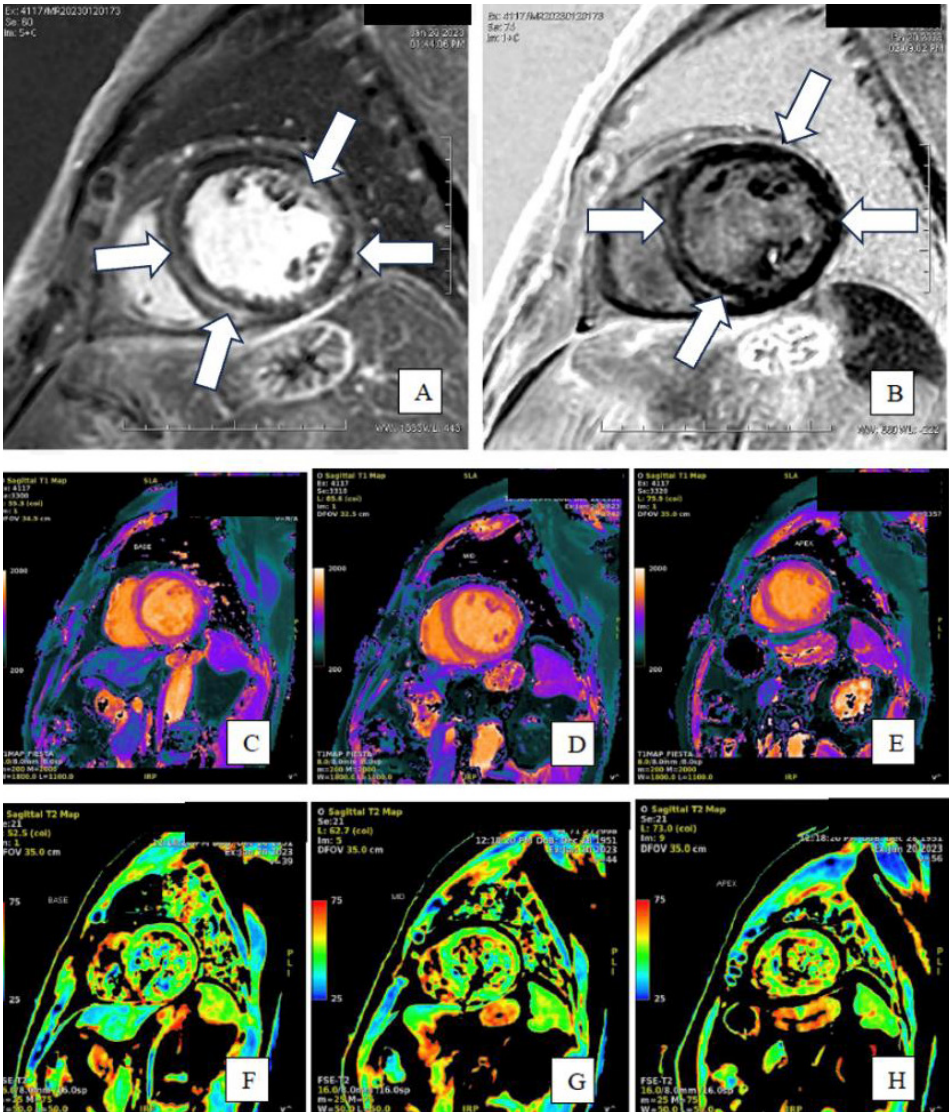

Figure 2. MRI examination. **A, B**. LGE showing non-ischemic pattern of hyperenhancement involving mid myocardium of inferoseptal, anteroseptal, anterior, and lateral walls. **C-H.** T1-T2 mapping showing increased T1 and T2 value in inferoseptal, anteroseptal, and lateral walls of the left ventricle. Left: base. Middle: Mid-section. Right: apex. (white arrow).

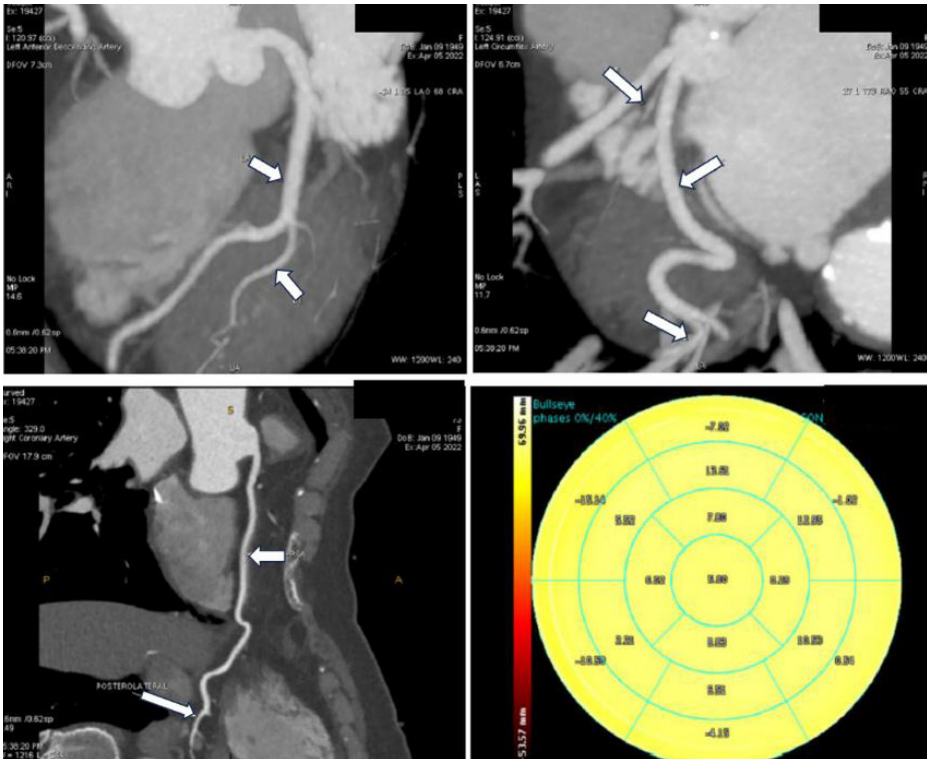

Figure 3. CT angiography revealed absent or no identifiable atherosclerotic plaque in the coronary arteries (white arrow).

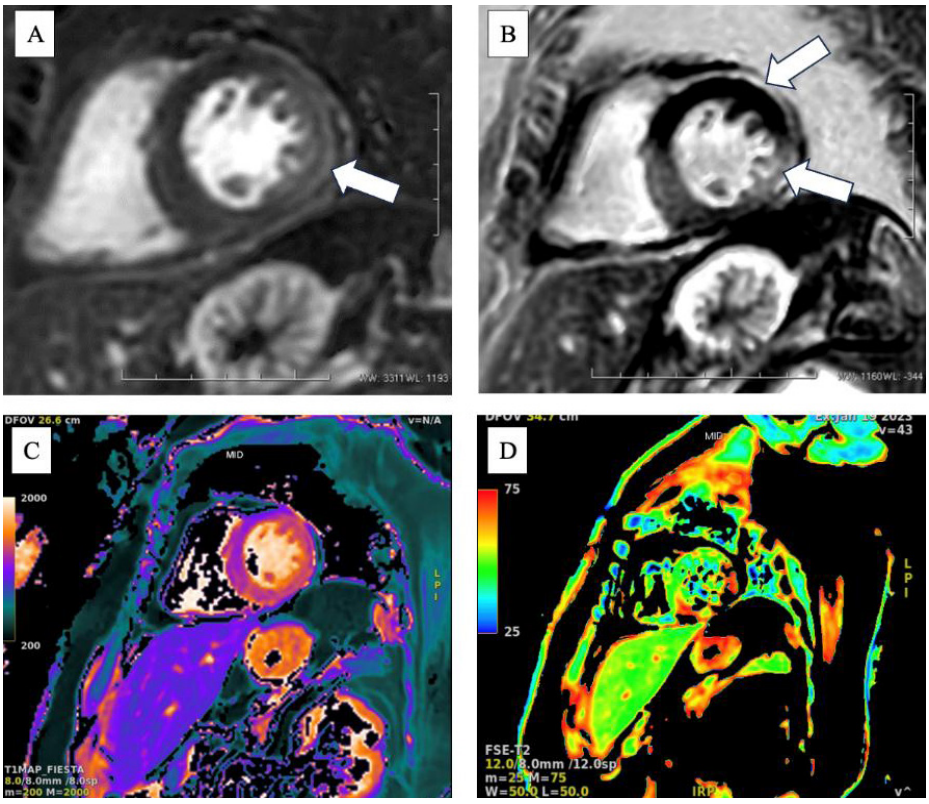

Figure 4. MRI results. **A, B.** LGE showed non-ischemic pattern of hyperenhancement involving midmyocardium in the lateral wall extending to anterior wall (white arrow). **C.** T1-mapping showed area with increase native T1 value in the midmyocardium. **D.** T2-mapping showed increased T2 value in the corresponding area.

indicative of fibrosis and myocardial edema in **Figure 5**. Left ventricular EF was within normal (66.10%). Patient was then diagnosed with acute myocarditis.

DISCUSSION

Myocarditis is an inflammatory condition of the heart, classified by the World Health Organization in 1996 as a secondary cardiomyopathy.[6] It can be caused by infections, exposure to toxins, and immune system activation. It can affect people of all ages. Its prevalence is unknown, although population-based autopsy reports estimated the incidence of myocarditis ranges from 0.12% to 12%.[7]

Clinical manifestations of myocarditis range from subclinical disease to sudden death. Evidence shows that the most common symptoms in myocarditis include chest pain (85%–95%), fever (65%), and dyspnea (19%–49%).[6] In viral myocarditis, patients may experience viral prodrome symptoms such as rash, fatigue, myalgia, arthralgia, and gastrointestinal/respiratory symptoms. Other cardiological symptoms include palpitations, syncope, and decreased exercise tolerance. Symptoms in children are more atypical including malaise, irritability, poor appetite, malaise, and cyanosis.[7]

It needs to be highlighted that chest pain in myocarditis may resemble typical angina which lead to common misdiagnosis. Moreover, myocarditis may result in ECG changes such as ST-segment elevations. Our subjects who presented with chest pain were initially suspected with myocardial infarction. However, CT angiography in myocarditis will reveal no significant plaque burden or calcification. Fernando, *et al*, reported a case of a patient with non-radiating chest pain accompanied by ST-segment elevation on ECG examination mimicking myocardial infarction. Cardiac catheterization revealed no significant stenosis. Inflammatory markers including erythrocyte sedimentation rate and C-reactive protein were elevated and the patient was then diagnosed with acute myocarditis.[8]

While they are useful for diagnosing acute coronary syndrome, the non-specific elevation of serum markers of inflammation and leukocyte count is not diagnostic for acute


myocarditis. Although abnormalities in the ECG may be present and could be associated with a poor prognosis in myocarditis, relying solely on the ECG is inadequate for the diagnosis of myocarditis.[9]

The gold standard in the diagnosis of myocardial disease is endomyocardial biopsy (EMB).[10] EMB is frequently performed in cases with life-threatening arrhythmia, worsening left ventricle (LV) dysfunction, and recurrent cases of myocarditis. Despite this, EMB still lacks sensitivity, with a diagnostic yield of only 39% in cases with new-onset heart failure within 2 weeks.[10] It is an invasive procedure that carries the risk of severe complications such as perforation and tamponade.[11]

Non-invasive modalities such as cardiac CT scan and MRI are useful tools in the evaluation of the patient with suspected myocarditis. The use of CT scan can assist in eliminating the possibility of other illnesses that have similar symptoms to viral myocarditis, such as acute coronary syndrome, aortic dissection, congestive heart failure, pneumonia, and acute pulmonary embolism.[12] Cardiac CT can also identify global and regional wall motion irregularities in the left ventricle. CT scan is more readily available with a shorter scanning time that can also be used as an alternative in patients not suitable for MRI (e.g., metallic implants, claustrophobia).[13]

Cardiac MRI is the primary imaging modality of choice in the diagnosis of myocarditis.[14] It allows tissue characterization and evaluation of myocardial inflammation, edema, and fibrosis. Late gadolinium enhancement (LGE) in myocarditis is typically subepicardial that can appear patchy. The diagnosis of myocarditis is primarily achieved by the Lake Louise Criteria (LLC) where MRI results are used to indicate inflammation in the heart muscle.[14] Diagnosis using MRI with revised LLC has a sensitivity and specificity of 88% and 96% respectively.[14] Safety, consistency between observers, clarity in visualizing heart architecture, and quantitative measurements

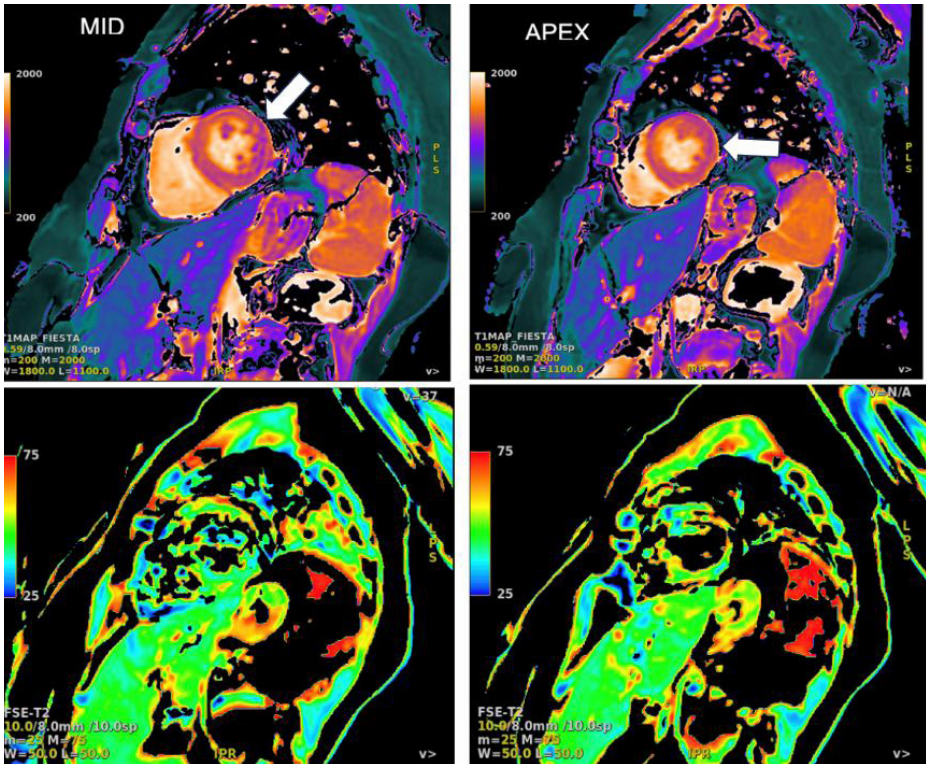

Figure 5. T1-T2 mapping of the patient in the mid and apex view showed an increase in native T1 and T2 values indicative of fibrosis and myocardial edema (white arrow).

are other benefits of cardiac MRI.[15]

Cardiac MRI with T1-T2 mapping offer several benefits such as the ability to quantitatively evaluate myocardial abnormalities and comparing them with normal values for the related tissues. T1 mapping is useful in detecting myocarditis at various stages, but it may not be as effective in differentiating between inflammatory and non-inflammatory conditions in chronic cases due to similar diffuse fibrosis characteristics.[16] T2 mapping is currently the most reliable technique in distinguishing between inflammatory and non-inflammatory conditions, particularly in chronic cases lasting over two weeks. T2 mapping provides a quantitative view of myocardial edema that correlates with injury and inflammation in the myocardium that usually appears 4-6 weeks after the onset of myocardial insult. A combination of T1 and T2 mapping has been found to have a diagnostic accuracy of 86.1% for myocarditis.[17] This characteristic is important as cardiac inflammatory conditions (e.g., myocarditis) are often underdiagnosed because they may mimic symptoms of heart failure. Moreover, as mentioned above, there were no specific changes in ECG, laboratory, or plain radiography in patients with myocarditis.[18]

CONCLUSION

Myocarditis is a potentially life-threatening condition that presents with a wide spectrum of symptoms. Most cases appear with chest pain or dyspnea that resemble other conditions such as myocardial infarction or heart failure. Cardiac magnetic resonance imaging (MRI) with T1-T2 mapping is a useful tool in the diagnosis of myocarditis. It allows more reliable quantitative measurements and a clear discrimination from other mimicking conditions.

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