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Journal of Cardiology & Current Research

Review Article

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Myocardial infarction and non-obstructive coronary arteries (MINOCA) associated to diastolic dysfunction of the left ventricle

Abstract

Patients with angina pectoris and demonstrated signs of ischemia but without significant coronary artery disease are at increased risk for major adverse cardiovascular events compared with asymptomatic general population. This syndrome called myocardial infarction and non-obstructive coronary arteries (MINOCA) may have different mechanisms of production. This abnormality was found to be related to abnormal coronary reactivity, micro-vascular coronary dysfunction, and plaque erosion/distal microembolization. However, it remains unclear whether these abnormalities manifest into actual changes in left ventricular (LV) function. Heart failure (HF) with preserved ejection fraction usually affects older women with some cardiovascular risk factors. This diastolic HF is increasingly recognized as a major contributing factor of morbidity and mortality. Multifactorial mechanisms have been implicated such as cardiac hypertrophy, myocardial fibrosis, metabolic dysfunction of cardiomyocytes, and microvascular abnormalities. There is an increasing relatively high incidence of newly onset HF hospitalizations and nonfatal acute coronary syndrome in these patients with MINOCA. It has been demonstrated that LV diastolic dysfunction occurs early in the ischemic cascade and may be a mediator of increased risk of HF and other cardiovascular events among patients with microvascular coronary disease. Therefore, early identification of cardiac abnormalities and diastolic dysfunction with sensitive cardiac MRI tissue tagging techniques provide an important treatment window for preventing disease progression in microvascular coronary disease.

Keywords: MINOCA, Cardiac MRI, Diastolic heart failure, Microvascular coronary disease

Volume 11 Issue 4 - 2018

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Received: April 18, 2018 | **Published:** July 05, 2018

Introduction

Patients with angina pectoris and demonstrated signs of ischemia but without significant coronary artery disease (CAD) present greater incidence of major adverse clinical events compared with the general population.[1–4] This syndrome called myocardial infarction and non-obstructive coronary arteries (MINOCA) may have different mechanisms of production. This abnormality was found to be related to abnormal coronary reactivity, micro-vascular coronary dysfunction, and plaque erosion/distal micro-embolization.[5–10] However, it is not clearly understood if these abnormalities would produce functionality alterations of left ventricle.

Diastolic heart failure, namely, heart failure (HF) with preserved ejection fraction, is a condition with similar cardiac outcomes compared with systolic HF, namely, HF with reduced ejection fraction.[11–15] Heart failure with preserved ejection fraction usually affects older women with some cardiovascular risk factors. This diastolic HF is increasingly recognized as a major contributing factor of morbidity and mortality.[11,12] Multifactorial mechanisms have been implicated such as myocardial hypertrophy and fibrosis, myocardial metabolic dysfunction, and microvascular alterations. It has been demonstrated that left ventricular (LV) diastolic dysfunction occurs early in the ischemic cascade and may be a mediator of increased risk of HF and other cardiovascular events among patients with microvascular coronary disease.[10]

It is more frequently recognized that HF patients will often have normal LV ejection fraction. Therefore, in order to achieve a targeted treatment in diastolic dysfunction HF patients in the early stages of the disease, we need more sensitive imaging auxiliary methods to evaluate the whole cardiac cycle. Therefore, we will analyze certain mechanisms and contemporary findings of LV diastolic function by cardiac MRI in patients with MINOCA.

LV diastolic function by cardiac MRI in patients with MINOCA

The WISE study and subsequent sub-studies demonstrated objective vascular abnormalities in patients with microvascular coronary disease.[1–6] They observed abnormalities in the metabolic reaction to mild stress testing using Phosphorus-31 magnetic resonance spectroscopy.[4] It was observed that invasive measurement of coronary flow reserve was abnormal in 47% of such patients, and acetylcholine induced a greater than 50% reduction in blood flow in half of the patients and vasospasm in 5%.[3]

Nelson MD et al studied the diastolic dysfunction in women with MINOCA utilizing cardiac magnetic resonance imaging (MRI).[16] They compared the findings of cardiac MRI-derived measurements of systolic and diastolic function of the study patients to those of healthy women matched for age and body size.[16] They incorporated MRI tissue tagging into the standard cardiac MRI protocol to evaluate LV systolic and diastolic function. Cardiac MRI tissue tagging is an accurate noninvasive imaging technique that allows detailed and important quantitative data about myocardial tissue deformation.[16–19] The application of this interesting cardiac MRI technique to different

kinds of entities has permitted the evaluation of LV diastolic function, and the early detection of subclinical LV dysfunction.[20–23] Multiple abnormalities in diastolic function were detected using tissue tagging analysis, a cardiac MRI technique that provides quantitative assessment of myocardial deformation throughout the cardiac cycle (Table 1).[17]

Table1 Diastolic function abnormalities detected by cardiac MRI in microvascular ischemia

Lower diastolic circumferential strain rate.
Lower peak rate of left ventricular untwisting.
Longer time to peak filling rate.
Longer peak ventricular untwisting rate.
Trend toward longer time to peak diastolic circumferential strain rate.
No difference in peak ventricular filling rate.

Cardiac MRI tissue tagging provides a more superior measurement of myocardial relaxation and supplies two important measures of LV diastolic function, namely, strain rate and the rate of ventricular untwisting. Diastolic strain rate indicates the rate of tissue deformation, and myocyte lengthening, during early diastole. This parameter is similar, although more superior, to the early myocardial tissue velocities obtained by Doppler ultrasound.[16–18] These imaging techniques can discard the diagnosis of cardiac hypertrophy as a major contributing factor by measuring LV mass and LV concentricity. Evidence of myocardial fibrosis can also be ruled out by delayed enhancement imaging with gadolinium. Impairment in LV relaxation rather than abnormality in compliance of the left ventricle may be the probable causal mechanism when hypertrophy or fibrosis is ruled out with this imaging modality. In this context, Nelson MD et al hypothesize that LV diastolic dysfunction may be secondary to several traditional risk factors such as systemic arterial hypertension, type II diabetes mellitus, and obesity which are commonly observed in MINOCA syndrome.[16]

Conventional Doppler ultrasound is also a well-known imaging technique to study LV diastolic function. Speckle-tracking echocardiography can also supply comparable strain information, with similar sensitivity and variability as cardiac MRI. However, it is out of the scope of this manuscript. Besides, cardiac MRI is clearly superior to echocardiography in terms of LV morphology and myocardial perfusion measurements. It has been demonstrated that patients with MINOCA have lower myocardial perfusion reserve index (MPRI) compared with controls. MPRI is a cardiac MRI-based, semi-quantitative measurement of myocardial perfusion in response to adenosine stress. It has been shown that this parameter has excellent diagnostic accuracy for obstructive CAD as determined by fractional flow reserve.[20] MPRI has been used to document microvascular disease in patients with ischemic symptoms and no obstructive CAD, although this is somewhat controversial. [21–23] Although, MPRI is more widely available than quantitative perfusion methods, it is not as accurate for the detection of ischemia in patients with epicardial obstructive CAD.[24–26] However, in patients with MINOCA, early identification of cardiac abnormalities and diastolic dysfunction with sensitive cardiac MRI tissue tagging techniques provide an important treatment window for preventing disease progression in microvascular coronary disease.[27–32]

Since the prevalence of ischemic heart disease is steadily increasing, the incidence of MINOCA patients is likely to increase too in years to come due to aging population. Coronary heart disease affects nearly 16 million persons in the USA.[33–37] More than 2 million cases of unstable angina and nearly 4 million cases of acute myocardial infarction occur annually in the world. The prevalence of patients who have survived an episode of AMI is estimated at 15 million, these patients are at high risk to develop additional coronary events.[38–42] With the widespread use of urgent coronary angiography in the early clinical management of acute coronary syndrome, it has been reported that as many as 10% of acute myocardial infarction patients have no evidence of obstructive coronary artery disease. It is not clearly understood whether they have similar clinical features and outcomes as patients with acute myocardial infarction with obstructive coronary artery disease. A previous meta-analysis data analyzing cardiac MRI findings in patients with MINOCA demonstrated that more than 30% of the patients had myocarditis and 20% had "true" myocardial infarction.[43] These imaging modality studies show that cardiac MRI performed at the early stages could yield a definite diagnosis in 90% of the patients. Indeed, the combined data of the meta-analysis and recent studies.[43–47] support the concept that early cardiac MRI with the latest imaging techniques can make the diagnosis in the vast majority of MINOCA patients. Therefore, this imaging technique is an important diagnostic tool clearly mentioned in this context in the recent position paper by the ESC.[30] Therefore, the objective observation of diastolic function alterations and tissue abnormalities by cardiac MRI in patients with MINOCA opens the door for further investigation about the association between microvascular disease and diastolic dysfunction for the interesting potential of predicting the risk for cardiovascular events.

Conclusion

There is an increasing relatively high incidence of newly onset HF hospitalizations and nonfatal acute coronary syndrome in these patients with myocardial ischemia with non-obstructive coronary heart disease. LV diastolic dysfunction occurs early in the ischemic cascade and may be a mediator of increased risk of HF and other cardiovascular events among patients with microvascular coronary disease. Therefore, early identification of cardiac abnormalities and diastolic dysfunction with sensitive cardiac MRI tissue tagging techniques provide an important treatment window for preventing disease progression in microvascular coronary disease.

Acknowledgments

None.

Conflict of interest

The author declares that there no conflict of interest.

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Citation: Alderete JF, Torales JM García LB, et al. Myocardial infarction and non-obstructive coronary arteries (MINOCA) associated to diastolic dysfunction of the left ventricle. *J Cardiol Curr Res*. 2018;11(4):161–164. DOI: 10.15406/jccr.2018.11.00391