eISSN 2255-0569

ORIGINAL

Study the late gadolinium enhancement (LGE) in patients with heart valvular disorders

Estudiar el realce tardío del gadolinio (LGE) en pacientes con trastornos valvulares del corazón

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Received: 13 - II - 2022
Accepted: 3 - III - 2022

doi: 10.3306/AJHS.2022.37.03.41

Abstract

Background: Various valvular disorders, even severe cases, may be asymptomatic. Studies have found abnormalities in the heart tissue, even in cases that are not currently being treated, by cardiac MRI (CMR) examination, and these findings are used to predict the prognosis of patients undergoing aortic or mitral surgery. Mortality or disability after surgery has been found to be beneficial. Some of these studies have also suggested that Late gadolinium Enhancement (LGE), which is administered by CMR, can also be used as a tool for risk stratification in asymptomatic patients.

Methods: This study was performed as a cross-sectional study on 355 Russian patients. The study population included all patients who underwent CMR during the study period. And their MRI patterns were examined for edema, hyperhemia, and fibrosis. The information required by patients including demographic and demographic characteristics (age and sex) and the variables required by patients were recorded in the patient checklist.

Results: The prevalence of LGE in midmyocardium and subendocardium in LV posterior wall in patients with less than moderate mitral stenosis was significantly higher than others. The pattern of LGE in the septum, which was significantly higher in patients with DCM (dilated cardiomyopathy) and moderate and higher mitral regurgitation, was significantly higher in midmyocardial LGE. Among patients with primary valve involvement, there was no significant difference between patients with involvement between patients with moderate and higher MR and AI, and patients with moderate MR and AI severity below average.

Conclusion: The prevalence of LGE in the midmyocardium and subendocardium in the LV posterior wall was significantly higher in patients with less than moderate mitral stenosis. In addition, midmyocardial LGE was significantly higher in patients with DCM and moderate and higher mitral regurgitation.

Key words: Cardiomyopathy, late gadolinium enhancement (LGE), valvular disorders.

Resumen

Antecedentes: Varios trastornos valvulares, incluso los casos graves, pueden ser asintomáticos. Los estudios han encontrado anomalías en el tejido cardíaco, incluso en los casos que no están siendo tratados actualmente, mediante un examen de resonancia magnética cardíaca (RMC), y estos hallazgos se utilizan para predecir el pronóstico de los pacientes sometidos a cirugía aórtica o mitral. Se ha comprobado que la mortalidad o la discapacidad después de la cirugía son beneficiosas. Algunos de estos estudios también han sugerido que el realce tardío de gadolinio (LGE), que se administra mediante RMC, también puede utilizarse como herramienta para la estratificación del riesgo en pacientes asintomáticos.

Métodos: Este estudio se realizó como un estudio transversal en 355 pacientes rusos. La población del estudio incluyó a todos los pacientes que se sometieron a una RMC durante el período de estudio. Y se examinaron sus patrones de RM para detectar edema, hiperemia y fibrosis. La información requerida por los pacientes, incluidas las características demográficas y de la población (edad y sexo), y las variables requeridas por los pacientes se registraron en la lista de comprobación de los pacientes.

Resultados: La prevalencia del RTG en el miocardio medio y en el subendocardio de la pared posterior del VI en los pacientes con estenosis mitral menos que moderada fue significativamente mayor que en los demás. El patrón de RTG en el septo, que fue significativamente mayor en los pacientes con MCD (miocardiopatía dilatada) y regurgitación mitral moderada y superior, fue significativamente mayor en el RTG en el miocardio medio. Entre los pacientes con afectación valvular primaria, no hubo diferencias significativas entre los pacientes con afectación entre los pacientes con RM e IA moderada y superior, y los pacientes con RM moderada e IA de gravedad inferior a la media.

Conclusiones: La prevalencia del RTG en el miocardio medio y el subendocardio en la pared posterior del VI fue significativamente mayor en los pacientes con estenosis mitral inferior a la moderada. Además, el RTG en el miocardio medio fue significativamente mayor en los pacientes con MCD y regurgitación mitral moderada y superior.

Palabras clave: Miocardiopatía, realce tardío de gadolinio (LGE), trastornos valvulares.

Introduction

Cardiac valvular disorders are an important category of cardiovascular disease. These disorders range from very mild and insignificant cases to severe and life-threatening cases. These diseases in different societies depending on the underlying factors and diseases, the general age of the population, the prevalence of infectious diseases, the prevalence of addiction Injectable and depending on gender can have different prevalence[1,2].

In developing countries, rheumatic fever is still very common, valvular diseases have different prevalence in different groups, for example, at a young age, the main causes are congenital heart disease, while at an older age, it is usually degenerative[3]. Some valvular disorders are also more common in certain groups, such as mitral valve prolapse are more common in women or right heart valve endocarditis and its complications is more common in injecting drug users[3-5]. Valvular disorders, may be asymptomatic even in severe form of them. Previous studies, have found abnormalities in the heart tissue in cardiac Magnetic resonance imaging (MRI) (CMR) even in mild or moderate valvular disease[6]. This findings can be beneficial for predicting the prognosis of patients undergoing aortic or mitral surgery in postoperative mortality or morbidity[7-9]. Some of these studies have also suggested that Late gadolinium Enhancement (LGE) supplied by CMR can also be used as a tool for risk stratification of asymptomatic patients[10].

Due to the wide range of valvular disorders and their high importance in quality of life and also the high accuracy of CMR in examining heart tissue in this study, we decided to investigate late gadolinium enhancement in patients with various valvular disorders.

Materials and methods

Ethics

This survey was ethically approved by the ethical council of research of the Iran University of Medical Sciences, Tehran, Iran (IR.IUMS.FMD.REC.1399.863). In this study, we adhered to all the ethical laws approved by the Ministry of Health at all stages. Also, in this study, no additional cost was imposed on the patient. In publishing the results of this study, the names of patients and participants in the project were not mentioned. In addition, the proposal to carry out this plan was submitted to him for approval by the University Medical Ethics Committee.

Study procedure

This study was a single center, retrospective, cross sectional study. This study designed to compare the differences of LGE pattern in different valvular disease. All patients who underwent cardiac MRI from 2017 February to December 2020 and had valvular disease in the MRI report were included in the study. Exclusions criteria were any sort of congenital heart disease. Three hundred and fifty five patients finally enrolled in this study to be analyzed statistically. 1.5 Tesla MRI technology with identical standards and protocol to all patients. Image acquisition was performed using ECG gated Steady-State Free Precession (SSFP) to multiple planes of the heart (long axis, short axis, 4 chamber, and 3 chamber). Gadolinium was injected via intravenous line with standard dose (0.1 mmol/kg). LGE image using phase-sensitive inversion recovery (PSIR) sequence were captured 10 minutes after gadolinium injection. All volumes and mass measurements were indexed to body surface area. CMR analysis and interpretation, myocardial fibrosis assessment and quantification was performed by a team of cardiovascular imaging cardiologists. Due to the different severity of the Valvular disease, for better data analysis, we classified the patients into two groups with at least moderate severity and patients with lower than moderate valvular disease.

Statistical analysis

Data analysis was performed by SPSS software. For qualitative variables, frequency and frequency are calculated, and for quantitative variables, mean and standard deviation are calculated. Chi-square test was used to test the hypotheses.

Results

In this study, a total of 355 patients were included. demographic data and severity of various valvular disorders and their causes can be seen in **tables I, II** and **III**.

The Late gadolinium Enhancement (LGE) pattern can be seen in in **table IV**.

Table I: Demographic characters of the studied population.

Demographic data 1	Mean	Std. Deviation	Minimum	Maximum
Age	39.91	19.534	1	84
LVEF	39.3524	16.05875	4.00	78.00
RVEF	45.0606	13.00391	1.00	74.00

Table II: Demographic characters of the studied population.

Demographic data		Frequency	Percent
Rhythm	Sinus	317	89.3
	Atrial fibrillation	26	7.3
	Atrial flutter/tachycardia	4	1.1
	Paced rhythm	8	2.3
History of prior surgery	No History	316	89.0
	Once	38	10.7
	2 and more	1	.3
CAD history	No	281	79.2
	History of PCI or CABG or MI or Angiography confirmed CAD	74	20.8
Gender	Male	230	64.8
	Female	125	35.2

Table III: Frequency of valvular disease by etiology.

Valvular disease		Frequency	Percent
Etiology of Valvular disease overall (diagnosis)	Primary	37	10.4
	DCM	83	23.4
	ICMP	72	20.3
	HCM	42	11.8
	Myocarditis	105	29.6
	NCLV	2	.6
	ARVC	7	2.0
	RCM	4	1.1
	CP	2	.6
	Cancer	1	.3
MR Severity	No MR	134	37.7
	Mild or trivial	110	31.0
	Mild to moderate	21	5.9
	At least moderate / moderate	55	15.5
	Moderate to severe	10	2.8
	Severe/very severe	25	7.0
	Total	355	100.0
MR Etiology	No MR	135	38.0
	Prolaptic	18	5.1
	Rheumatic	19	5.4
	Functional (HF/Ischemia)	183	51.5
MS severity	No MS	347	97.7
	Mild	2	.6
	Moderate/at least moderate	2	.6
	Moderate to severe /severe	3	.8
AI severity	No AI	280	78.9
	Mild or trivial	53	14.9
	Mild to moderate	2	.6
	At least moderate / moderate	12	3.4
	Moderate to severe	3	.8
	Severe/very severe	5	1.4
AI etiology	No AI	314	88.5
	Prolaptic	3	.8
	Rheumatic	10	2.8
	Bicuspid	7	2.0
	Degenerative	21	5.9
AS severity	No AS	348	98.0
	Mild	2	.6
	Moderate/at least moderate	1	.3
	Moderate to severe/severe	4	1.1
TR severity	No TR	251	70.7
	Mild or trivial	68	19.2
	Mild to moderate	2	.6
	At least moderate/moderate	16	4.5
	Moderate to severe	3	.8
	Severe/very severe	15	4.2
TR etiology	No TR	251	70.7
	Proleptic	6	1.7
	Rheumatic	4	1.1
	Functional	94	26.5
PI Severity	No PI	351	98.9
	Mild or trivial	2	.6
	At least moderate/moderate	2	.6
PI Etiology	Normal	353	99.4
	Proleptic	1	.3
	functional	1	.3

LGE pattern in different valvular disorders among patients with at least moderate severity of valvular disorders and patients with lower than moderate valvular disease, none of the patterns were significantly different between the two groups except one case. The prevalence of LGE in midmyocardium and subendocardium in LV posterior wall in patients with less than moderate mitral stenosis was significantly higher than others (P-Value <0.001).

Among patients, only three patients with concurrent MR and AS were evaluated for significant valvular disorders (moderate and higher). Also, only 3% of patients (11 patients) had MR and AI simultaneously.

Table IV: Late gadolinium Enhancement (LGE) pattern.

LGE pattern		Frequency	Percent
LV anterior wall	No LGE	265	74.6
	Midmyocardial LGE	14	3.9
	Subepicardial LGE	11	3.1
	Subendocardial LGE	15	4.2
	Transmural LGE	44	12.4
	Edema	5	1.4
	Hyperemia	1	.3
LV Lateral wall	Normal	248	69.9
	Midmyocardial LGE	17	4.8
	Subepicardial LGE	50	14.1
	Subendocardial LGE	13	3.7
	Transmural LGE	22	6.2
	Edema	5	1.4
LV Inferior wall	Normal	246	69.3
	Midmyocardial LGE	24	6.8
	Subepicardial LGE	38	10.7
	Subendocardial LGE	13	3.7
	Transmural LGE	29	8.2
	Edema	4	1.1
	Hyperemia	1	.3
LV Post wall	Normal	336	94.6
	Midmyocardial LGE	3	.8
	Subepicardial LGE	11	3.1
	Subendocardial LGE	3	.8
	Transmural LGE	1	.3
	Hyperemia	1	.3
Septum	Normal	221	62.3
	Midmyocardial LGE	85	23.9
	Subepicardial LGE	19	5.4
	Subendocardial LGE	14	3.9
	Transmural LGE	11	3.1
	Edema	3	.8
	Hyperemia	2	.6
RV free wall	Normal	347	97.7
	LGE	8	2.3

Among primary myocardial diseases, three of the most common diseases among our patients (DCM, HCM and ICMP) were analyze for difference of LGE pattern in different severity of valvular disease. We only compare different LGE pattern in patents with MR due to the very low prevalence of other valvular disorders in these patients. Statistical analysis showed no significant differences between the two groups of study, except for the LGE pattern in the septum in patient with DCM, which was significantly higher in patients with moderate and higher MR in midmyocardial LGE. (P-Value: 0.001).

When we compare patients with primary valvular involvement with these three groups (Primary myocardial disease), the LGE pattern is significantly different (P-Value <0.001) in all part of LV and RV. Except in LV Posterior wall. (P-Value: 0.5)and in RV free wall. (P-Value: 0.054) And when we compare the LGE pattern in myocarditis patients with these three groups of cardiomyopathies, The LGE pattern is significantly different (P-Value <0.001) in all part of LV and RV. except in RV free wall. (P-Value: 0.44) But when we compare patients with primary valve involvement with patients with myocarditis in terms of LGE pattern, the difference is significant only in the lateral, inferior and septal walls.

Among patients with primary valve involvement, there was no significant difference between patients with moderate and higher MR and patients with less than

moderate MR intensity. The same was true of aortic valve insufficiency. Due to the low prevalence of other valvular disorders, comparison between them was omitted. And also due to the low prevalence of valvular disorders in patients with myocarditis, the comparison between this cases was omitted.

Discussion

Late gadolinium enhancement is a technique used in cardiac MRI for cardiac tissue characterization, in particular, the assessment of regional scar formation and myocardial fibrosis. Late gadolinium enhancement is based on the shortening of T1 and different regional distribution patterns of gadolinium-based contrast agents within the extracellular space of the myocardium. It also depends on varying uptake and washout patterns within the normal myocardium and those different disease processes. This is depicted by applying an inversion pulse to null the inherent signal of the myocardium after a certain amount of time[11].

In this study, we examined the valvular disorders and the prevalence of LGE in different parts of the LV and RV wall. This issue has not been done with such details and precision in a study that was completely new in its kind.
In different valvular disorders among patients with at least moderate valvular disease and patients with lower valvular disease, none of the patterns showed a significant difference between the two groups of study, except the prevalence of LGE in the midmyocardium and subendocardium in LV posterior wall who was significantly higher in patients with lower mitral stenosis (P-Value <0.001).

Due to the very low prevalence of concurrent valvular disorders, it was not possible to investigate LGE pattern in pressure overload and volume overload or their combination.

In the study of the effect of valvular disorders on the LGE pattern in patients with cardiomyopathy, only in DCM patients midmyocardial LGE in the septum was significantly higher in patients with moderate and higher MR. In comparison of patients with primary valvular involvement with these three groups of cardiomyopathy, the LGE pattern was significantly different from these three groups in all cases. Except in LV Posterior wall. Also, in comparing the LGE pattern in patients with myocarditis and these three groups of cardiomyopathies, the LGE pattern is significantly different from these three groups in all cases, except in RV free wall. But the difference in patints with primary valvular involvement and myocarditis, only was in the lateral, inferior and septal walls LGE.

Hypertrophic cardiomyopathy (HCM) is the most common genetic disease of the heart. HCM is characterized by a wide range of clinical expression, ranging from asymptomatic mutation carriers to sudden cardiac death as the first manifestation of the disease. Over 1000 mutations have been identified, classically in genes encoding sarcomeric proteins. Noninvasive imaging is central to the diagnosis of HCM and cardiovascular magnetic resonance (CMR) is increasingly used to characterize morphologic, functional and tissue abnormalities associated with HCM. The early and overt phenotypic expression of disease that may be identified by CMR is reviewed. Diastolic dysfunction may be an early marker of the disease, present in mutation carriers prior to the development of left ventricular hypertrophy (LVH). Late gadolinium enhancement by CMR is present in approximately 60% of HCM patients with LVH and may provide novel information regarding risk stratification in HCM. It is likely that integrating genetic advances with enhanced phenotypic characterization of HCM with novel CMR techniques will importantly improve our understanding of this complex disease[12-14].

Conclusion

The prevalence of LGE in the midmyocardium and subendocardium in the LV posterior wall was significantly higher in patients with less than moderate mitral stenosis than others. In addition, midmyocardial septal LGE was significantly higher in patients with moderate and higher MR in DCM patients.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Boudoulas KD, Borer JS, Boudoulas H. Etiology of valvular heart disease in the 21st century. Cardiology. 2013;126(3):139-52.

2. Lincoln J, Garg V. Etiology of Valvular Heart Disease–Genetic and Developmental Origins–. Circulation Journal. 2014:CJ-14.

3. Maganti K, Rigolin VH, Sarano ME, Bonow RO. Valvular heart disease: diagnosis and management. InMayo Clinic Proceedings 2010 May 1 (Vol. 85, No. 5, pp. 483-500). Elsevier.

4. Iung B, Vahanian A. Epidemiology of valvular heart disease in the adult. Nature Reviews Cardiology. 2011 Mar;8(3):162-72.

5. Mylonakis E, Calderwood SB. Infective endocarditis in adults. New England Journal of Medicine. 2001 Nov 1;345(18):1318-30.

6. Myerson SG. CMR in Evaluating Valvular Heart Disease: Diagnosis, Severity, and Outcomes. JACC: Cardiovascular Imaging. 2020 Nov 25.

7. Garg P, Swift AJ, Zhong L, Carlhäll CJ, Ebbers T, Westenberg J, et al. Assessment of mitral valve regurgitation by cardiovascular magnetic resonance imaging. Nature Reviews Cardiology. 2020 May;17(5):298-312.

8. Swingen C, Kelly RF. Cardiac magnetic resonance imaging for ischemic mitral regurgitation: A guide through complex surgical terrain. The Journal of thoracic and cardiovascular surgery. 2016 Nov 24;154(1):159-60.

9. Blanken CP, Farag ES, Boekholdt SM, Leiner T, Kluin J, Nederveen AJ, et al. Advanced cardiac MRI techniques for evaluation of left sided valvular heart disease. Journal of Magnetic Resonance Imaging. 2018 Aug;48(2):318-29.

10. Balciunaite G, Skorniakov V, Rimkus A, Zaremba T, Palionis D, Valeviciene N, et al. Prevalence and prognostic value of late gadolinium enhancement on CMR in aortic stenosis: meta-analysis. European radiology. 2020 Jan;30(1):640-51.

11. Kuruvilla S, Adenaw N, Katwal AB, Lipinski MJ, Kramer CM, Salerno M. Late gadolinium enhancement on cardiac magnetic resonance predicts adverse cardiovascular outcomes in nonischemic cardiomyopathy: a systematic review and meta-analysis. Circulation: Cardiovascular Imaging. 2014 Mar;7(2):250-8.

12. Noureldin RA, Liu S, Nacif MS, Judge DP, Halushka MK, Abraham TP,et al. The diagnosis of hypertrophic cardiomyopathy by cardiovascular magnetic resonance. Journal of Cardiovascular Magnetic Resonance. 2012 Dec;14(1):1-3.

13. Eijgenraam TR, Silljé HH, de Boer RA. Current understanding of fibrosis in genetic cardiomyopathies. Trends in cardiovascular medicine. 2020 Aug 1;30(6):353-61.

14. Unger P, Pibarot P, Tribouilloy C, Lancellotti P, Maisano F, Iung B, et al. Multiple and mixed valvular heart diseases: pathophysiology, imaging, and management. Circulation: Cardiovascular Imaging. 2018 Aug;11(8):e007862.