Research Brief

Utility of late gadolinium enhancement on magnetic resonance imaging in hypertrophic cardiomyopathy patients in an Indian cohort

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ARTICLE INFO

ABSTRACT

This prospective observational study sought to correlate segmental late gadolinium enhancement (LGE) seen in cardiac magnetic resonance imaging with occurrence of ventricular arrhythmias (VAs) in patients with hypertrophic cardiomyopathy. LGE was assessed in a 17-segmental model of heart. Of 57 patients, VAs were present in 26.3% of patients and 10.5% had sustained ventricular tachycardia. LGE was present in 43.9% of patients. Presence of LGE in 4 or more segments was associated with VAs with a sensitivity of 73% and specificity of 76% with area under curve of 0.733 in C-statistics.

1. Introduction

Hypertrophic cardiomyopathy (HCM) is a heterogeneous cardiac disease with a diverse clinical manifestation and course, presenting in all age groups from infancy to the very elderly.[1,2] Because late gadolinium enhancement (LGE) is believed to represent myocardial fibrosis or scarring, it has been hypothesized that LGE may represent myocardium prone to ventricular tachyarrhythmia.[3–6] This study sought to correlate segmental wall thickness and LGE seen in cardiac magnetic resonance imaging (cMRI) with occurrence of ventricular arrhythmias (VAs) in patients with HCM.

2. Materials and methods

The present study was a prospective observational study and done in a tertiary care referral centre in South Kerala, India. All consecutive patients with a diagnosis of HCM after the initial clinical examination, 12 lead electrocardiography (ECG) and transthoracic echocardiography (TTE) were evaluated by cMRI. LGE and segmental wall thickness was documented in the standard 17 segment model for left ventricle (LV). A 24-h ambulatory ECG recording was evaluated for presence of sustained or non-sustained ventricular tachycardias (NSVT). NSVT was defined as presence of more than or equal to 3 consecutive ventricular complexes occurring at a rate of more than or equal to 100 beats per minute and lasting for less than 30 s. Such rhythm lasting for more than 30 s was termed sustained ventricular tachycardia. Exclusion criteria included presence of coronary artery disease, documented myocardial infarction in the past, more than 50% stenosis in the epicardial coronaries by angiogram. Patients who were unable to undergo cMRI due to any reason like non MRI compatible prosthesis, claustrophobia, chronic kidney disease (serum creatinine more than 1.4 mg/dl) were also excluded.

2.1. Statistical analysis

All data are presented as mean ± standard deviation. Continuous parameters were compared using a 2-tailed student's *t*-test while Mann–Whitney *U* test was applied for comparing nonparametric data. C statistics with the help of receiver operating characteristic (ROC) curves was used to assess sensitivity and specificity of LGE and segmental wall thickness for prediction of ventricular arrhythmias. All results were considered statistically significant

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when $p < 0.05$. Analyses were performed using Statistical Package for Social Sciences (SPSS for windows 14.0, Chicago, IL, USA).

3. Results

Of the 80 patients screened for the study, 57 patients were available for final analysis. Baseline characteristics of patients are presented in Table 1.The mean LV function was 64.2%. Three patients (5.2%) of 57 had LV ejection fraction less than 50%. VAs were present in 26.3% of total population of which 10.5% had sustained ventricular tachycardia. The sex distribution, age group and presentation was similar in groups with and without VAs. Clinical factors including history of syncope and palpitations were not different in patients with and without ventricular arrhythmias.

3.1. cMRI findings and ventricular arrhythmias

LGE was present in 25 of 57 (43.9%) patients. Most common pattern of enhancement was in the mid myocardial region. LGE was more common in basal anteroseptal and mid anteroseptal and mid inferoseptal segments. There was no LGE in 56.1%, midmyocardial in 33.3%, subendocardial in 7%, subendocardial as well as mid myocardial in 2% and transmural LGE in 2% of patients.

A significant number of patients with LGE (44%) had documented VAs compared with 12.5% of patients without LGE. Around 87% of patients without LGE did not have documented VAs. Conversely, 73.3% of patients with VAs had LGE positivity compared to 33.3% of patients without VAs ($p = 0.007$).

Odds ratio for occurrence of VAs was highest for LGE by cMRI compared to traditional risk factors. Patients with VAs showed LGE in more number of segments compared with patients not having ventricular arrhythmias (6.4 ± 5.8 Vs 2.5 ± 5.1, $p = 0.019$). Generation of ROC curve showed that presence of LGE in ≥ 4 segments was associated with occurrence of ventricular arrhythmias with a sensitivity of 73% and specificity of 76% (Area under curve = 0.733) (Fig. 1). LV wall thickness of more than 22.85 mm predicted sustained or nonsustained ventricular tachycardia with a sensitivity of 53% and specificity of 71% only (Area under curve = 0.612).

There was no statistically significant difference in segmental wall thickness (in any of the 17 segments) in patients with and without ventricular arrhythmias. Segmental wall thickness was similar in patients with and without LGE as well. Three out of 5 patients with maximal Left ventricular wall thickness >30 mm had documented ventricular arrhythmias compared to 12 out of 52 patients with maximal left ventricular wall thickness <30 mm.

4. Discussion

Because LGE in HCM patients is believed to represent myocardial fibrosis or scarring, it has been hypothesized that LGE may represent myocardium prone to VAs.[7–11] The present study was
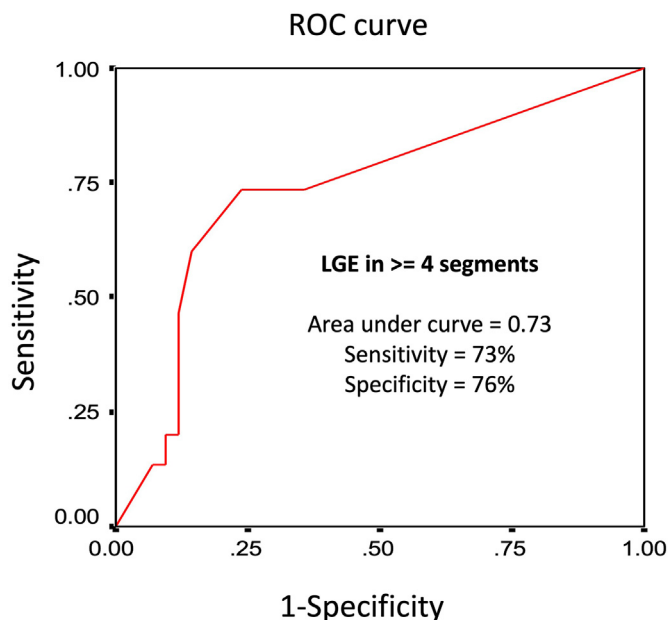

Fig. 1. Receiver operating characteristic curve analysis of late gadolinium enhancement in cardiac segments for prediction of ventricular arrhythmias.

conducted in an Indian Cohort of HCM patients to assess role of LGE in cMRI for prediction of ventricular arrhythmias.

There was no statistical difference between patients with and without sustained or non-sustained ventricular tachycardia with regard to age, sex, presence or absence of symptoms, nature of symptoms, family history of SCD and segmental wall thickness.

The incidence of VAs in LGE positive patients was slightly higher in our study compared to previously published data of (44% vs 27%) which may be explained by referral bias at a tertiary care centre.[12] Absence of LGE was associated with a high negative predictive value of ventricular arrhythmias (87.5%) however, positive predictive value of LGE for VA was low (44%).

Extent of LGE as defined by the number of segments showing this finding was also more in patients with VAs compared to patients without VAs. This finding also lends credence to the hypothesis that VAs are more common in patients with more myocardial fibrosis. Presence of LGE in ≥ 4 segments predicted occurrence of sustained or non-sustained ventricular tachycardia with a sensitivity of 73% and specificity of 76%. This was a better predictor compared to LV wall thickness.

Over the past decade multiple studies have demonstrated the utility of myocardial fibrosis picked up by LGE in CMR as an independent predictor of adverse cardiovascular outcomes including ventricular arrhythmias and SCD. This study, in addition, showed that presence of LGE in 4 or more segments is a good predictor of sustained or non-sustained ventricular tachycardia.

Table 1
Baseline characteristics of patients ($n = 57$).

Characteristic	
Males (n, %)	42 (73.7%)
Age (mean)	42.3 ± 18.4 years
LV function (mean)	64.2%
Obstructive HCM (n)	27
Apical HCM (n)	5
Mean follow-up	12.5 ± 3.98 months
Asymptomatic (%)	17.5%

HCM, hypertrophic cardiomyopathy; LV, left ventricle.

5. Limitations

This is a single centre study conducted in a tertiary care centre. Extent of LGE was correlated according to number of LV segments involved and not according to the amount of myocardium involved. Hard clinical endpoints like cardiac mortality, appropriate ICD shocks etc were not studied in this study.

6. Conclusions

In patients with HCM, presence of LGE in ≥ 4 segments in cMRI predicts occurrence of ventricular arrhythmias with high degree of sensitivity and specificity. Absence of LGE on cMRI carries a high negative predictive value for ventricular arrhythmias.

Declaration of Competing interest

None.

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