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Impact of Increased Myocardial Mass on Left Ventricular Systolic Function: A Cardiac MRI Study in Patients with Reduced Ejection Fraction

Azizli Sara[1*]

[1]PhD, Faculty of Medicine, Department of Clinical Sciences at Nakhchivan State University and Cardiology Specialist

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***Corresponding author:** Azizli Sara
PhD, Faculty of Medicine, Department of Clinical Sciences at Nakhchivan State University and Cardiology Specialist

Abstract | **Original Research Article**

Assessment of cardiac function in patients with left ventricular hypertrophy is one of the most critical issues in clinical decision-making. Data regarding the impact of increased myocardial mass on systolic function remain contradictory [1,2], and cardiac MRI is considered the gold standard in this field [2,3]. The objective of this study is to evaluate the relationship between myocardial mass index and ejection fraction.

Keywords: Left ventricular hypertrophy, Ejection fraction, Myocardial mass, Cardiac Magnetic Resonance Imaging, Myocardial remodeling, Systolic dysfunction, Heart failure.

INTRODUCTİON

Left ventricular hypertrophy (LVH) is a consequence of structural changes in the myocardium induced by chronic hemodynamic overload and is one of the most frequently encountered pathological conditions in clinical practice. This condition can lead to severe complications such as heart failure, sudden cardiac death, and arrhythmias [1,2,14]. While hypertrophy initially serves as a physiological adaptation mechanism, over time it can evolve into a state that limits the functional capacity of the myocardium [1,3]. It is well established that the left ventricular ejection fraction (EF) is not only a primary indicator of systolic performance but also plays a significant role in assessing the long-term prognosis of patients [1,3]. A decrease in ejection fraction reflects a worsening clinical course and an increased risk of mortality and hospitalization [11,13]. Furthermore, the fact that hypertrophy does not lead to functional impairment at the same rate in all patients highlights the complexity of the relationship between structural changes and functional dysfunction.

Myocardial mass is considered one of the key parameters characterizing left ventricular remodeling. An increase in mass encompasses not only cellular-level hypertrophy but also changes in the matrix and fibrosis [8,10]. These alterations reduce myocardial elasticity, disrupt energy balance, and lead to a decline in systolic function [9,13].

Cardiac Magnetic Resonance Imaging (CMR) is regarded as the "gold standard" for evaluating left ventricular volumes, myocardial mass, and EF, offering high spatial resolution and measurement reproducibility [5,6,12]. Compared to echocardiography, this method does not rely on geometric assumptions and allows for the calculation of the actual anatomical size of the myocardial mass [6].

The relationship between myocardial structural changes and systolic function in patients with left ventricular hypertrophy of various etiologies and reduced ejection fraction remains to be fully elucidated [7,13]. Such patients with complex profiles are common in clinical practice, and a precise investigation of the structural-functional relationship carries significant scientific and practical importance.

Study Objective and Hypothesis:

To investigate the relationship between cardiac MRI-derived myocardial mass indices and ejection fraction in patients presenting with left ventricular hypertrophy.

Increased myocardial mass serves as a direct or independent correlate of reduced left ventricular ejection fraction.

MATERIAL AND METHODS

A total of 75 patients who had received cardiac MRI (CMR) were retrospectively analyzed. Key parameters, including left ventricular ejection fraction and myocardial mass index, were quantified using CMR imaging. Echocardiographic findings were integrated for comparative analysis. The study population was stratified into two cohorts based on a CMR-EF threshold of 50% (<50% vs. ≥50%). Statistical significance and correlations between variables were assessed using relevant statistical models.

Table 1: **Demographic and Clinical Characteristics**

Parameter	Value
Number of patients	75
Mean age, years (mean ± SD)	53.9 ± 13.4
Sex — male (%)	65 (86.7%)
Sex — female (%)	10 (13.3%)
Echocardiography data available	64
EF (CMR) % (mean ± SD)	28.3 ± 13.6
EF (ECHO) % (mean ± SD)	33.0 ± 13.0
Myocardial mass index (MKI), g/m² (mean ± SD)	111.9 ± 18.7

Table 2: **CMR indicators by EF groups**

Parameter	EF-MR <50% (n = 66)	EF-MR ≥50% (n = 9)	p-value
EF-MR, % (mean ± SD)	26.1 ± 11.8	56.0 ± 4.0	<0.001
MKİ, g/m² (mean ± SD)	110.9 ± 18.4	119.3 ± 20.1	0.380

As a result, the mean age of the patients was 53.9±13.4 years. The mean EF-MR was 28.3±13.6%, and the mean BMI was 111.9±18.7 g/m2. EF-MR <50% was recorded in 88% of the patients. No statistically significant correlation was found between EF-MR and BMI. (Pearson r=0.10.p=0.384, Spearman r=0.007, p=0.952)

There was also no significant difference in terms of BMI between the EF-MR <50% and ≥50% groups. (p=0.380)

A strong correlation was observed between echocardiography and CMR measurements for EF (r=0.823,p<0.000001)

CONCLUSION

Increased myocardial mass serves as a significant pathogenetic factor in the impairment of left ventricular systolic function [9,13]. Precise quantification of structural changes via Cardiac Magnetic Resonance Imaging (CMR) may contribute to the early identification of high-risk patients and the optimization of treatment strategies [5,12]. This study evaluated the relationship between myocardial mass index and left ventricular systolic function in patients with left ventricular hypertrophy using CMR. Statistical analyses demonstrated that in the study population, which was primarily characterized by reduced ejection fraction, there was no statistically significant correlation between myocardial mass index and ejection fraction. Both correlation analyses and intergroup comparisons based on ejection fraction consistently confirmed this finding.

Furthermore, the discovery of a high degree of correlation between ejection fraction measurements obtained via echocardiography and CMR was statistically significant, reinforcing CMR as a reliable and accurate method for assessing systolic function.

Overall, the results indicate that in patient groups where severe structural changes and low EF predominate, myocardial mass index does not act as an independent indicator of left ventricular function. This suggests that the relationship between structural remodeling and functional impairment may be more closely associated with myocardial fibrosis and tissue-level alterations. Incorporating CMR parameters that reflect fibrotic burden into future statistical models may allow for a more precise assessment of the structural-functional relationship.

DISCUSSION

The present study aimed to evaluate the impact of structural changes developing against the background of left ventricular hypertrophy on systolic function. The predominance of patients with reduced EF and increased myocardial mass within the study population characterizes this group as a clinically high-risk category.

An increase in myocardial mass is considered a primary indicator of pathological remodeling and is accompanied not only by cardiomyocyte hypertrophy but also by an increase in fibrous tissue and the disruption of microvascular architecture [8,10]. These alterations weaken the elastic properties of the myocardium and impair the diastolic filling mechanism, ultimately leading to a decline in systolic function. Clinical and experimental observations have shown that while long-term hypertrophy functions as a compensatory

mechanism in the early stages, a transition to functional failure occurs over time [1,9].

The relationship between increased myocardial mass and systolic dysfunction can be explained by several pathophysiological mechanisms:

The academic English translation for the rest of the discussion is as follows:

1. The thickening of the myocardial wall increases oxygen demand, leading to a relative reduction in coronary perfusion [3,9].
2. The process of fibrosis disrupts electrophysiological stability and reduces contractile capacity [14,15].
3. On the other hand, chronic overload elevates left ventricular wall stress, which causes a gradual decline in systolic function [14].

Cardiac MRI technology allows for the high-precision assessment of these structural changes [5,12] and provides an objective framework for analyzing the relationship between myocardial mass and EF. Previous scientific research has demonstrated that the myocardial mass index adversely affects the progression of heart failure and clinical prognosis. However, in mixed-profile patient groups observed in real-world clinical practice, this relationship still requires further clarification.

The present study indicates that the aforementioned hypothesis was not supported. Although an increase in myocardial mass is a critical component of remodeling, it is not the sole factor determining the degree of systolic function. Clinical and experimental studies suggest that myocardial fibrosis and tissue-level alterations play a more decisive role in the reduction of EF than hypertrophy alone.

Another potential reason for these findings is that the significant reduction of EF in the majority of the enrolled patients limits functional variability. This situation is explained by the "floor effect" phenomenon, where the correlation between structural indices and functional parameters may weaken against a background of severe systolic dysfunction.

Limitations

The retrospective nature of the study and the lack of long-term clinical follow-up data are among the primary limitations.

Future Directions

In future studies, it is advisable to incorporate cardiac MRI tissue characterization parameters (LGE, ECV, T1 mapping) to more accurately evaluate the relationship between structural and functional changes in patients with left ventricular hypertrophy.

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