The role of magnetic resonance imaging in the diagnosis of post-infarction left ventricular aneurysms: a single-center prospective observational study

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Abstract

Introduction. Magnetic resonance imaging allows for the assessment of overall and regional myocardial contractility of the left ventricle, and the use of contrast enhancement evaluates the depth of wall damage, which together serve as important prognostic criteria for the improvement of myocardial contractile function in the postoperative period.

Objective. To determine the diagnostic capabilities of magnetic resonance imaging in post-infarction cardiac aneurysms.

Methods. For inclusion in the prospective observational study, 160 patients with post-infarction heart aneurysms were assessed. Preoperative modeling of the left ventricle cavity was performed on all patients.

Results. Magnetic resonance imaging reliably detects a greater number of segments with impaired kinetic function compared to echocardiography. In the assessment of local contractility using delayed contrast enhancement, a higher number of segments with impaired kinetics were identified. On average, each patient had 4.40 ± 0.95 segments with abnormal kinetics. The average difference in the number of segments amounted to 68 segments [60; 87]. A negative correlation was observed between the depth of myocardial damage and the type of local contractility impairment: as the transmurality index increased, the number of segments with hypokinesis decreased ($r = -0.74$; $p = 0.032$), while the number of segments with akinesis increased ($r = 0.82$; $p = 0.026$). In terms of diagnostic performance, MRI demonstrated superior sensitivity and specificity for diagnosing post-infarction left ventricular aneurysm, with values of 97.6 % and 100 %, respectively, compared to echocardiography, which had sensitivity and specificity values of 68.5 % and 8.3 %, respectively.

Conclusion. Magnetic resonance imaging reliably detects a greater number of segments with impaired kinetic function compared to echocardiography. It allows for the reliable detection of a greater number of segments with kinetic impairment compared to echocardiography. The use of MRI with delayed contrast enhancement increases the informativeness of the method. This technique is safe and does not increase hospital mortality.

Keywords: cardiac magnetic resonance imaging; diagnostic performance; left ventricular aneurysm

Роль магнитно-резонансной томографии в диагностике постинфарктных аневризм левого желудочка: одноцентровое проспективное наблюдательное исследование

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Аннотация

Актуальность. Магнитно-резонансная томография позволяет оценить общую и регионарную сократимость миокарда левого желудочка, а применение контрастного усиления – глубину поражения стенки, что в совокупности является важным прогностическим критерием улучшения сократительной способности миокарда в послеоперационном периоде.

Цель. Определить диагностические возможности магнитно-резонансной томографии при постинфарктных аневризмах сердца.

Методы. Для включения в проспективное наблюдательное исследование методом ультразвукового сканирования и магнитно-резонансной томографии обследовано 160 пациентов с постинфарктной аневризмой сердца. Всем пациентам выполнено предоперационное моделирование полости левого желудочка.

Результаты. Магнитно-резонансная томография позволяет определить большее количество сегментов с нарушением кинетики по сравнению с эхокардиографией. При оценке локальной сократимости при магнитно-резонансной томографии с отсроченным контрастированием определено большее количество сегментов с нарушенным кинезом. В среднем на одного пациента пришлось 4,40 ± 0,95 сегмента с нарушенной кинетикой. Средняя разница по количеству сегментов составила 68 [60; 87]. Выявлена отрицательная корреляционная связь между глубиной поражения миокарда и вариантом нарушения локальной сократимости: с увеличением индекса трансмуральности уменьшается количество сегментов с гипокинезом ($r = –0,74$; $p = 0,032$) и увеличивается количество сегментов с акинезом ($r = 0,82$; $p = 0,026$). При оценке диагностической эффективности магнитно-резонансная томография показала результаты выше по показателю чувствительности и специфичности в диагностике постинфарктной аневризмы левого желудочка – 97,6 и 100 %, а при эхокардиографии показатели составили 68,5 и 8,3 % соответственно.

Заключение. Магнитно-резонансная томография позволяет определить большее количество сегментов с нарушением кинетики по сравнению с эхокардиографией. Применение магнитно-резонансной томографии с отсроченным контрастированием значительно повышает информативность метода. Данный метод является безопасным и не увеличивает госпитальную летальность.

Ключевые слова: аневризма левого желудочка; диагностика аневризмы сердца; магнитно-резонансная томография сердца

Introduction

Despite advances in modern cardiology in the treatment of patients with acute myocardial infarction (MI), a significant group of patients remains in whom a post-infarction left ventricular (LV) aneurysm develops [1; 2], requiring surgical intervention [3]. This cohort of patients presents with a more severe condition [4] compared to uncomplicated coronary artery disease (CAD), as the formation of a post-MI LV aneurysm often occurs against a background of multivessel coronary artery disease [5] and is accompanied by a reduction in LV systolic function [6]. Consequently, this leads to a decline in quality of life and work capacity [7; 8].

The primary method for treating chronic heart failure (CHF) resulting from a post-MI LV aneurysm is currently surgical. Despite the long history of addressing this issue, many questions remain regarding patient selection for surgical treatment. Modern diagnostic methods, particularly cardiac magnetic resonance imaging (MRI), allow for the differentiation of heart wall layers [9] and enable the assessment of global and regional LV myocardial contractility, providing a realistic picture of cardiac functional capacity [10] and the presence of intracardiac thrombi [11]. Furthermore, contrast-enhanced MRI allows for the evaluation of the depth of myocardial scar tissue [12–14], serving as an important prognostic criterion for the improvement of LV myocardial contractile function following revascularization [15]. The primary endpoint of the study was the absolute difference between the predicted (based on modeling) and the actual post-operative end-systolic volume index (ESVi). The sample size calculation was based on the assumption that this difference would be 10 ml/m^2 in the MRI group and 15 ml/m^2 in the echocardiography (Echo) group, i.e., a clinically significant effect of 5 ml/m^2, with a standard deviation of 9 ml/m^2. It was thus calculated that to detect a clinically significant effect, it would be sufficient to include 104 patients in the study (52 in each group). To compensate for incomplete observations, the calculated sample size was increased by 15 %, resulting in a final sample size of 120 patients (60 in each group) with a power of 80 % and a type I error rate of 5 %.

The study consists of two phases. This article is dedicated to the first phase of the study, where 160 patients were screened for eligibility criteria. The results of their Echo and MRI examinations were subsequently used to assess the diagnostic capabilities of these methods in detecting post-MI LV aneurysms. The second phase of the

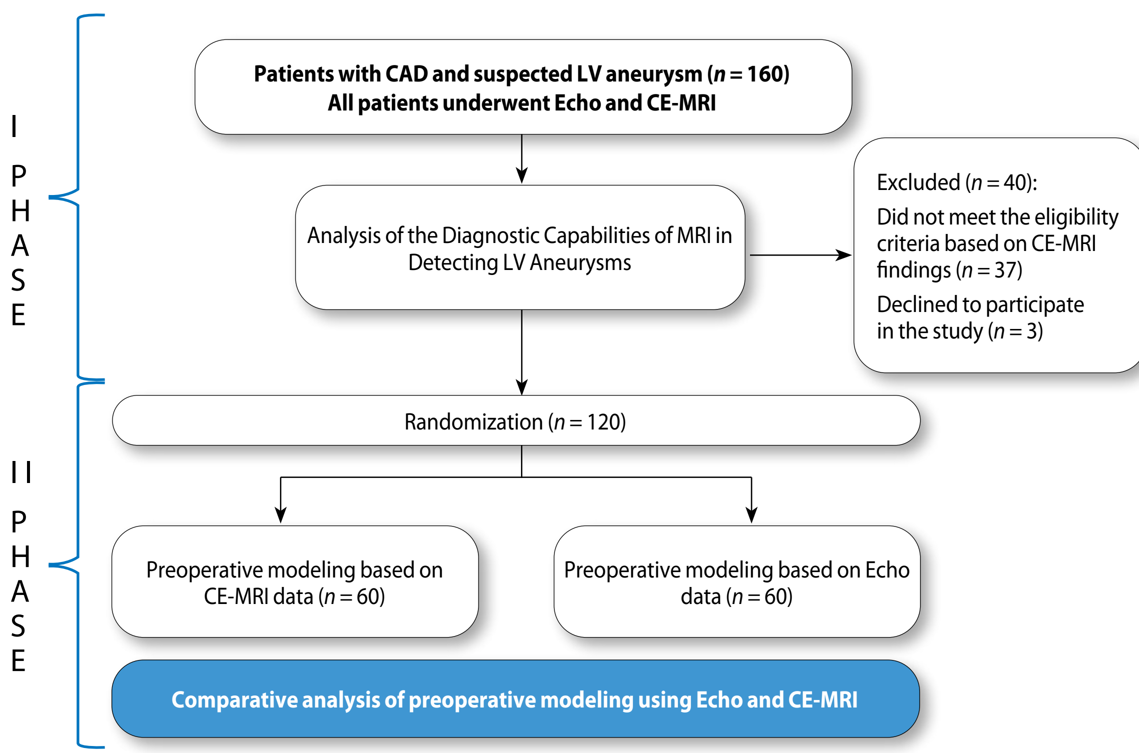

Fig. 1. Flowchart

Note. CAD – Coronary artery disease; CE-MRI – Contrast-enhanced cardiac magnetic resonance imaging; Echo – Echocardiography; LV – Left ventricle.

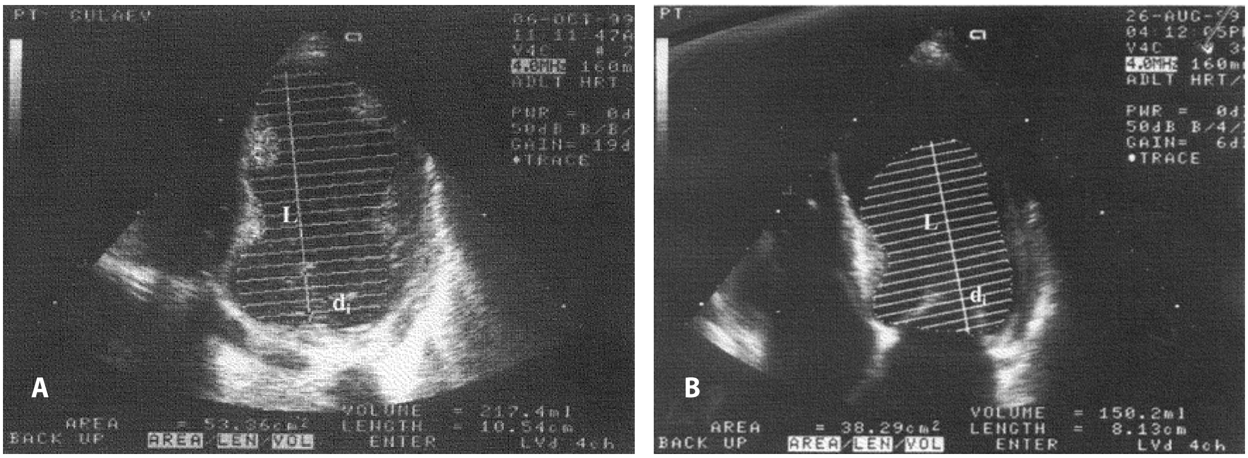

Fig. 2. Stages of preoperative modeling based on echocardiography: A – Determination of left ventricular end-diastolic volume (LV EDV); B – Modeling of LV EDV

study involving patient randomization is not covered in this article.

Objective of the study is to determine the diagnostic capabilities of MRI in detecting post-infarction cardiac aneurysms.

Methods

This was a single-center prospective study. The study subjects were patients with CAD in whom a LV aneurysm was detected by Echo. The study design was based on LV cavity modeling using MRI data, the results of which served as a guide for reducing the LV cavity during surgical intervention. The study consisted of two phases (Fig. 1). In the first phase, 160 patients were screened for eligibility.

Inclusion and Exclusion Criteria

Inclusion criteria for patients were: age between 30 and 75 years (inclusive), presence of coronary artery pathology requiring coronary artery bypass grafting (CABG), a history of myocardial infarction, and impaired regional LV myocardial contractility according to Echo.

Exclusion criteria for patients were: presence of contraindications to MRI (specifically, MR-incompatible pacemakers or other electronic devices previously implanted in patients), and patient refusal to participate in the study. All patients initially underwent Echo, based on which a diagnosis of post-infarction cardiac aneurysm was established. Subsequently, coronary angiography and contrast-enhanced cardiac magnetic resonance imaging (CE-MRI) were performed. Based on the results of Echo and MRI examinations, preoperative LV cavity modeling was performed for all patients. This article does not discuss randomization and its results. The presented results pertain to the initial 160 patients.

Echocardiographic examination was performed using Vivid 7 (General Electric, USA) and Philips iE33 (Philips Healthcare, USA) systems. In the preoperative period, all patients underwent transthoracic echocardiography according to a standard protocol in compliance with the recommendations of the American Society of Echocardiography and the European Association of Echocardiography. The study protocol included the assessment of standard parameters of myocardial pump and contractile function. The examination was conducted with the patient lying in the left lateral decubitus position.

Linear dimensions were measured in the longitudinal view using 2D mode, accounting for changes in shape during systole and diastole. Left ventricular end-diastolic volume (EDV), end-systolic volume (ESV), and ejection fraction (EF) were calculated using Simpson's method in the 4-chamber and 2-chamber views. The cardiac valve apparatus and the presence of intracardiac thrombi were assessed. Analysis of regional LV contractility was performed using the standard 17-segment model. The study protocol recorded the following parameters: left ventricular end-diastolic diameter (EDD, cm), basal-apical dimension (BAD, cm), end-systolic volume (ESV, ml) and end-diastolic volume (EDV, ml), stroke volume index (SVI, ml/m^2), left ventricular ejection fraction (LVEF, %), as well as the thickness of the posterior myocardial wall (cm) and the interventricular septum (cm). The methodology for preoperative modeling based on echocardiographic data is described in detail in the monograph by Chernyavsky A.M. et al., "Reconstructive Surgery of Post-Infarction Left Ventricular Aneurysms" [16]. The essence of the method lies in determining the optimal end-diastolic volume (EDV) (Fig. 2) based on the relationship between

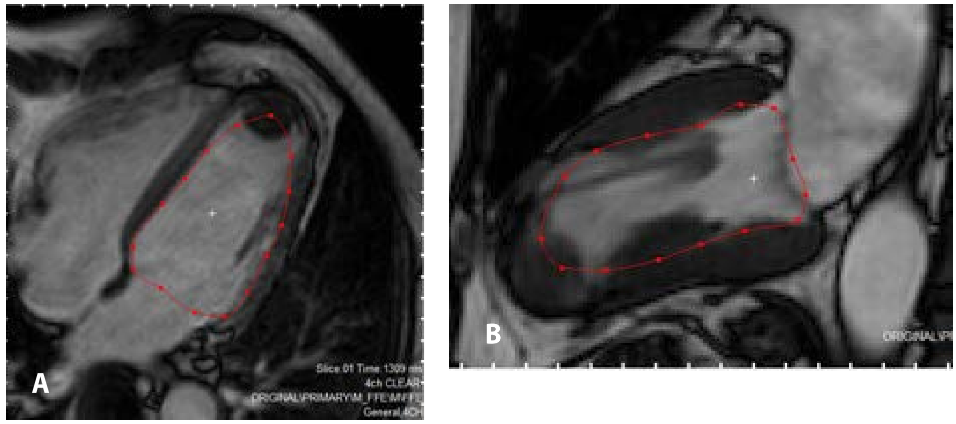

Fig. 3. Stages of preoperative modeling based on MRI:
A – Modeling of left ventricular end-diastolic volume in the 4-chamber view;
B – Modeling of the left ventricular cavity in the 2-chamber view

the stroke volume index and the ejection fraction of the contracting portion of the left ventricle. The permissible resection area of the aneurysmal portion of the LV is calculated as the difference between the original LV cavity area and the area corresponding to the optimal volume determined above.

The extent of CAD was assessed using selective coronary angiography via the Judkins technique, with images stored on digital media. The procedure was performed via a transradial approach by puncturing the right radial artery. The study was conducted using the radiopaque contrast agents “Ultravist-320”, “Visipaque”, or “Omnipaque”. The contrast agent was administered manually directly into the coronary artery ostium, with 5 to 8 ml per injection for each projection. Coronary arteries were visualized in standard projections. For result analysis, angiographically significant stenosis was defined as a narrowing exceeding 70 % of the coronary artery diameter.

MRI was performed according to a standard protocol on a Phillips Achieva 1.5T scanner. A prerequisite for obtaining high-quality data is cardiac synchronization with breath-holding. The MRI study followed a standard program for functional and morphological assessment before and after early and late contrast enhancement using a gadolinium-based contrast agent at a dose of 0.2 ml/kg of patient weight. Following a localizer scan of the chest, functional imaging series using Fiesta-CINE sequences were acquired in standard planes (2-chamber and 4-chamber long-axis views). Subsequently, the contrast agent was administered. Immediately after contrast injection, T1-weighted TSE images were acquired along the 2-chamber and 4-chamber long axes to detect intracavitary thrombotic masses. This was followed by a functional image series using Fiesta-CINE sequences in the 2-chamber short-axis view. At 10–15 minutes post-contrast injection, a series of late gadolinium enhancement images were acquired using a T1-weighted phase-sensitive inversion recovery technique in the short-axis 2-chamber view to identify and quantify the volume of myocardial scar tissue. The original myocardial thickness was taken as 100 %. The degree of contrast enhancement was determined by the ratio of the thickness of the affected myocardium to the total left ventricular wall thickness at that level. The depth of myocardial involvement was categorized as less than 50 %, 50–75 %, and 75–100 %.

MR image analysis included preoperative modeling, performed using MedViso software. The essence of the modeling (Fig. 3) was to maximally exclude zones with 50–75 % and 75–100 % depth of myocardial involvement while achieving the target stroke volume and increasing the LV EF.

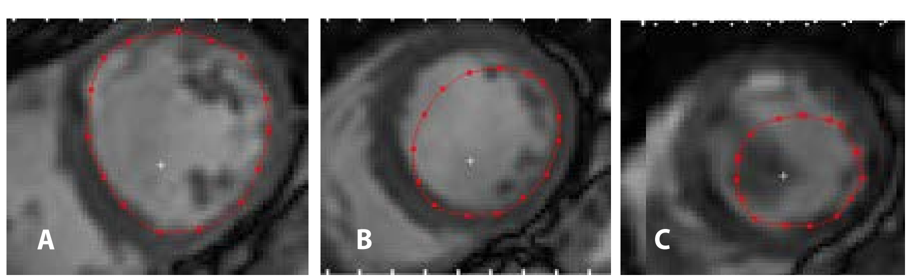

Fig. 4. Preoperative modeling of the left ventricular (LV) cavity in the 2-chamber short-axis view:
A – Modeling at the level of the mitral valve;
B – Modeling at the mid-level of the cardiac long axis;
C – Modeling in the distal portions

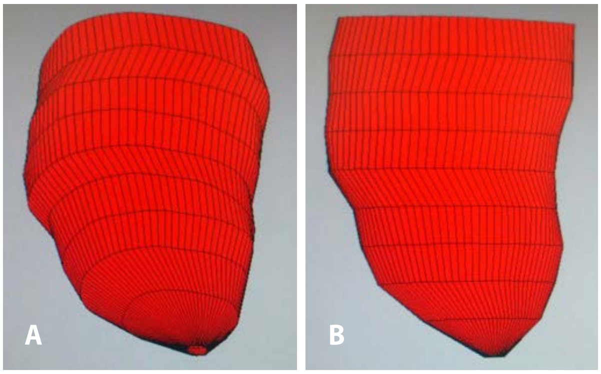

Fig. 5. 3D model of the simulated left ventricular (LV) cavity: A – Physiological orientation; B – Vertical orientation

Adjustment of the planned cavity volume is performed by increasing the LV EDV. If the volumetric and functional parameters of the planned cavity volume are optimal, the inner contour tracing (Fig. 4) is automatically transferred from the 4chamber projection to the 2chamber projection by shifting the coordinate axis.

Subsequently, the inner cardiac contour is projected onto diastolic cine images in the SA-12 program at each level. Thus, on each image, four coordinate points of the planned cavity contour are projected. By tracing these points, a preoperative 3D model (Fig. 5) of the left ventricular diastolic cavity is constructed.

Based on the 3D model, resection points for scar tissue were determined along the anterior, inferior, lateral walls, and the interventricular septum, starting from the level of the mitral valve annulus. These data from the preoperative magnetic resonance imaging modeling serve as a guide for the surgical reconstruction of the left ventricular cavity. Following the modeling phase, 40 patients were excluded from the analysis (37 had no indication for aneurysmectomy and LV cavity reconstruction based on the modeling results, and 3 declined further participation in the study). Thus, the diagnostic capabilities of the MRI method were assessed by analyzing data from 160 patients, while the remaining 120 patients were randomized using the envelope method for the second phase of the study (Fig. 1). The first group (n = 60) comprised patients whose LV cavity reconstruction was guided by preoperative MRI modeling data. The second group (n = 60) comprised patients whose surgical intervention was guided by preoperative echocardiographic modeling data. This article pertains to the first phase of the study, and all calculations were performed based on the initial cohort of 160 patients. The study conforms to the principles of the Declaration of Helsinki. The research protocol was approved (Protocol No. 1, dated 08.10.2014). The following parameters were used to evaluate the efficacy of the MRI method: the number of segments identified with impaired kinetics and the depth of myocardial involvement (transmurality index). The transmurality index was assessed based on the thickness of contrast-enhanced myocardium within each individual segment. Depending on the obtained transmurality index values, patients were categorized into subgroups: values less than 0.5 indicated patients with subendocardial contrast enhancement, while values greater than 0.5 indicated transmural contrast enhancement. To assess the localization of scar tissue and regional wall motion abnormalities, the standardized 17-segment model adapted by Cerqueira M.D. et al. [17] was used.

Statistical Analysis

The diagnostic accuracy of MRI and Echo in detecting post-infarction LV aneurysms was compared by determining their diagnostic characteristics (sensitivity and specificity) relative to the intraoperative diagnosis, which served as the reference standard. Continuous (quantitative) variables were tested for normality using the Kolmogorov-Smirnov test. Depending on the test results, data are presented either as the mean with standard deviation (M ± SD) for normally distributed variables, or as the median with interquartile range (Me [Q1; Q3]) for non-normally distributed variables. Categorical variables are presented as absolute numbers with percentages (n (%)). The direction and strength of the correlation between two quantitative indicators were assessed using Pearson's correlation coefficient (r). The strength of the correlation was evaluated using Chaddock's scale for the absolute value of the correlation coefficient ($|r|$): less than 0.3 – weak; 0.3 to 0.5 – moderate; 0.5 to 0.7 – noticeable; 0.7 to 0.9 – high; 0.9 to 0.99 – very high. The direction of the correlation was considered positive if $r > 0$ and negative if $r < 0$. The statistical significance of the correlation coefficient was tested using Student's t-test. A correlation was considered statistically significant at $p < 0.05$. Statistical analysis was performed using R software (R Core Team, 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: https://www.R-project.org/).

Results

The study included 160 patients diagnosed with post-infarction cardiac aneurysm based on Echo. The vast majority of patients were male (86.9 %); the mean age was 59 ± 9 years; the time since the last coronary event was 11.5 ± 8 months; angina pectoris of functional class III was present in 63 % of cases (101 patients); heart failure of

Table 1. Clinical, demographic, and functional characteristics of the patients

Parameter	Result	
	Echo-cardiography (Biplane)	Cardiac MRI
Sex		
Male, *n* (%)	139 (86.9)	
Female, *n* (%)	21 (13.1)	
Age, years	59 ± 9	
Body Mass Index (BMI), kg/m²	29.8 ± 4	
Angina pectoris functional class	3 [2; 3]*	
Heart failure functional class	3 [2; 3]*	
LV End-Diastolic Volume, ml	197 ± 45	245 ± 49
LV End-Diastolic Volume Index (EDVi), ml/m²	98 ± 21	126 ± 27
LV End-Systolic Volume, ml	116 ± 37	177 ± 47
LV End-Systolic Volume Inde, ml/m²	61 ± 18	92 ± 25
LV Ejection Fraction, %	39 ± 6	27 ± 6
Posterior Wall Thickness, cm	1.1 ± 0.2	0.9 ± 0.2
Interventricular Septum Thickness, cm	1.2 ± 0.3	1.1 ± 0.2

Note. Data are presented as mean ± standard deviation or as median [interquartile range; Q1; Q3] (*). BMI – Body Mass Index; EDVi – End-Diastolic Volume Index; ESVi – End-Systolic Volume Index; FC – Functional Class; IVS – Interventricular Septum; LV – Left Ventricle.

NYHA functional class II and III was identified in 40 (25 %) and 117 (73 %) patients, respectively. Among comorbidities, arterial hypertension and atherosclerosis of the brachiocephalic arteries were the most frequently observed. All patients underwent both echocardiography and MRI (Table 1). According to echocardiography, mitral regurgitation was grade II in 50 % of cases and grade III in 38 % of cases.

Table 2. Number of segments with impaired regional contractility

Type of Kinetic Abnormality	Number of Segments		Number of Mismatches
	Echo	MRI	
Hypokinesis, *n* (%)	203 (7.5)	259 (9.5)	56
Akinesis, *n* (%)	237 (8.7)	276 (10.1)	39
Dyskinesis, *n* (%)	137 (5.0)	179 (6.6)	42
Total	577 (21.2)	714 (26.3)	137

Note. Echo – echocardiography; MRI – magnetic resonance imagining. Percentages are calculated from the total number of myocardial segments analyzed (*n* = 2720; 160 patients × 17 segments).

According to coronary angiography results, three-vessel coronary artery disease was identified in 59 (36.9 %) patients, two-vessel disease in 57 (35.6 %) patients, and single-vessel disease in 42 (25.3 %) patients. Two patients (1.2 %) had no angiographically significant coronary artery lesions. Among the entire cohort, 16 (10 %) patients had a stenosis of the left main coronary artery exceeding 50 %. When angiographically significant stenosis involved a single vessel, it invariably affected the left anterior descending artery. In cases of two-vessel disease, angiographically significant stenosis involved the left anterior descending and circumflex arteries in 35 % of cases (20 patients), or the left anterior descending and right coronary arteries in 65 % of cases (36 patients), with one exception. In that single case, no significant left anterior descending artery lesion was found, and stenosis was present in the circumflex and right coronary arteries. A comparison of regional wall motion abnormality data between echocardiography and MRI revealed that MRI identified a greater number of segments with impaired contractility, including those with hypokinesis and akinesis (Table 2). On average, MRI detected 4.4 ± 0.95 segments with abnormal kinetics per patient. The mean difference in the number of segments was 68 segments [60; 87].

MRI with contrast enhancement revealed a statistically significant correlation between the depth of myocardi-

Table 3. Correlation analysis between the depth of myocardial involvement and regional wall motion abnormalities

Type of Wall Motion Abnormality	Transmurality Index by Thickness		Pearson's Correlation Coefficient (*r*)	*p*-value for Pearson's Correlation
	<0.5 (*n* = 143)	>0.5 (*n* = 17)		
Hypokinesis, *n* (%)	230 (8.5)	29 (1.1)	–0.73	0.032
Akinesis, *n* (%)	208 (7.6)	68 (2.5)	0.81	0.026

Note. Percentages indicate the proportion of segments relative to the total number of segments analyzed.

Table 4. Concordance rate between ultrasound-based preoperative and intraoperative diagnoses in post-infarction left ventricular aneurysm

Study method	Indication for LV cavity reconstruction	Surgery performed		Total observations
		Not performed	Performed	
Echocardiography	Surgery not indicated, *n* (%)	3 (2)	39 (24)	42
	Surgery indicated, *n* (%)	33 (21)	85 (53)	118
Total		36	124	160

al involvement and the type of regional wall motion abnormality (Table 3).

We identified a negative correlation between these parameters: as the transmurality index by thickness increased, the number of segments with hypokinesis decreased (Pearson's correlation coefficient $r = -0.73$; $p = 0.032$), and the number of segments with akinesis increased ($r = 0.81$; $p = 0.026$). Consequently, regional wall motion abnormality shows a statistically significant dependence on the transmurality index. Subsequently, an assessment of the diagnostic capabilities of both methods was conducted in patients with a post-infarction cardiac aneurysm. The concordance rate between the preoperative and intraoperative diagnoses was evaluated to address the question of the necessity, appropriateness, and planning of surgical intervention for LV aneurysm. The preoperative decision was based on modeling data and the calculated projected volumetric-functional parameters [16].

As shown in Table 4, surgery (aneurysmectomy with LV reconstruction) was performed in only 85 out of 118 cases (72 %) where it was indicated based on echocardiography. Conversely, in 92 % of cases (39 out of 42) where surgery was deemed not indicated by preoperative modeling, LV cavity reconstruction surgery was ultimately performed based on intraoperative findings. Considering these data, it can be concluded that echocardiography alone cannot provide a definitive answer regarding the necessity of surgical intervention for post-infarction LV aneurysm. In cases where surgery was indicated but not performed, the decision was made intraoperatively by the operating surgeon. A similar assessment was conducted for the concordance rate between preoperative and intraoperative diagnoses using contrast-enhanced cardiac MRI.

As seen in Table 5, all 120 patients (100 %) with indications for LV aneurysm repair based on preoperative modeling using MRI results underwent LV cavity reconstruction surgery. Only in 3 cases (7.5 %) out of 40, where surgery was not indicated by preoperative modeling results, was LV cavity reconstruction surgery nevertheless performed based on intraoperative findings. In cases where surgery was not initially indicated but was ultimately performed, the decision was made intraoperatively by the operating surgeon. By combining the data from Tables 4 and 5, we obtain a contingency table of true and false diagnostic results for post-infarction LV aneurysms using the two imaging methods.

Based on the data from Table 6, the sensitivity and specificity of the two methods for diagnosing post-infarction cardiac aneurysms and determining the indications for left ventricular cavity reconstruction were determined.

For both metrics, MRI demonstrated superior results, attributed to the objective visualization of all cardiac structures and the assessment of the extent of myocardial scar tissue. In a similar manner, the diagnostic accura-

Table 5. Concordance rate between preoperative tomographic (MRI-based) and intraoperative diagnoses in post-infarction left ventricular aneurysm

Study Method	Indication for LV cavity reconstruction	Surgery performed		Total observations
		Not Performed	Performed	
Contrast-Enhanced MRI	Surgery not indicated, *n* (%)	37 (23)	3 (2)	40
	Surgery indicated, *n* (%)	0	120 (75)	120
Total		37	123	160

Note. Based on the data, contrast-enhanced MRI demonstrated a significantly higher concordance with intraoperative decisions, correctly identifying cases where surgery was not needed and providing strong agreement when it was indicated.

Table 6. Objective parameters of the diagnostic value of echocardiographic and magnetic resonance imaging methods for post-infarction left ventricular aneurysms

Characteristic	Interpretation of Result	Imaging Method	
		Echocardiography	Magnetic Resonance Imaging
Sensitivity (Se)	True Positive (TP)	85	120
	False Negative (FN)	39	3
Specificity (Sp)	True Negative (TN)	3	37
	False Positive (FP)	33	0
Total Observations		160	160

Note. Sensitivity and specificity were calculated using intraoperative findings as the reference standard. TP: Surgery indicated by imaging and performed; FN: Surgery indicated by imaging but not performed; TN: Surgery not indicated by imaging and not performed; FP: Surgery not indicated by imaging but performed.

cy of the two imaging methods was evaluated regarding the detection of intracardiac thrombi, and their diagnostic performance in visualizing intracardiac masses was calculated.

Based on the obtained data, the diagnostic accuracy of the two methods for visualizing intracardiac masses was calculated.

The accuracy of magnetic resonance imaging in visualizing intracardiac masses is superior compared to echocardiography. This is attributed to the clear visualization of all cardiac structures, including the apex, where blood flow stasis most frequently occurs against the backdrop of post-infarction LV aneurysm formation, thereby promoting the development of mural thrombi. For both metrics, MRI demonstrated superior results: sensitivity of 94.9 % versus 78 % for Echo, and specificity of 98.4 % versus 91.5 %, respectively. At the same time, the frequency of detecting intracardiac thrombi was comparable: 50.6 % by Echo and 48.1 % by MRI. However, the rate of false-negative results in detecting intracardiac thrombi was two times lower for MRI compared to Echo, at 8.1 % versus 16.3 %, respectively.

Table 7. Accuracy of echocardiography and magnetic resonance imaging methods in diagnosing post-infarction cardiac aneurysms, %

Diagnostic Metric	Echocardiography	Magnetic Resonance Imaging
Sensitivity	68.5	97.6
Specificity	8.3	100

Note. Sensitivity and specificity were calculated using intraoperative findings as the reference standard for determining the need for left ventricular cavity reconstruction.

Discussion

MRI demonstrates high diagnostic accuracy, defined by its sensitivity and specificity, in detecting heart disease [18]. Cardiac MRI with late gadolinium enhancement significantly aids in assessing myocardial structure [19; 20], especially against the backdrop of changes in the anatomical shape and size of cardiac chambers [21] and variations in myocardial thickness across different regions [22]. This study evaluated the diagnostic capabilities,

Table 8. Concordance rate between preoperative and intraoperative findings in the diagnosis of intracardiac thrombi

Cardiac Imaging Method	Preoperative Imaging Result for LV Thrombus	Intraoperative Finding of Intracardiac Thrombus	
		Present	Absent
Echocardiography	Present	67	14
	Absent	26	53
Magnetic Resonance Imaging	Present	66	11
	Absent	13	70

Table 9. Accuracy of echocardiography and magnetic resonance imaging in the diagnosis of intracardiac thrombosis, %

Diagnostic Metric	Echocardiography	Magnetic Resonance Imaging
Sensitivity	78.0	94.9
Specificity	91.5	98.4

imaging accuracy, sensitivity, and specificity of MRI for a specific nosological form of CAD: post-infarction LV aneurysm. The obtained data on the depth and extent of scar tissue allowed for a correlation analysis with the types of myocardial kinetic abnormalities. This information is extremely important in managing a patient with a post-infarction cardiac aneurysm and aids in selecting the optimal treatment strategy. The diagnostic efficacy of the method for CAD, which encompasses several nosological forms, has been assessed by several authors in large patient cohorts [23; 24]. In these studies, diagnostic efficacy was evaluated for visualizing the cause of exertional angina [25], acute myocardial infarction [26], and post-infarction cardiosclerosis [27], without specifically isolating a group of patients with post-infarction LV aneurysm. Nevertheless, the reported results for sensitivity and specificity in diagnosing post-infarction cardiosclerosis are comparable to our findings, at 93.2 % and 98.5 %, respectively.

In clinical practice, MRI is used as an adjunctive diagnostic method in complex cases, such as the development of heart failure in the context of a post-infarction cardiac aneurysm, to assess myocardial viability. However, considering the high sensitivity and specificity of MRI in diagnosing post-infarction LV aneurysms demonstrated in our study, we propose that this method be considered primary in the decision-making process regarding surgical intervention for LV cavity reconstruction. A definitive decision following contrast-enhanced MRI is facilitated by its clear visualization of cardiac structures, which is crucial for planning the extent of surgical intervention. It is important to note here that all patients included in this study underwent initial screening using ultrasound as the primary cardiac imaging method. Therefore, from a statistical standpoint, claiming an absolute advantage of cardiac MRI is not entirely accurate – this refers only to a limited cohort of patients in whom the initial suspicion of a cardiac aneurysm and intracardiac thrombus was raised by ultrasound.

Thus, our findings allow us to recommend contrast-enhanced cardiac MRI as an essential component of the preoperative evaluation for patients with post-infarction cardiac aneurysm undergoing surgical LV cavity reconstruction. The results of the study should be interpreted considering its limitation in the form of a relatively small sample size.

Conclusion

In patients with a history of myocardial infarction, contrast-enhanced cardiac MRI, applied following initial ultrasound screening, demonstrated advantages in diagnosing post-infarction changes. Compared to echocardiography, it showed higher sensitivity and specificity in detecting both aneurysms and intracavitary thrombi and identified a greater number of segments with impaired regional contractility. Furthermore, the method is safe and does not increase in-hospital mortality.

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