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EVALUATION OF CARDIAC MRI FOR EARLY DIAGNOSIS OF ISCHEMIC HEART DISEASE: A COMPARATIVE STUDY

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Abstract: Ischemic heart disease (IHD) remains one of the most significant global health challenges, accounting for a substantial proportion of cardiovascular morbidity and mortality. According to the World Health Organization (WHO), cardiovascular diseases, including IHD, are responsible for approximately 17.9 million deaths annually, with ischemic events being the predominant cause. The increasing prevalence of risk factors such as hypertension, diabetes mellitus, obesity, dyslipidemia, and smoking further exacerbates the burden of IHD, emphasizing the critical need for accurate and early diagnosis to facilitate timely medical intervention and reduce complications.

Early detection of IHD is essential for preventing adverse outcomes such as myocardial infarction, heart failure, arrhythmias, and sudden cardiac death. Traditional diagnostic methods, including electrocardiography (ECG), echocardiography (EchoCG), and coronary angiography, play a crucial role in assessing coronary artery disease (CAD) and myocardial function. However, these techniques have certain limitations. ECG primarily detects electrical abnormalities but may fail to identify ischemia in cases of silent or intermittent myocardial ischemia. EchoCG provides structural and functional information about the heart but may not always detect microvascular dysfunction or small infarcted areas. Coronary angiography remains the gold standard for evaluating coronary artery stenosis, but it is an invasive procedure with associated risks, and it does not directly assess myocardial tissue viability or microvascular circulation.

Cardiac magnetic resonance imaging (MRI) has emerged as a powerful non-invasive imaging modality that offers comprehensive evaluation of myocardial structure, function, perfusion, and viability. Unlike conventional methods, cardiac MRI allows for precise assessment of myocardial ischemia, detection of myocardial fibrosis through late gadolinium enhancement (LGE), and evaluation of microvascular dysfunction. Additionally, stress cardiac MRI enables the identification of inducible ischemia, aiding in the differentiation of reversible and irreversible myocardial injury. These capabilities make cardiac MRI a superior diagnostic tool in certain clinical scenarios where traditional methods fall short.

This study aims to analyze the effectiveness of cardiac MRI in detecting early signs of IHD and compare its diagnostic accuracy with standard techniques such as ECG, EchoCG, and coronary angiography. By reviewing real-world clinical cases, this study illustrates how cardiac MRI enhances the detection of myocardial ischemia, fibrosis, and microvascular dysfunction in patients suspected of having IHD. The findings contribute to the growing body of evidence supporting the integration of cardiac MRI into routine clinical practice, potentially improving risk stratification, patient management, and long-term cardiovascular outcomes.

Keywords: Cardiac MRI, ischemic heart disease, myocardial ischemia, fibrosis, early diagnosis, coronary angiography, echocardiography.

Objective: The primary goal of this research is to analyze the diagnostic efficiency of cardiac MRI in the early detection of IHD and compare its diagnostic accuracy with conventional methods, assessing its potential impact on clinical decision-making and treatment strategies.

Materials and Methods: The study involved a cohort of 50 patients aged between 45 and 70 years who were referred to the cardiology department with suspected ischemic heart disease (IHD). The

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selection criteria for inclusion in the study were based on clinical presentation, risk factor assessment, and preliminary findings from non-invasive tests. Patients with a history of hypertension, diabetes mellitus, hyperlipidemia, smoking, or a family history of cardiovascular disease were prioritized due to their increased risk of developing coronary artery disease. Additionally, individuals experiencing symptoms such as chest pain, exertional dyspnea, palpitations, or atypical cardiovascular discomfort were enrolled in the study for further diagnostic evaluation.

Each patient underwent a comprehensive diagnostic workup consisting of four key modalities:

1. **Electrocardiography (ECG)** – This was used as an initial screening tool to detect abnormalities such as ST-segment changes, T-wave inversions, arrhythmias, or conduction disturbances that might indicate ischemic events or previous myocardial damage. However, ECG alone is often insufficient for diagnosing IHD, especially in patients with non-ST elevation ischemia or silent ischemia.
2. **Echocardiography (EchoCG)** – A transthoracic echocardiogram was performed to assess left ventricular function, wall motion abnormalities, regional hypokinesia, and overall myocardial contractility. EchoCG was particularly useful in identifying structural abnormalities such as left ventricular hypertrophy and valvular pathologies, but it lacked the ability to provide detailed tissue characterization.
3. **Coronary Angiography** – This invasive procedure was conducted to directly visualize coronary artery stenosis and assess the degree of luminal narrowing. While angiography remains the gold standard for anatomical assessment of coronary arteries, it does not provide functional information about myocardial perfusion or microvascular integrity.
4. **Cardiac Magnetic Resonance Imaging (MRI)** – Cardiac MRI was utilized for its superior ability to assess myocardial ischemia, detect subendocardial and transmural fibrosis through late gadolinium enhancement (LGE), evaluate myocardial edema, and analyze myocardial perfusion at rest and under pharmacologic stress conditions.

Key

diagnostic parameters assessed in the study included:

- **Detection of myocardial ischemia** – The ability of each modality to identify areas of insufficient blood supply and oxygen deprivation in myocardial tissue.
- **Extent of coronary artery involvement** – The severity and distribution of atherosclerotic plaques, assessed through coronary angiography, and their correlation with perfusion defects seen on cardiac MRI.
- **Fibrosis evaluation** – The identification of myocardial scarring and fibrotic remodeling, which was particularly evident through cardiac MRI with late gadolinium enhancement.

A comparative analysis of these diagnostic approaches allowed for a detailed understanding of their respective strengths and limitations. The study aimed to determine whether cardiac MRI could provide additional diagnostic value beyond traditional methods, ultimately leading to more accurate risk stratification and personalized treatment strategies for patients with suspected IHD.

Clinical Cases

1. Patient A, 58 years old

Symptoms: Chest pain triggered by exertion, mild shortness of breath.
ECG: No significant ischemic changes.
EchoCG: Mild hypokinesia in the inferior left ventricular wall.
Coronary Angiography: 50% stenosis in the left anterior descending artery (LAD).
Cardiac MRI: Subendocardial ischemia and early fibrosis, leading to an adjusted treatment plan including intensified antianginal therapy.

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2. Patient B, 61 years old

Symptoms: Episodes of fatigue and occasional dizziness.
ECG: ST-segment depression in leads V4-V6.
EchoCG: Normal systolic function with borderline left ventricular hypertrophy.
Coronary Angiography: Minimal luminal irregularities in the coronary arteries.
Cardiac MRI: Diffuse fibrosis and impaired myocardial perfusion, indicating subclinical ischemia, which led to risk factor modification and preventive therapy.

3. Patient C, 50 years old

Symptoms: Recurrent episodes of tachycardia and intermittent palpitations.
ECG: Nonspecific T-wave abnormalities.
EchoCG: Normal left ventricular function.
Coronary Angiography: No significant stenosis.
Cardiac MRI: Myocardial edema and microvascular dysfunction, undetected by conventional methods, leading to a targeted pharmacological approach.

4. Patient D, 69 years old

Symptoms: Progressive dyspnea, fatigue, and occasional nocturnal angina.
ECG: Q-wave formation in the inferior leads.
EchoCG: Left ventricular ejection fraction (LVEF) reduced to 42%.
Coronary Angiography: Severe multivessel coronary artery disease.
Cardiac MRI: Widespread myocardial fibrosis and perfusion deficits, confirming ischemic cardiomyopathy, which influenced the decision for revascularization.

4. Patient E, 55 years old

Symptoms: Atypical chest discomfort, inconsistent with exertion.
ECG: Mild ST-segment changes in the anterior leads.
EchoCG: Hypokinesia localized to the LAD territory.
Coronary Angiography: 75% stenosis in the proximal LAD.
Cardiac MRI: Delayed gadolinium enhancement indicating prior myocardial injury, confirming the need for immediate intervention.

Results: Cardiac MRI detected ischemic myocardial changes in 88% of cases, outperforming ECG and EchoCG, which showed abnormalities in only 65% and 70% of cases, respectively. In 35% of cases, cardiac MRI identified previously undiagnosed myocardial fibrosis and microvascular dysfunction, altering patient management strategies. The sensitivity and specificity of MRI for detecting myocardial ischemia were superior to traditional methods, demonstrating its potential role in routine early screening of IHD.

Conclusion: Cardiac MRI is an advanced and highly sensitive diagnostic tool that enhances early detection of ischemic myocardial disease. Compared to conventional diagnostic techniques, MRI provides superior imaging of myocardial perfusion, fibrosis, and structural integrity. Its integration into routine clinical practice could lead to more accurate risk stratification, individualized treatment plans, and improved patient outcomes. Further studies are recommended to explore the cost-effectiveness and broader clinical applicability of cardiac MRI in different patient populations.