OVERVIEW OF PERCUTANEOUS CORONARY INTERVENTION OF RIGHT CORONARY ARTERY ON RIGHT VENTRICULAR FUNCTION AFTER ACUTE INFERIOR MYOCARDIAL INFARCTION

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Abstract

Background: Myocardial infarction (MI) was previously thought to be a disease affecting mainly the left ventricle. Right ventricular infarction was just a pathological entity. Several authors had recognized the presence of the right ventricular (RV) dysfunction of acute MI but little attention was paid to its clinical significance. The relevance of RV function, is poorly defined in post-AMI patients. The involvement of the RV during inferior AMI has been defined as a strong predictor of major complications and in-hospital mortality that often more than 25% compared to patients without RV involvement. Percutaneous coronary intervention (PCI), known as coronary angioplasty, is a nonsurgical technique for treating obstructive coronary artery disease This article aimed to review the percutaneous Coronary Intervention of right coronary artery on right ventricular function after acute inferior myocardial infarction.

Keywords: Myocardial Infarction; Percutaneous Coronary Intervention; Right Ventricular Function

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Introduction

Myocardial Infarction (MI) is defined as death or necrosis of myocardial cells. It is a diagnosis at the end of the spectrum of myocardial ischemia or acute coronary syndromes. Myocardial infarction occurs when myocardial ischemia exceeds a critical threshold and overwhelms myocardial cellular repair mechanisms designed to maintain normal operating function and hemostasis. An estimated 7.2 million deaths per year worldwide are due to ischemic disorders of the heart **(1)**.

Inferior wall myocardial infarction (MI) occurs from a coronary artery occlusion with resultant decreased perfusion to that region of the myocardium. Unless there is timely treatment, this results in myocardial ischemia followed by infarction. In most patients, the inferior myocardium is supplied by the right coronary artery. In about 6-10% of the population, because of left dominance, the left circumflex will supply the posterior descending coronary artery. Approximately 40% of all MIs involve the inferior wall. Traditionally, inferior MIs have a better prognosis than those in other regions, such as the anterior wall of the heart. The mortality rate of an inferior wall MI is less than 10%. However, several complicating factors that increase mortality, including right ventricular infarction, hypotension, bradycardia heart block, and cardiogenic shock **(2)**.

Patients with acute coronary syndrome may present with either ST segment elevation myocardial infarction (STEMI), Non-ST segment elevation myocardial infarction (NSTEMI) or unstable angina. These conditions share common pathophysiological mechanisms related to coronary plaque instability (erosion or rupture), thrombosis and vasospasm, resulting in either sub-endocardial or transmural ischemia **(3)**.

Although isolated RV infarction had been described in autopsy reports as less than 3% of all acute myocardial infarction. The incidence of right ventricular infarction associated with inferior wall myocardial infarction has been shown to be as high as 30% **-** 50% **(4).** It has also been shown that RV infarction occurs exclusively in association with IWMI or infero-posterior myocardial infarction **(5)**.

Because of the rich perfusion of RV from both the right and left coronary systems, this results in a relatively small number of RVMIs, with the majority of the myocardium remaining viable even in the absence of reperfusion. However, Recovery from RV myocardial impairment (mainly linked to stunning or hibernation) may be rather slow and is associated with a high rate of in-hospital mortality **(6).**

Diagnosis of RVMI:

It is essential to consider the diagnosis of RVMI, particularly in the presence of an inferior wall MI. The typical triad observed on physical examination is hypotension occurring with jugular vein distention and clear lung fields. The presence of preserved left ventricular (LV) function also helps confirm the diagnosis **(7).**

A tricuspid regurgitation (TR) murmur, Kussmaul’s sign (an increase in inspiratory central venous pressure, visible as jugular vein distention) and pulsus paradoxus are signs of significant hemodynamic compromise due to RV ischemia. In some cases, these manifestations are not present on admission and do not occur until diuretics or nitrates are administered **(8).**

Electrocardiography:

Because RVMIs are usually associated with IWMIs, evaluation using standard 12-lead electrocardiography (ECG) often reveals corresponding ST segment elevations in leads II, III and aVF. Disproportionate ST segment elevation with greater ST elevation in lead III than in lead II is pathognomonic for an RVMI, and RV involvement should be considered **(9).**

Because standard 12-lead ECG images mainly assess the LV, right-sided precordial leads should always be used. These can show ST segment elevation across the entire right precordium from V1R through V6R; a sole ST segment elevation in lead V4R >1.0 mm is a reliable indicator of an RV infarction **(Fig. 1)**, with 100% sensitivity, 87% specificity and 92% predictive accuracy**.** Furthermore, higher ST segment elevations in V4R have been found to be independent predictive factors for more significant RV dysfunction and higher mortality rates **(10).**

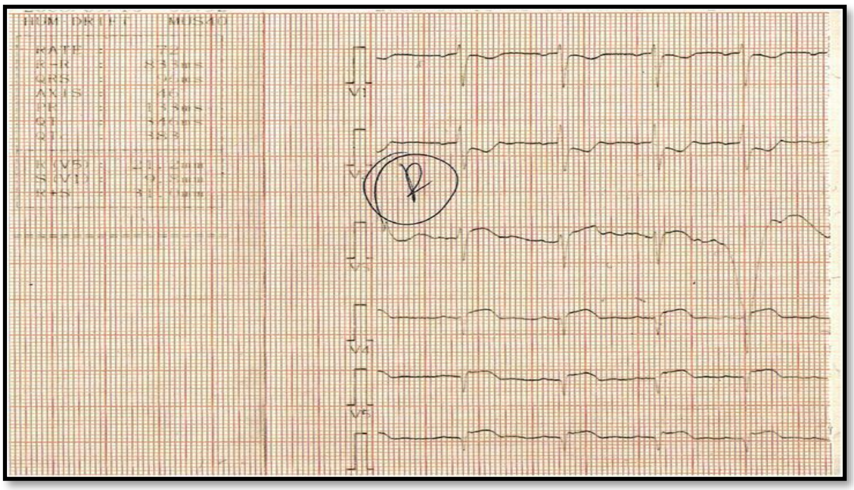

Figure (1): Electrocardiogram showing right-sided precordial leads and V3-V6 ST segment elevation in a patient with right ventricular myocardial infarction [10].

Echocardiography:

Major progress has been achieved in echocardiography and radionuclide techniques; these modalities revealed that RV involvement may be account for as much as 59% of the patients with IWMI at the initial presentation**.** In particular, echocardiography is a widely available and inexpensive tool for the evaluation of the size and function of the right ventricle **(11)**.

However, echocardiographic imaging of the RV has technical challenges due to the chamber's complex shape; the RV cannot be completely visualized in any single two-dimensional (2D) echocardiographic view. Furthermore, although RV infarction inherently complicates the initial management in cases of acute infarction, echocardiographic abnormalities can be temporary and resolve within a few hours**.** Therefore, information from all available Echo windows is necessary for the complete assessment of the RV **(Fig. 2)**. Although not validated in acute situations, three-dimensional (3D) echocardiographic RV volumes are comparable to those derived by CMR and are probably more accurate than 2D echocardiographic volumes **(10)**.

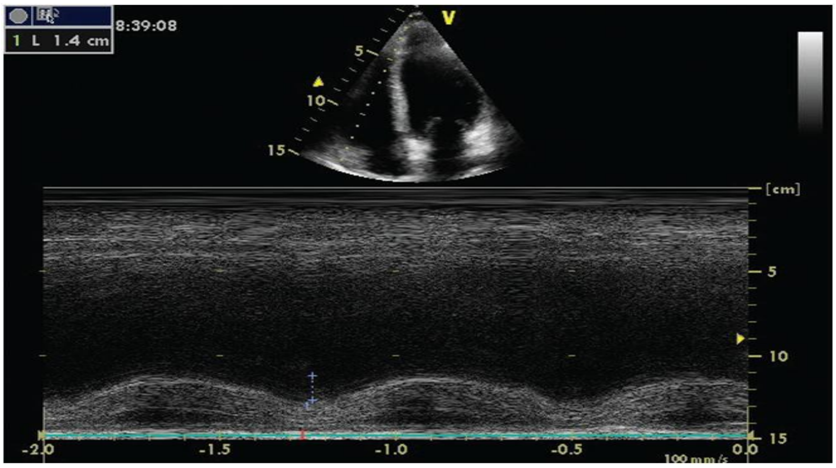

Figure (2): Right ventricle systolic dysfunction, estimated using tricuspid annular plane systolic excursion (TAPSE) method echocardiograph [10].

Coronary angiography:

Angiography usually reveals occlusion of the right coronary artery (RCA) proximal to the acute marginal branch**,** while more proximal occlusions usually suggest more extensive necrosis of the posterior and, potentially, the anterior RV myocardial wall**.** In patients with left coronary artery dominance, a left circumflex coronary artery (LCX) occlusion may also be found. Although being rare, RV involvement may be present in patients with an occlusion in the left anterior descending artery **(Fig. 3).** A previous study indicated that 97 hearts with anterior MIs and found that 13% of them were also associated with RVMIs **(12)**.

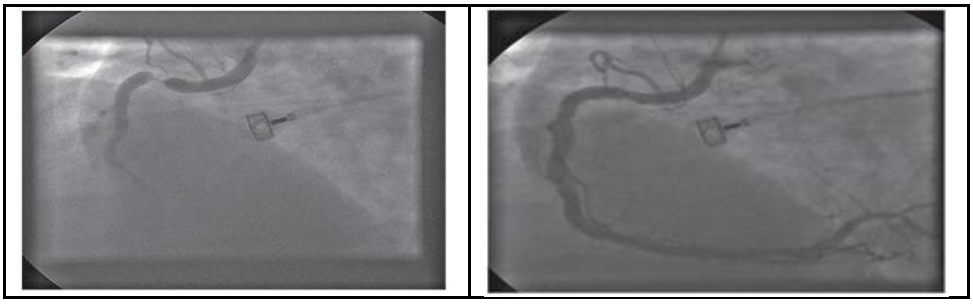

Figure (3): Angiogram showing the right coronary artery before (**left**) and after **(right)** revascularization **[10].**

The common complications including LV ischemic dysfunction, cardiogenic shock, inter-ventricular septal rupture, RV papillary muscle ruptures and tricuspid regurgitation that required emergency surgical repair **(13)**.

Percutaneous coronary intervention of RCA on RV function after acute inferior myocardial infarction

The prognosis of patients after acute myocardial infarction (AMI) is determined by the interaction of a large number of factors. Besides the importance of clinical parameters, several studies have described the use of 2D echocardiography for the identification of patients who are at risk of adverse outcome. These investigations revealed that the presence of left ventricular (LV) dysfunction, on 2D echocardiography shortly after AMI, is one of the most important prognostic parameters. Therefore, noninvasive assessment of LV function has become essential for post-AMI risk stratification **(14)**.

RV dysfunction is associated with an adverse prognosis in post-AMI patients with moderate to severe LV dysfunction. However, in patients who undergo primary percutaneous coronary intervention (PCI), the degree of LV dysfunction is generally mild **(15)**.

The relation between RV function and adverse events in patients treated with primary percutaneous coronary intervention for AMI. RV function provides strong prognostic information in AMI patients treated with primary PCI. RV strain is an independent predictor of all-cause mortality, reinfection, and hospitalization for HF. In addition, RV strain provides incremental value over clinical information, infarct characteristics, LV function, and RVFAC. Quantitative assessment of RV function with RV strain may improve the risk stratification of patients after AMI **(16)**.

Various parameters of RV function within 24 h of presentation in first episode of acute inferior wall MI and concluded that echocardiographic assessment of various parameters of RV function showed significant difference between groups with or without proximal RCA lesion. Tissue Doppler systolic annular velocity, myocardial performance index and TAPSE are easy to perform and useful in predicting proximal RCA as infarct related artery **(17)**.

RV ejection fraction (RVEF) and RV scar size were measured with MRI at 4 months. Tricuspid annular plane systolic excursion (TAPSE) and RV free wall longitudinal strain (FWLS) were assessed using echocardiography before discharge and at 4 months. They studied 258 patients without diabetes mellitus; their mean age was 58 – 11 years, 79% men and mean LV ejection fraction was 54 – 8%. Before discharge, 5.2% of patients had TAPSE <17mm, 32% had FWLS > 20% and 11% had FWLS > 15%. During 4 months, TAPSE increased from 22.8 – 3.6 to 25.1 – 3.9 mm and FWLS increased from 22.6 – 5.8 to 25.9 – 4.7%. After 4 months, mean RVEF on MRI was 64.1 – 5.2% and RV scar was detected in 5 patients (2%). There was no correlation between LV scar size and RVEF, or RV FWLS. In conclusion, RV dysfunction is reversible in most patients and permanent RV ischemic injury is very uncommon 4 months after acute MI treated with primary PCI **(18)**.

Quantification of RV function:

Multiple methods have been described to quantify RV function with 2D echocardiography. In clinical practice, qualitative assessment of RV function is usually performed, whether or not in combination with TAPSE or RVFAC. Both measurements are simple to perform and associated with prognosis, particularly in patients with LV dysfunction after AMI **(19)**. This may also apply for subtle changes in RV function after AMI. Peak RV longitudinal strain, which quantifies the maximal shortening in the RV free wall from apex to base, is likely to be a good estimator of RV function because 80% of the stroke volume is generated by longitudinal shortening of the RV free wall **(20)**.

RV function and outcome:

In the past, the clinical importance of RV function has been underestimated. Although RV dysfunction was reported to recover to some extent after AMI, the value of RV function for the prediction of long-term outcome has been well recognized in patients with inferior AMI and LV dysfunction **(21)**. Patients with RV involvement in inferior AMI were at increased risk of adverse events and demonstrated that RV involvement is not due to more extensive infarction of the LV **(22)**.

In post-AMI patients with LV dysfunction, Anavekar et al. **(23)** confirmed that RV function is weakly correlated with LV function and demonstrated that RV function quantified with RVFAC was independently associated with an increased risk of mortality and HF.

RV function was studied extensively with assessments currently used in clinical practice (TAPSE and RVFAC) and novel speckle-tracking–derived strain. TAPSE was a strong univariate predictor of adverse events but did not remain significant in multivariable analysis. In AMI patients; TAPSE was an independent predictor of mortality after adjustment for LVEF and age **(24)**. However, in the GISSI-3 echo substudy, which included 500 AMI patients, TAPSE was significantly associated with LVEF, which may explain why TAPSE did not provide incremental value to clinical information, infarct characteristics, and LV function and why TAPSE was not an independent predictor of adverse outcome **(25)**.

RV strain:

Although strain was primarily developed for the measurement of LV deformation, previous reports have demonstrated the usefulness of RV strain in several populations to detect subtle changes in RV function. Measurement of longitudinal strain of the RV is a reliable method for the assessment of RV function, because 80% of the stroke volume is generated by longitudinal shortening of the RV free wall **(26)**.

CONCLUSION:

An extended hospital stay and significant consequences are independently predicted when the RV is implicated in an inferior wall MI. Atrioventricular blockage to a high degree is also caused by ischemia to the conducting pathways, which frequently necessitates pacing.

Primary PCI of proximal right coronary artery can improve right ventricular systolic and diastolic dysfunction in patients with acute inferior wall myocardial infarction.

No Conflict of interest.

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