The role of multimodality imaging in HIV-related heart disease

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INTRODUCTION

The review by Mondal et al. in this issue of the *Journal of Nuclear Cardiology*¹ describes the mechanisms, management, and role of imaging in coronary artery disease (CAD) associated with human immunodeficiency virus (HIV). Although CAD is the predominant cardiac manifestation of HIV, other cardiac manifestations are frequent and deserve appropriate attention. Our editorial builds up and elaborates on the review by Mondal et al. and briefly discusses all common cardiac manifestations of HIV and supportive imaging modalities for diagnosis and management.

Antiretroviral therapy (ART) against HIV has significantly improved life expectancy among those affected with HIV.^{2,3} However, this has resulted in an exponential rise in non-HIV-related morbidity especially those associated with cardiovascular disease (CVD).^{4,5} We summarize below the mechanisms and possible role of multimodal imaging to diagnose and follow HIV-related cardiac manifestations.

MECHANISMS OF CARDIAC MANIFESTATIONS IN HIV

Although is the most common manifestation of HIV-related heart disease, HIV can affect heart in several ways. (Figure 1) Traditional risk factors like smoking, obesity, diabetes are more prevalent among HIV affected individuals than unaffected individuals leading to higher prevalence of CAD.^{6–8} Inflammation and immune dysfunction are hallmark of HIV and among the major risk factors which lead to a myriad of manifestations like myocarditis with associated cardiomyopathy, arrhythmia, coagulation disorders, pericardial disease, and arteriopathy causing pulmonary hypertension.^{9–11} Furthermore, behavioral and psychiatric disorders are more common in those with HIV making these patients prone to cardiovascular risk of psychiatric and illicit drugs use.¹²

ART despite their good efficacy against HIV are associated with significant side effects like dyslipidemia which in turn lead to CAD.¹³ These therapies may also have serious interactions with other therapies causing cardiac toxicity.¹⁴ The opportunistic infections associated with advanced HIV can lead to valvular heart disease and cardiac neoplasm.³ Kaposi sarcoma and malignant lymphoma are some of the common malignancies involving the heart, pericardium, coronary artery adventitia, and the great vessels.¹⁵

ROLE OF IMAGING MODALITIES IN HIV-RELATED HEART DISEASE

HIV can affect the heart in several ways as described above hence HIV-related heart disease presents a perfect target for multimodality imaging to elucidate diagnosis and mechanisms for personalized treatment of these patients. Table 1 describes how imaging modalities can elucidate the complex nature

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Figure 1. Complex pathophysiology of cardiac manifestations of HIV.

of HIV-related heart disease. Echocardiography remains the first imaging modality to assess myocardial function in patients suspected with heart failure from any cause. Echocardiography serves as a robust and tested modality in assessing various myocardial properties like ventricular function, valvular assessment, and pericardial disease. Echocardiography is the screening test for assessing pulmonary hypertension which is frequently found in patients with HIV.¹⁶ The utilization of global longitudinal strain assessed by echocardiography in patients with HIV in detecting early systolic dysfunction has detected a correlation between CD4 T-cell count and global longitudinal strain.^{17,18} Stress echocardiography (SE) an established modality in assessing CAD has been well studied in HIV individuals with risk of CAD and effectively stratifies patients into a low- and high-risk category.^{19,20} The presence of ischemia and scar detected by echocardiography serve as independent predictors of CVD in patients with HIV.²⁰

Myocardial perfusion imaging (MPI) with single-photon emission computerized tomography (SPECT) and positron emission tomography (PET) has high sensitivity and specificity in diagnosing CAD in the HIV cohorts.^{21,22} SPECT, which is more commonly available in comparison to PET, is one of the initial tests for evaluating HIV patients with symptoms suggestive of CAD. PET allows evaluation of myocardial perfusion, assessment of quantitative myocardial blood flow (MBF), and coronary flow reserve (CFR). Both PET and SPECT aid in understanding the mechanisms of cardiomyopathy by assessing viability, cardiac stunning, and the presence of scar in patients with HIV which

provide valuable insights for definite management. Multi Gated Blood Pool Scan(MUGA), another nuclear imaging modality is the gold standard for getting an accurate estimate of ventricular function.²³

Multidetector computed tomography (MDCT) is establishing itself as a reliable imaging modality that can accurately identify plaque burden, coronary artery anomalies, and the patency of coronary artery bypass grafts.^{24,25} MDCT has evolved as an adjunct to coronary catheterization in the assessment of patients with intermediate risk of CAD and serve a gatekeeper in ensuring appropriate triage of patients for catheterization.²⁶ Measurement of coronary artery calcium (CAC) has proven to correlate well with predicting future cardiac events in the general population.^{27,28} In the Multicenter AIDS cohort study (MACS), MDCT performed on patients with HIV showed a higher incidence of non-calcified plaque with a higher burden observed in patients with higher viremia compared to suppressed viremia.^{29,30}

Cardiac magnetic resonance (CMR) can measure ventricular volume, ejection fraction, assess ischemia by evaluating regional wall motion abnormalities, diagnose myocarditis using T2-weighted, early T1-weighted, and delayed gadolinium-enhanced imaging to evaluate infiltrative disease and assessment of myocardial viability in both general and HIV population.³¹ CMR is the gold standard for assessing right ventricular function and a well-validated modality to study pericardial disease and myocardial malignancy.³²

Like the general population, cardiac catheterization remains the gold standard for the diagnosis and

Table 1. Clinical and investigational roles of multimodality imaging in HIV-related heart disease multidetector computed tomography (MDCT); cardiac magnetic resonance (CMR); single-photon emission computerized tomography (SPECT); positron emission tomography (PET)

Cardiac manifestations	Echocardiography	MDCT	CMR	SPECT	PET	Cardiac Catheterization
Atherosclerosis						
Non-obstructive	-	Well Validated	-	Validated(CAC from AC CT)	Validated (CAC from AC CT)	-
Obstructive						
Qualitative	Validated	Well validated	Well validated	Well validated	Well validated	Gold standard
Quantitative (MFR, MBF)	Validated	Investigational	Validated	Investigational	Well validated	Validated
Ventricular function						
Diastolic	Well validated	Investigational	Investigational	MUGA mostly Investigational	Investigational	Gold standard
Systolic	Well validated	Investigational	Gold Standard	Validated	Validated	Validated (ventriculography)
Strain analysis	Well validated	Investigational	Well Validated	Investigational	Investigational	Investigational
Mechanisms of ventricular dysfunction						
Viability/scar/ hibernation	Well validated	Investigational	Well validated	Well validated but not sensitive	Well validated	-
Inflammation	-	-	Well validated	Scintigraphy not sensitive	Well validated	-
Right ventricle function	Well validated	Validated	Gold standard	Qualitative/ investigational	Qualitative/	investigational
Gold standard for diagnosis of pulmonary hypertension						
Valve function	Well validated	Validated	Validated	Qualitative/ investigational	Qualitative/	investigational
Validated						
Pericardial disease	Well validated	Well Validated	Gold standard	-	Investigational	-
Neoplasm	Validated	Well validated	Well validated	-	Well Validated	-

management of obstructive CAD in HIV patients. Right heart catheterization (RHC) remains the gold standard for the diagnosis of pulmonary hypertension. Technological advances in non-invasive cross-sectional imaging modalities like the MDCT, magnetic resonance angiography have shifted the dependence from cardiac catheterization in the assessment of CAD, inflammatory disease of great vessels like aortitis and study of valvular disease.

In conclusion, as patients with HIV are living longer, the prevalence of developing chronic disease with predominant cardiovascular manifestations is growing. The need for better diagnostic and therapeutic interventions for cardiovascular manifestations using multimodality imaging will be the next frontier. Clinicians should be astute in identifying risk factors for cardiovascular manifestations and familiarize themselves with appropriate screening using various imaging modalities and aggressive management of risk factors in HIV cohorts.

Disclosures

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