The role of echocardiography in acute viral myocarditis

Mamotabo R Matshela

Abstract

The diagnosis of acute viral myocarditis can be very challenging during the initial evaluation, warranting multiple diagnostic tests to be performed, including a full echocardiographic evaluation to exclude other aetiologies that might present similarly. Acute myocarditis may masquerade as acute myocardial infarction in older patients or as any form of cardiomyopathy in young patients. As a result, all these patients need a thorough evaluation and to be managed at a high cardiac-care setting from the very outset. A wide range of diagnostic tests may be warranted, including conventional echocardiography, to exclude other underlying cardiac diseases, to evaluate cardiac chamber size, wall thickness, ventricular function and the presence of pericardial collections, and to assist in guiding further management. Although left ventricular dysfunction tends to be described more often, right ventricular dysfunction has been reported as the most likely cause of unfavourable outcomes, compared with left ventricular dysfunction. Therefore it is important to thoroughly evaluate and report all echocardiographic parameters for both ventricles and to determine the prognosis.

Keywords: acute viral myocarditis, echocardiography, speckle-tracking echocardiography

Submitted 26/6/17, accepted 16/11/18
Cardiovasc J Afr 2019, 30: online publication www.cvja.co.za

DOI: 10.5830/CVJA-2018-069

Diagnosis of acute viral myocarditis can be challenging as its clinical presentation may masquerade as other cardiac conditions, such as an acute myocardial infarction. As a result, all patients with suspected acute viral myocarditis should undergo thorough evaluation, including a full echocardiographic assessment to exclude other causes that could present in a similar fashion. Most importantly, these patients need closer monitoring and should be managed in a high-care or cardiac-care setting.

Diagnosis of acute viral myocarditis is based on the presenting symptoms, elevated cardiac markers suggestive of myocardial necrosis, and electrocardiographic and echocardiographic changes. Although a wide range of diagnostic tests may be warranted when initially evaluating these patients, conventional echocardiography remains a crucial imaging modality to exclude other underlying cardiac diseases, to evaluate cardiac chamber size, wall thickness, ventricular function and presence of pericardial collections, to differentiate fulminant from acute myocarditis, and to help guide the patient’s management.

There is earlier information on the role of echocardiography in myocarditis, however data on new or advanced echocardiographic imaging modalities are limited; as a result, future research is warranted in this area. Hence, the main objective of this article was to review the role of different echocardiographic modalities that may be useful during suspicion of acute viral myocarditis, as well as to report on new or advanced echocardiographic modalities to be applied during echocardiographic assessment, including contrast and speckle-tracking echocardiography.

Two-dimensional transthoracic echocardiography

Conventional echocardiography forms a crucial component for diagnostic work up in patients suspected of acute myocarditis. Two-dimensional transthoracic echocardiography (2D-TTE) plays a crucial role in evaluating ventricular function and excluding other causes of chest pain or heart failure, including valvular, congenital and ischaemic heart diseases, and pericardial diseases.

Previous data have extensively reported on acute myocarditis as an important masquerader of acute myocardial infarction, therefore regional wall-motion abnormalities should be looked for during TTE, particularly in elderly patients or those with traditional risk factors for coronary artery diseases, as opposed to young, healthy athletes. Even though 2D-TTE features of acute myocarditis are non-specific, it is still useful to exclude potential differentials, assist in guiding further management, including follow ups, and for prognostic purposes.

Echocardiographic criteria for myocarditis

Despite the fact that echocardiographic diagnosis of acute myocarditis has been hampered by non-specific features at the time of examination, the diagnostic criteria were previously suggested and have been adopted. These criteria focus mainly on distinguishing fulminant from acute myocarditis and are very important in assisting triaging patients for specialised care, depending on the disease stage.

Several studies have previously evaluated the role of echocardiography during initial and follow-up management of patients suspected of or confirmed with acute myocarditis. Therefore echocardiography plays a crucial role and should be implemented at the initial evaluation and during the follow up.
Left ventricular function

Hsiao et al. reported septal wall thickness, left ventricular dimensions and ejection fraction in acute myocarditis patients compared with healthy controls, and further implemented the role of two-dimensional speckle-tracking echocardiography (2D-STE). Here, the authors demonstrated that 2D-STE could be helpful when evaluating patients with acute myocarditis during initial presentation of the disease process, compared with 2D-TTE.

Traditionally, echocardiographic findings in patients with acute myocarditis include left ventricular (LV) regional/segmental or global dysfunction and overall LV dilatation, however normal LV function continues to be reported in biopsy-proven acute myocarditis. Occasionally, myocardial interstitial oedema, or global dysfunction and overall LV dilatation, however normal 2D-TTE.

During initial presentation of the disease process, compared with be helpful when evaluating patients with acute myocarditis (2D-STE). Here, the authors demonstrated that 2D-STE could detect early ventricular dysfunction compared with conventional echocardiography, and it is also useful for long-term prognostic purposes.

In the recent past, a case of acute viral myocarditis was reported where significantly impaired LV longitudinal, circumferential and radial systolic strain parameters were demonstrated. The authors also reported significantly attenuated inferior, inferolateral and apical segmental strain values, with the inferolateral segment demonstrating a paradoxical circumferential strain.

In a larger study of 28 consecutive patients with cardiac magnetic resonance (CMR) imaging-verified diagnosis of acute myocarditis based on the Lake Louise criteria, Logstrup et al. indicated that 2D-STE was useful during the initial evaluation, as global longitudinal systolic strain added supportive information to clinical and conventional echocardiography. Furthermore the authors also reported that global longitudinal systolic myocardial strain (including epicardial and endocardial longitudinal systolic strain) correlated strongly with the degree of myocardial oedema. The same study highlighted that 2D-STE was undoubtedly useful for the diagnosis and to evaluate the degree of myocardial dysfunction in acute myocarditis.

Even though three-dimensional (3D) STE is still evolving, Caspar et al. demonstrated significantly lower 3D global longitudinal, circumferential, area and radial strain values in acute viral myocarditis cohorts compared with normal healthy controls, despite documented preserved baseline LV ejection fraction on standard echocardiography in both groups.

Right ventricular function

The LV is the most commonly assessed and reported cardiac chamber in acute myocarditis, however echocardiographic assessment of right ventricular (RV) function is also highly recommended in any form of myocarditis. Pinamonti et al. retrospectively reviewed echocardiographic images of 42 patients with biopsy-proven myocarditis and reported RV dysfunction to be fairly common, as 23% of their study patients had evidence of RV dysfunction.

RV dysfunction in patients with acute viral myocarditis has been reported as the most likely cause of poorer outcomes in terms of death and increased need for cardiac transplantation compared with LV dysfunction. The LV–RV interaction has also been reported to be crucial in patients with myocarditis, as significantly impaired LV function was reported more often in patients with depressed RV function than in those with normal RV function during the initial presentation.

Speckle-tracking echocardiography

STE is a new echocardiographic technology with high sensitivity and reproducibility for detection of subclinical ventricular systolic and diastolic dysfunction. The invention of STE strain and strain rate indices are useful to evaluate intrinsic cardiac deformation. STE indices provide accurate measurements of both regional and global ventricular contractility enhanced by angle independency and fewer pitfalls throughout the motion plane, compared with conventional 2D echocardiography. STE has demonstrated its superior utility compared with conventional echocardiography in patients presenting with acute myocarditis or any form of inflammatory cardiomyopathy.

The 2D-STE strain and strain rate parameters are useful prognostic measures, even in patients presumed to have preserved LV ejection fraction at baseline and during the follow-up periods of the acute myocarditis process. In addition, strain parameters could be useful in predicting deterioration and overall event-free survival after an evidenced or recovery from acute viral myocarditis, and to differentiate myocarditis from other conditions including coronary artery disease.

An additional report indicated that STE should be recommended in daily clinical practice to evaluate multiple cardiac conditions, including inflammatory cardiomyopathies, as strain parameters could detect early ventricular dysfunction compared with conventional echocardiography, and it is also useful for long-term prognostic purposes.

Tissue Doppler imaging

Tissue Doppler imaging (TDI) indices are important and more specific when evaluating patients with acute myocarditis. Despite limited reports on the detection of myocarditis by novel echocardiographic modalities, such as tissue Doppler, studies have demonstrated impaired longitudinal segmental myocardial strain on Doppler echocardiography due to myocardial oedema. Furthermore, tissue Doppler parameters and contrast-enhanced CMR could synergistically help in confirming the diagnosis and guide further management.

Smedema et al. reported a case where the authors demonstrated the importance of TDI as part of the diagnostic work-up and management of acute myocarditis. In the same report, the authors further highlighted TDI indices, which were indicative of abnormalities suggestive of myocardial scarring.

Here the echocardiographic parameters were better suited to characterise acute myocardial tissue changes and changes over time in patients with acute myocarditis.

Contrast echocardiography

Generally, the clinical applications of contrast echocardiography include LV quantification and Doppler enhancement, which are useful during the evaluation of ventricular function, particularly in patients with a poor echocardiographic window.
Although the clinical utility of contrast echocardiography in acute myocarditis is yet to be demonstrated and is controversial, contrast echocardiography is used routinely to exclude LV apical thrombus in patients with acute myocardial infarction and could also be useful in acute myocarditis, particularly in patients with impaired LV systolic function.

The presence of LV thrombus may be difficult to confidently image using standard TTE and, as recommended by national guidelines, contrast echocardiography can be useful to aid in the diagnosis in difficult situations. A LV mural thrombus is a common complication, particularly in patients with LV dilatation and significantly impaired contractility, so contrast echocardiography could be used in those patients in guiding further management to prevent peripheral embolisation. Other imaging modalities, including CMR or 3D echocardiography, should be considered for confirmatory purposes.

Three-dimensional echocardiography

The real-time 3D-TTE is an advanced and important echocardiographic imaging modality used to evaluate cardiac patients; however its role in acute myocarditis is yet to be elucidated as larger data on its utility are limited. Despite this pitfall, a case was previously reported using real-time 3D echocardiography in acute myocarditis. Thuny et al. reported the role of both 2D and 3D echocardiography in a 43-year-old male with acute myocarditis, where the authors demonstrated the presence of hypokinetic and impaired LV contractility and biventricular thromboses, which were better delineated by 3D compared with 2D echocardiography.

Differentiating acute from fulminant myocarditis

Echocardiography in patients with myocarditis allows for serial assessment of LV dysfunction and is useful to distinguish fulminant from acute myocarditis. Fulminant myocarditis is characterised by the presence of a normal cavity and hypocontractile LV with increased septal thickness, compared with acute myocarditis. Acute myocarditis is characterised by marked LV dilatation, normal septal thickness and ventricular dysfunction. In any form of myocarditis or inflammatory cardiomyopathy, cardiac function should be monitored using serial echocardiograms to demonstrate any change over time. In general, LV function improves over a period of approximately six months in fulminant myocarditis, compared with acute myocarditis.

An athlete with myocarditis

Responding to increased cardiac output demanded during exercise, both ventricles must increase stroke volume, which imposes high stress on myocardial structures, more so on the RV, which normally works at low pressures compared with the LV. Previously, studies on athletes’ hearts were more focused on the LV; however recently, due to the evolution of advanced echocardiographic techniques and CMR, RV exercise-induced remodelling has been demonstrated.

Echocardiography is a widely available imaging modality that could provide useful information in sports cardiology, particularly in areas of pre-participation screening and to evaluate exercise-induced cardiac remodelling. Based on current guidelines, it is recommended resuming competitive sport once there are no biomarkers or evidence of inflammation and no concerns regarding arrhythmias, and after the LV has assumed normality. Prior to clearance, the athlete should demonstrate a normal work-up based on an echocardiogram, exercise electrocardiogram and Holter monitor. If the athlete wishes to return to competitive sporting activity, recommendations are provided on how best to do so in a safe manner and should be followed closely, using intermittent repeated rhythm monitors, imaging and stress testing, depending on the sporting activity and degree of delayed gadolinium enhancement.

Since several reports have indicated a strong prognostic role for residual myocardial scarring after myocarditis, athletes should be prohibited from participating in competitive sport if there is evidence or concern regarding either ventricular arrhythmias or progressive LV dysfunction, which could be associated with the presence of residual myocardial scarring. Furthermore, CMR has added prognostic implications, as evidence of late gadolinium enhancement was significantly associated with major adverse cardiac events in athletes. Despite current advancements in imaging, including echocardiography, for young athletes wishing to return to sport after an acute episode of myocarditis, more data on advanced echocardiography, including STE, are warranted.

Discussion

Even though only standard echocardiography has been used, reports indicate that echocardiography plays some part during the initial evaluation and subsequently in diagnosing possible myocarditis. This limitation, compared with normal healthy individuals, is mostly due to normal reported evaluations in those with less severe forms of myocarditis. Despite these negatives, multiple abnormalities have been reported, namely segmental and global ventricular wall-motion abnormalities, and different patterns of cardiomyopathies, such as dilated, hypertrophic or even restrictive forms of cardiomyopathy in patients with histology-proven myocarditis. In addition, areas of necrosis and inflammation have been reported, which are associated with or lead to myocardial perfusion defects on further imaging.

Despite the lack of prior larger reports, studies or broader knowledge of myocardial contrast echocardiography in acute myocarditis, contrast echocardiography is useful to rule out ventricular mural thrombus. It is also useful in guiding further management and to prevent embolisation, which could lead to devastating outcomes, particularly in severely impaired ventricular contractility.

Two-dimensional STE strain echocardiography is useful in evaluating regional contractile function and assisting with detecting subclinical myocardial dysfunction, despite presumed normal ventricular function, based on conventional echocardiography. 2D-STE has a favourable signal-to-noise ratio, angle independence and the ability to differentiate active from passive myocardial motion, compared with standard echocardiography.

Despite limited information about the sensitivity and specificity of some of these newer echocardiographic techniques, their availability allows a window of opportunity to prospectively address important questions in myocarditis. Furthermore, since
there are no well-established echocardiographic criteria to predict outcomes in patients with any form of myocarditis, it is a good opportunity to develop new criteria to guide management and for prognostic purposes in future. Despite this premise, systolic and diastolic dysfunction, the presence of regional wall-motion abnormalities, and changes in echocardiographic image texture have previously been reported, which may be modified with larger studies in the future. Echocardiography may further assist with classification of myocarditis patients into clinically relevant subgroups, with prognostic implications.

Conclusion

The presentation of acute myocarditis may masquerade as other cardiac conditions, making the diagnosis even more challenging. A wide range of diagnostic tests may be warranted when initially evaluating patients with suspected acute myocarditis, where conventional echocardiography could assist in excluding other cardiac diseases. Conventional echocardiography could be useful to evaluate cardiac chamber size and function, exclude complications, and help guide further management in terms of optimising heart failure and thromboprophylaxis therapies accordingly.

New and advanced echocardiographic modalities, including STE, should be considered for future daily clinical practice for early detection of subclinical ventricular dysfunction, to help develop criteria to predict outcomes, and for prognostic purposes. Most clinicians are concerned with LV dysfunction, however echocardiographic exclusion of RV dysfunction is crucial because RV dysfunction in acute myocarditis is common and predicts poorer outcomes and an increased need for cardiac transplantation, compared with LV dysfunction.

References

26. Zou YH, Lin L, Xiao H, Xiang DC. A Rare case of toxic myocarditis


60. Belck JT, Bierig SM, Chadwell K, Roberts B. Clinical application of harmonic power Doppler imaging in the assessment of myocardial


