EVALUATION OF LEFT VENTRICULAR FUNCTION BY BEDSIDE ULTRASOUND IN ACUTE TOXIC MYOCARDITIS

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Abstract—Background: Myocarditis can be difficult to diagnose in the Emergency Department (ED) due to the lack of classic symptoms and the wide variation in presentations. Poor cardiac contractility is a common finding in myocarditis and can be evaluated by bedside ultrasound. Objective: To demonstrate the utility of fractional shortening measurements as an estimation of left ventricular function during bedside cardiac ultrasound evaluation in the ED. Case Report: A 54-year-old man presented to the ED complaining of 3 days of chest tightness, palpitations, and dyspnea, as well as persistent abdominal pain and vomiting. An electrocardiogram (ECG) showed sinus tachycardia with presumably new ST-segment elevation and signs of an incomplete right bundle branch block. A bedside echocardiogram was performed by the emergency physician that showed poor left ventricular function by endocardial fractional shortening measurements. On further questioning, the patient revealed that for the past 2 weeks he had been regularly huffing a commercially available compressed air duster. Based on these history and examination findings, the patient was given a presumptive diagnosis of toxic myocarditis. A follow-up echocardiogram approximately 7 weeks later demonstrated resolution of the left ventricular systolic dysfunction and his ECG findings normalized. Conclusion: Cardiac ultrasound findings of severely reduced global function measured by endocardial fractional shortening were seen in this patient and supported the diagnosis of myocarditis. Endocardial fractional shortening is a useful means of easily evaluating and documenting left ventricular function and can be performed at the bedside in the ED. 

Keywords—emergency ultrasound; endocardial fractional shortening; echocardiography; myocarditis; toxic inhalation

INTRODUCTION

Myocarditis is an inflammatory process that typically presents with a non-ischemic dilated cardiomyopathy. The most common etiology is a viral infection, although hypersensitivity, sarcoidosis, and toxins are also well-described but easily forgotten causes (1). Patient presentations can vary widely; symptoms include fever, chest pain, or a viral prodrome, but there are no classic symptoms. Standard Emergency Department (ED) diagnosis of myocarditis typically employs electrocardiogram (ECG), chest radiography, cardiac enzymes, clinical presentation, history, and physical examination (2).

Given the difficulty of diagnosing myocarditis, it is useful to remember that myocarditis causes visible and measurable cardiac changes. In an unstable or critically ill patient that arrives in the ED with chest pain, bedside echocardiography can rule out tamponade and assess cardiac movement. Poor cardiac contractility is a common manifestation of myocarditis and can be measured on presentation to the ED.

Here we demonstrate the use of endocardial fractional shortening in bedside emergency echocardiography to
help support and document a clinical diagnosis of myocardi- 
tis with an unusual etiology.

CASE REPORT

A 54-year-old man presented to the ED complaining of 
3 days of chest tightness, palpitations, and dyspnea, as 
well as persistent abdominal pain and vomiting. His past 
medical history was significant for hypertension, aortic 
valve replacement (on Coumadin), alcohol abuse, gastric 
reflux disease, and hyperlipidemia. On arrival, he ap-
peared mildly dyspneic, but room air oxygen saturations 
were normal. The cardiac monitor demonstrated 
frequent premature ventricular contractions. Vital signs 
were as follows: pulse 114 beats/min, blood pressure 
122/97 mm Hg, respiratory rate 11 breaths/min, and tem-
perature 37.6°C (99.7°F). His physical examination was 
notable for dry mucous membranes, tachycardia, and a sig-
nificant systolic click. Lung sounds were clear and his neu-
rological and abdominal examination were both normal.

An ECG showed sinus tachycardia with presumably
new ST-segment elevation in leads II, III, aVF, V2, and 
V3 (no recent prior ECGs) and signs of an incomplete 
right bundle branch block (Figure 1). There were no 
reciprocal changes noted in the initial ECG. His com-
plete blood count and toxicology screen were unremarkable, but his electrolytes, international normal-
ized ratio (INR), and cardiac enzymes were abnormal. 
Significant abnormal values were as follows: potassium 
2.7, blood urea nitrogen 30, creatinine 1.9 (prior creati-
nine 0.6-0.7), creatinine kinase 1751, troponin T 3.95, 
and INR 3.9.

A bedside echocardiogram was performed by the 
emergency physician during the secondary survey that 
showed poor global cardiac contractility in the apical 
four-chamber and parasternal long-axis views (Figures 
2, 3). Endocardial fractional shortening (eFS) from the 
parasternal short axis (left ventricular [LV] diameter at 
end-systole and end-diastole expressed as a percentage) 
was measured to be 13.3% (Figure 4). Normal eFS is 
25–45% (3).

On further questioning, the patient revealed that 2 
weeks prior he had a fractured tooth that he repaired at
home using super glue and DUST-OFF® DUSTER (1,1 difluoroethane; Falcon Safety Products Inc., Branchburg, NJ) as a drying agent. The DUST-OFF created a euphoric feeling, so he began huffing approximately six cans per day up until the time of presentation. Cardiology was consulted and it was determined that, given the history, ECG, and elevated INR, the patient was not a candidate for immediate catheterization. Based on the history, examination, and laboratory findings, the patient was given a presumptive diagnosis of toxic myocarditis and acute kidney injury.

A formal echocardiogram performed by Cardiology confirmed decreased cardiac function with a calculated ejection fraction (EF) of 25–30%. Review of his medical chart showed that 3 months prior, the patient had a routine echocardiogram with a normal EF. The patient was admitted to the cardiac intensive care unit and treated supportively. Given his history of coronary artery disease, diffuse ST-segment elevation, and abnormal cardiac enzymes; cardiac catheterization was performed and the study was negative for vessel disease. His renal insufficiency eventually resolved. The final diagnosis was a toxic myocarditis secondary to inhaled halogenated hydrocarbons. A follow-up echocardiogram approximately 7 weeks later demonstrated resolution of the LV systolic dysfunction with an EF of 55–60%, and his ECG findings normalized.

**DISCUSSION**

Inhaling or huffing halogenated hydrocarbons is a known cause of toxic myocarditis. A feeling of euphoria results from inhalation, which has led to its use as a substance of abuse, and it has been reported in at least one study to be the cause of a fatal cardiac dysrhythmia (4). Bundle branch blocks and LV systolic depression have been previously reported manifestations of toxic myocarditis due to hydrocarbon inhalation (5).

In cases of suspected myocarditis, LV function can be useful information to help support a diagnosis. LV function is most commonly reported as EF; however, deriving this value would be difficult to learn and time-consuming for an emergency setting. Two alternative methods of evaluating LV function by ultrasound are endocardial fractional shortening and midwall fractional shortening. Endocardial fractional shortening (eFS) is obtained using M-mode measurements through the mid-portion of the left ventricle in a parasternal long or parasternal short view. LV diameter (LVD) is calculated during end-systole (LVDs) and end-diastole (LVDd) and expressed as a percentage [(LVDd/LVDs) × 100] (6). A recent study by Gunst et al. demonstrated that eFS was an accurate bedside estimation of cardiac index in surgical intensive care unit patients as compared to pulmonary artery catheter values (7). Midwall fractional shortening (mwFS) is another measurement that can be used for the assessment of LV function, particularly in patients with concentric LV hypertrophy (8). Although potentially more accurate than eFS, measurements for mwFS require a more complex calculation, which would be unreasonable for rapid bedside assessment. Reference values for EF, eFS, and mwFS can be found in Table 6 of the chamber quantification guidelines published by the American Society of Echocardiography (3). Although not equal to EF, eFS correlates well with LV function and is an easy quantitative measure of LV function that most emergency clinicians will be able to perform. In addition, eFS is
a useful means of depicting LV function in a still ultrasound image for the medical record.

**CONCLUSION**

ED bedside echocardiography proved useful in the initial diagnosis of myocarditis because the poor cardiac contractility was readily visible. Endocardial fractional shortening correlates well with LV function and is an easy bedside measurement that can be used for both diagnostic and documentation purposes.

**REFERENCES**