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doi:10.1016/j.ijcard.2012.03.002

Screening children with suspected myocarditis for global and regional myocardial dysfunction using two-dimensional speckle tracking echocardiography: Is it of use?

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ARTICLE INFO

Article history:

Received 2 January 2012

Accepted 5 March 2012

Available online 28 March 2012

Keywords:

Myocarditis

Cardiac magnetic resonance imaging

Speckle tracking echocardiography

Delayed enhancement

LV torsion

Myocarditis may be difficult to diagnose in children when no pronounced cardiac dysfunction is present [1]. Although endomyocardial biopsy has been considered the diagnostic standard for acute myocarditis, it is not performed routinely due to many inherent risks and the low sensitivity of the Dallas criteria [1]. Moreover, the diagnostic value of conventional echocardiography seems limited because many patients have a normal echocardiogram [1]. However, two-dimensional speckle tracking echocardiography (STE), a new technique for the assessment of regional and global myocardial strain and strain rate, may have a clinical utility in this setting [2,3].

Three consecutive male patients with suspected myocarditis underwent STE. All patients had a normal conventional echocardiogram (ejection fraction >60%). Images were obtained using a commercially available cardiac ultrasound machine (Vivid 7 Dimension, GE Healthcare, Horten, Norway) at a frame rate of 55 to 80 frames/s, by one of the authors (FUTC). Gray-scale digital cine loops were acquired from the long-axis, 2- and 4-chamber views. Left ventricular (LV) short-axis planes at the basal, midventricular, and apical levels were obtained, as previously described [3–5]. Measurements were compared to normal values, and LV twist was normalized to the long-axis LV length (N-twist in °/cm) [4,5].

Patient 1, a 13-year old adolescent, presented with chest pain and fever. Electrocardiography (ECG) revealed T-wave abnormalities. His troponin T level was strongly elevated with 2.230 µg/l (normal ≤0.1 µg/l). STE demonstrated a normal global longitudinal peak systolic strain –21.9% (normal –21.8 ± 1.3%). However, global radial and circumferential strain values were reduced (Fig. 1), and LV twist was augmented (Fig. 2A). Cardiac magnetic resonance imaging (MRI) confirmed myocarditis in this patient (Fig. 1). Although LV twist mechanics (17.1°, N-twist 1.92°/cm, normal 1.63 ± 0.32°/cm [4]) and radial strain values (65.2%, normal 58.0 ± 5.4% [5]) normalized during follow-up, regional circumferential strain abnormalities were demonstrated 6 months after diagnosis (LV inferior and posterior segments).

Patient 2, a 16-year old boy, was sent to our clinic with suspected myocarditis. An ECG showed inversion of T waves in leads V4–V6. C-reactive protein level was 112.6 mg/l (<5.0 mg/l). Creatinine kinase-MB isoenzyme (CK-MB) was slightly elevated. His global longitudinal peak systolic strain was normal at presentation (–22.6%), but decreased during the following days (–17.3%, normal –22.5 ± 1.3%). Initially, LV twist was augmented (17.7°, N-twist 2.10°/cm, normal 1.63 ± 0.32°/cm), decreased on day 3 (8.4°, N-twist 1.0°/cm), and showed reversed apical rotation on day 14. Even 2 months after myocarditis was diagnosed, reversed apical rotation persisted. Moreover, global peak radial and circumferential strain were initially only mildly reduced (+52.5%, normal 58.1 ± 4.0%; and –18.3%, normal –23.6 ± 2.0%, respectively), but showed increasing impairment during follow-up (+33.5%, and –17.3%, respectively). Particularly, regional circumferential strain was reduced in the lateral, posterior and inferior segments.

Patient 3 is a 15-year old soccer player. He did not recover from an upper respiratory tract infection 1 week earlier, and complained of fatigueness, dyspnea and chest pain. Troponin T levels were elevated and his ECG showed T-wave abnormalities. LV twist was impaired (Fig. 2B). Longitudinal (–21.8%) and radial (+64.0) strain values were normal. Global circumferential strain was reduced (–15.5%, normal –23.5 ± 1.8%), particularly in the lateral, posterior, and inferior segments. Although, no long- and short-axis myocardial dysfunction developed during follow-up, LV twist and circumferential strain remained impaired during follow-up.

This report describes the clinical utility of STE in 3 patients with suspected acute myocarditis. Using STE, regional and global myocardial dysfunction were demonstrated in all patients. Moreover, a cardiac MRI with gadolinium infusion in one of our patients confirmed the presence

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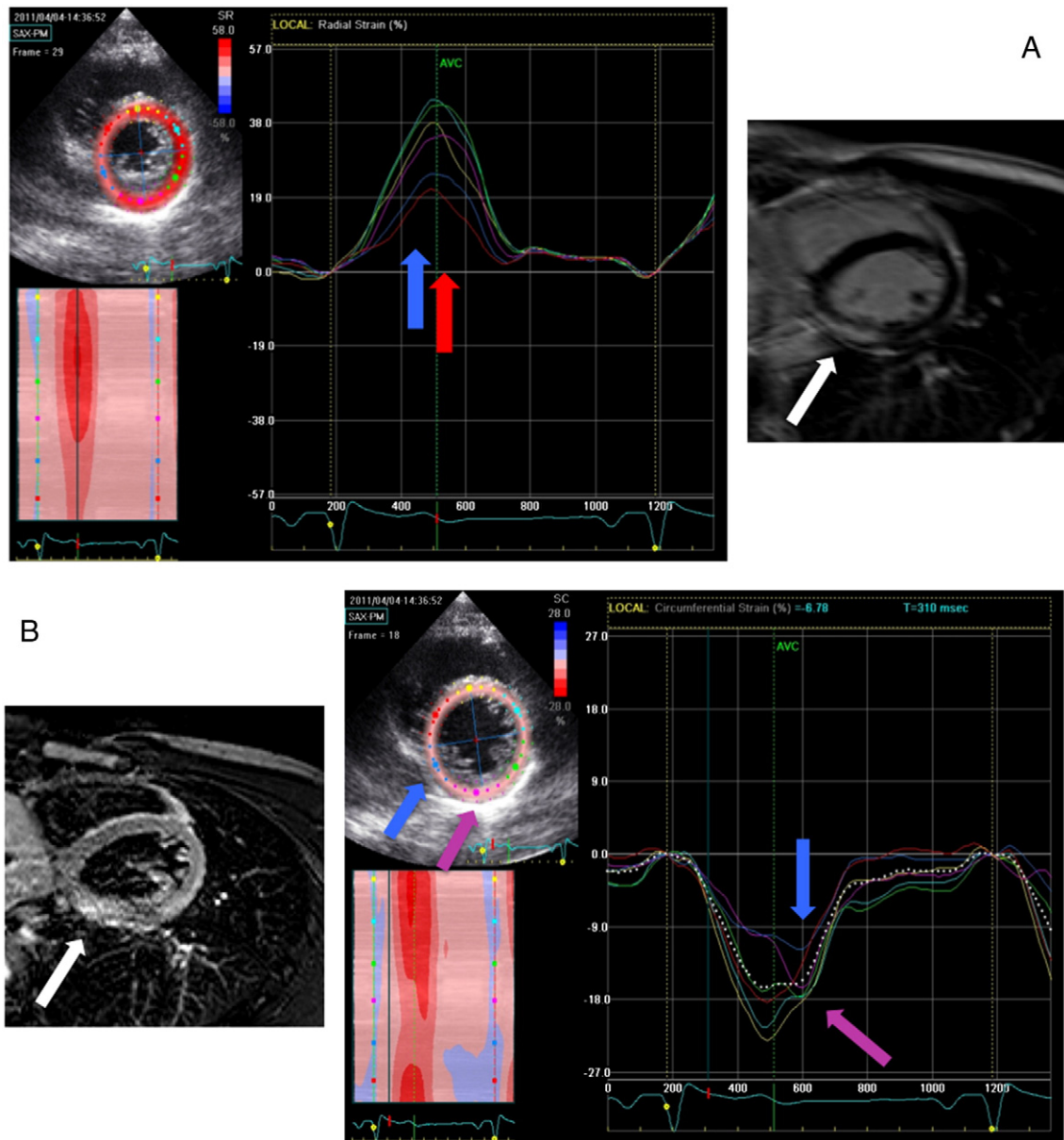


Fig. 1. (A): *Left panel*, LV mid-ventricular short axis plane demonstrating reduced global radial peak systolic strain ($+34.5\%$, normal $58.0 \pm 5.4\%$). In particular, regional myocardial dysfunction was seen in the septal (red arrow), inferior (blue arrow), and to a lesser extent, posterior walls (purple curve). *Right panel*, subepicardial late gadolinium enhancement of the inferior and posterior segments of the LV (white arrow), reflecting necrosis and/or myocardial fibrosis. (B): *Left panel*, T2-weighted spin-echo image of the LV short-axis plane with high signal intensity of the inferior and parts of the posterior wall, indicating regional myocardial edema (white arrow). *Right panel*, corresponding LV mid-ventricular short axis plane demonstrating reduced peak systolic circumferential strain of the inferior (blue arrow) and posterior wall (purple arrow). Both myocardial segments showed postsystolic shortening. AVC = aortic valve closure.

of tissue edema and necrosis/myocardial fibrosis, which are important diagnostic features of myocarditis [2]. LV segments showing myocardial inflammation on MRI corresponded well with segments demonstrating impaired myocardial strain using STE. Therefore, STE may be used for evaluating regional and global myocardial function in patients with suspected myocarditis and a normal conventional echocardiogram.

As longitudinal and radial strain values were impaired in only two of the patients in our small case series, LV twist mechanics and circumferential strain were abnormal in all patients. In addition, different patterns of LV twist abnormalities were observed, including paradoxically increased LV twist, which has been described before in childhood myocarditis [3], and reduced LV rotational mechanics. Augmentation of LV twist seems an important mechanism of the heart to compensate for impaired cardiac function [3]. Furthermore, recent evidence suggests that LV twist is a sensitive marker of cardiac

dysfunction and predicts the presence of ventricular dyssynchrony [2], making STE a promising screening tool for (subclinical) myocardial dysfunction in disease states such as myocarditis.

The extent of myocardial inflammation may explain the STE abnormalities found in myocarditis. The MRI-pattern of gadolinium enhancement in myocarditis has a typically patchy tissue distribution and is most often subepicardially located [1]. This pattern of myocardial injury is associated with marked impairment of circumferential strain and LV twist, which is demonstrated in many cardiovascular diseases [2]. This pattern of myocardial dysfunction was seen in patients 1 and 3. On the other hand, myocarditis having a more diffuse or transmural character may impair both long-axis and short-axis cardiac function, as was probably the case in patient 2.

Both regional and global myocardial function deteriorated during the first 14 days in patient 2. This finding may have important clinical

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