Cardiac Imaging

Can Univentricular Heart Be Associated with "Rigid Body Rotation"? A Case from the Three-Dimensional Speckle-Tracking Echocardiographic MAGYAR-Path Study

Attila Nemes, Kálmán Havasi, Péter Domsik, Anita Kalapos, Tamás Forster

Second Department of Medicine and Cardiology Centre, Medical Faculty, Albert Szent-Györgyi Clinical Center, University of Szeged, Szeged, Hungary

Key words:
Univentricular heart, single ventricle, rotation, twist, three-dimensional, echocardiography.

Manuscript received:
November 18, 2013;
Accepted:
February 17, 2014.

Address:
Attila Nemes

Second Department of Medicine and Cardiology Center
Medical Faculty
University of Szeged
H-6723 Szeged
Semmelweis St. 6
Hungary
P.O. Box 427
nemes.attila@med.u-szeged.hu

Left ventricular (LV) twist results from the movement of two orthogonally oriented muscular bands of a helical myocardial structure with a consequent clockwise rotation of the LV base and counterclockwise rotation of the LV apex.[1-3] Three-dimensional (3D) speckle-tracking echocardiography (STE) is useful for the non-invasive evaluation of LV rotational mechanics.[2-4] We present the case of an 18-year-old boy with a univentricular heart due to tricuspid atresia after a Fontan procedure, with LV characteristics, who was examined with standard two-dimensional echocardiography and 3DSTE at the Cardiology Center of the University of Szeged, Hungary. He was involved in the MAGYAR-Path Study (Motion Analysis of the heart and Great vessels bY three-dimension-Al speckle-tRacking echocardiography in Pathological cases). Informed consent was obtained from the patient's family and the study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki, as reflected in *a priori* approval by the institution's human research committee. Two-dimensional echocardiography confirmed the univentricular heart (Figure 1). Three short-axis views and the apical 4-chamber and 2-chamber views extracted from 3D echocardiographic datasets are shown in Figures 2 & 3. During 3DSTE analysis, severely decreased basal and apical rotations could be detected, which were in the same counterclockwise direction with a near absence of twist – the so-called "rigid body rotation" (RBR) of the LV (Figure 4).

In a recent study, a dramatic decrease in apical rotation could be demonstrated in patients with a single ventricle using STE (velocity vector imaging).[5] Van Dalen et al were the first to demonstrate LV-RBR in patients with non-compaction of the LV.[6] LV-RBR could be demonstrated in 53.3% of 60 patients with non-compaction cardiomyopathy (NCCM).[7] In another smaller study, 9 out of 9 NCCM patients showed LV-RBR.[8] Other authors found the sensitivity and specificity of LV-RBR to be 88% and 78%, respectively, for differentiating NCCM from non-specific "hypertrabeculation" of the LV.[9] To the best of the authors' knowledge, this is the first time that RBR has been demonstrated in a univentricular heart. However, further studies with a larger number of patients with a univentricular heart are warranted to confirm our findings.

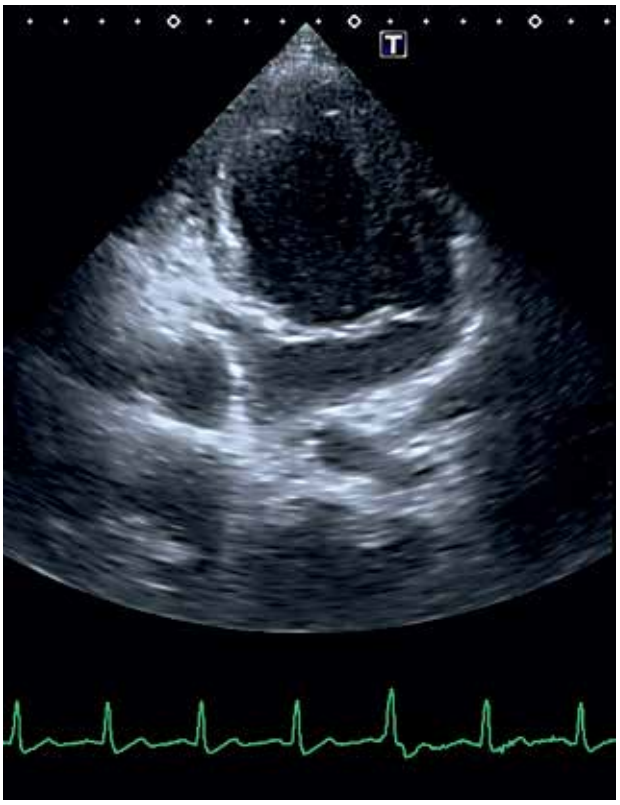

Figure 1. An 18-year-old boy with a univentricular heart is imaged by transthoracic echocardiography.

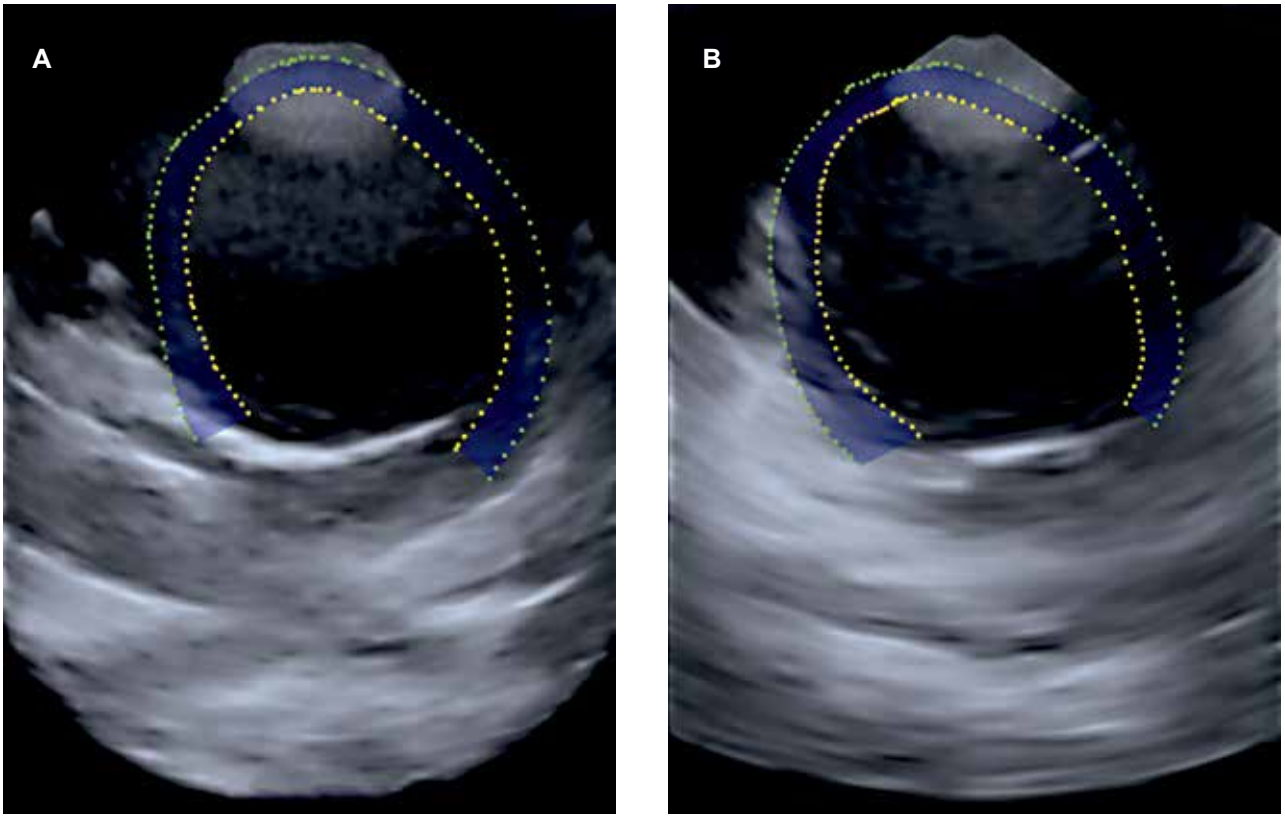

Figure 2. Apical 4-chamber (A) and 2-chamber (B) views at different levels of the left ventricle extracted from the three-dimensional echocardiographic dataset.

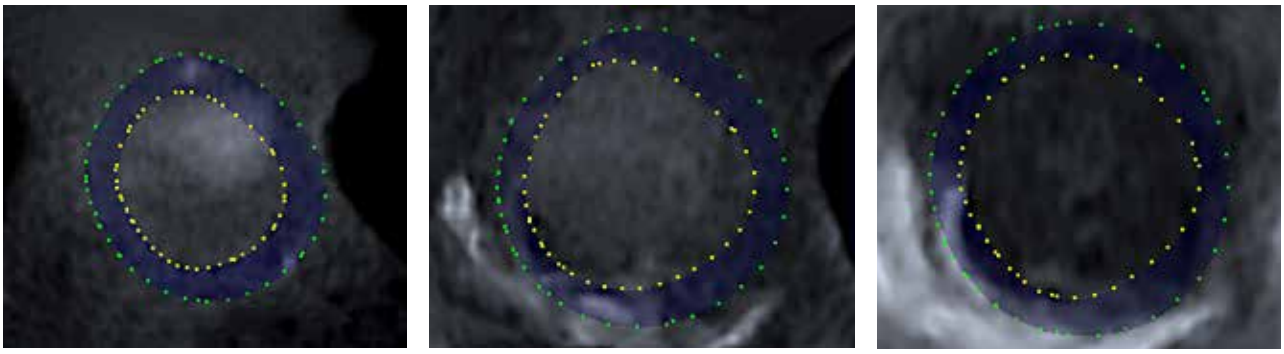

Figure 3. Short-axis views at different levels of the left ventricle extracted from the three-dimensional echocardiographic dataset.

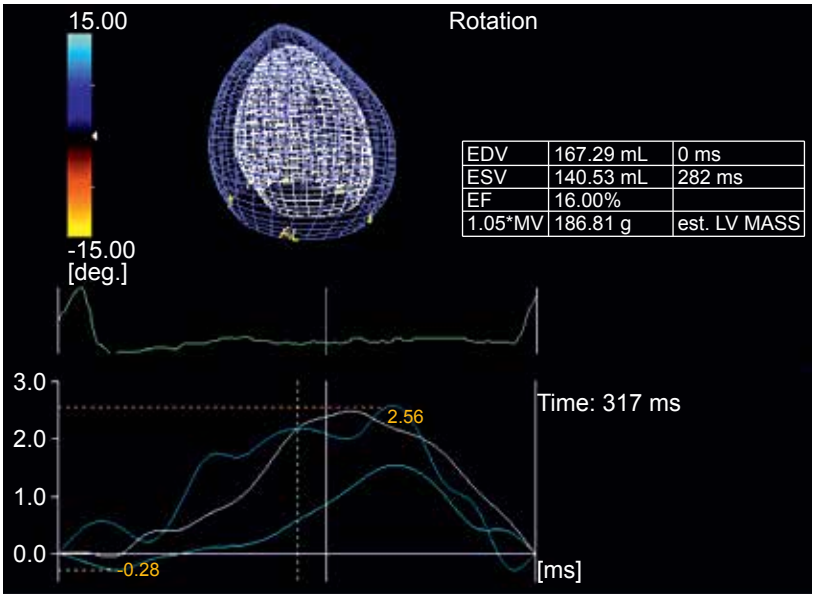

Figure 4. A three-dimensional cast of the left ventricle (LV) and calculated volumetric and functional LV parameters. LV basal and apical rotations proved to be in the same direction, with a near absence of LV twist, in the patient with a univentricular heart. EDV – end-diastolic volume; ESV – end-systolic volume; EF – ejection fraction; est. LV mass – estimated left-ventricular mass.

Acknowledgements

Attila Nemes, MD, holds a János Bolyai Research Fellowship (Budapest, Hungary).

References

1. Nemes A, Kalapos A, Domsik P, Forster T. [Left ventricular rotation and twist of the heart. Clarification of some concepts]. Orv Hetil. 2012; 153: 1547-1551.
2. Nemes A, Kalapos A, Domsik P, Forster T. Identification of left ventricular "rigid body rotation" by three-dimensional speckle-tracking echocardiography in a patient with noncompaction of the left ventricle: a case from the MAGYAR-Path Study. Echocardiography. 2012; 29: E237-240.
3. Urbano Moral JA, Arias Godinez JA, Maron MS, et al. Left ventricular twist mechanics in hypertrophic cardiomyopathy assessed by three-dimensional speckle tracking echocardiography. Am J Cardiol. 2011; 108: 1788-1795.
4. Nemes A, Kalapos A, Domsik P, Forster T. [Three-dimensional speckle-tracking echocardiography -- a further step in non-invasive three-dimensional cardiac imaging]. Orv Hetil. 2012; 153: 1570-1577.
5. Truong UT, Li X, Broberg CS, et al. Significance of mechanical alterations in single ventricle patients on twisting and circumferential strain as determined by analysis of strain from gradient cine magnetic resonance imaging sequences. Am J Cardiol. 2010; 105: 1465-1469.
6. van Dalen BM, Caliskan K, Soliman OI, et al. Left ventricular solid body rotation in non-compaction cardiomyopathy: a potential new objective and quantitative functional diagnostic criterion? Eur J Heart Fail. 2008; 10: 1088-1093.
7. Peters F, Khandheria BK, Libhaber E, et al. Left ventricular twist in left ventricular noncompaction. Eur Heart J Cardiovasc Imaging. 2014; 15: 48-55.
8. Kalapos A, Domsik P, Forster T, Nemes A. [Comparative evaluation of left ventricular function by two-dimensional echocardiography and three-dimensional speckle-tracking echocardiography in noncompaction cardiomyopathy. Results from the MAGYAR-Path Study]. Orv Hetil. 2013; 154: 1352-1359.
9. van Dalen BM, Caliskan K, Soliman OI, et al. Diagnostic value of rigid body rotation in noncompaction cardiomyopathy. J Am Soc Echocardiogr. 2011; 24: 548-555.