Cardiac Imaging

Are Left Ventricular Rotational Mechanics Non-Inverted in *Situs Inversus Totalis*? (A case from the three-dimensional speckle-tracking echocardiographic MAGYAR-Path Study)

Attila Nemes[1], Péter Domsik[1], Antal Szabó-Biczók[2], Gábor Bogáts[2], Anita Kalapos[1], Tamás Forster[1]

[1]*Second Department of Medicine and Cardiology Center,* [2]*Department of Cardiac Surgery, Department of Cardiology, Medical Faculty, Albert Szent-Györgyi Clinical Center, University of Szeged, Szeged, Hungary*

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Address:
Attila Nemes

Second Department of Medicine and Cardiology Center
Medical Faculty,
University of Szeged
H-6725 Szeged
Semmelweis street 6
Hungary P.O. Box 427
nemes.attila@med.u-szeged.hu

Three-dimensional speckle-tracking echocardiography (3DSTE) is a new, noninvasive method for evaluating left ventricular (LV) volumes, strain, and rotational parameters through strain analysis in four dimensions.[1,2] LV twist can be evaluated by 3DSTE as the net difference in counterclockwise apical and clockwise basal LV rotations during systole in *situs solitus* (normal situation).[3] In *situs inversus totalis* (SIT) the major visceral organs, including the heart, are mirrored from their normal positions.

A 56-year-old male patient with SIT was referred to the cardiac surgery department because of significant aortic valve stenosis. The patient was enrolled into the MAGYAR-Path Study. The institution's human research committee approved the study, which complied with the 1975 Declaration of Helsinki. The patient gave informed consent. Complete two-dimensional Doppler echocardiography and 3DSTE were performed in this patient before operation. Apical 4-chamber (A) and 2-chamber (B) and short–axis views at different levels (C3, C5, C7) of the heart extracted from 3D echocardiographic datasets of the SIT patient and of a healthy subject are presented in Figures 1 and 2.

LV rotational mechanics showed the same deformation sample in SIT as compared to the healthy control, which is only partially in agreement with previous findings. Recently, Frank et al have demonstrated in mutant mice that mirror-image cardiac looping does not result in mirror-image rotation of the morphological LV, suggesting that fiber orientation and cardiac mechanics may be abnormal in individuals with reversal of cardiac *situs*.[4] These results could indicate that myofiber orientation and cardiac looping may be independently regulated. In another human magnetic resonance imaging study by Delhaas et al, LV systolic motion in a limited number of SIT patients was found to be non-uniform and, apart from rigid body motion, could be described as having both LV base and LV apex fixed, while the mid-ventricle rotated clockwise in between, as viewed from the apex.[5] Moreover, both basal and apical LV segments showed hyperrotation in the presented SIT patient, which could be explained by the significant aortic valve stenosis. This is in agreement with recent

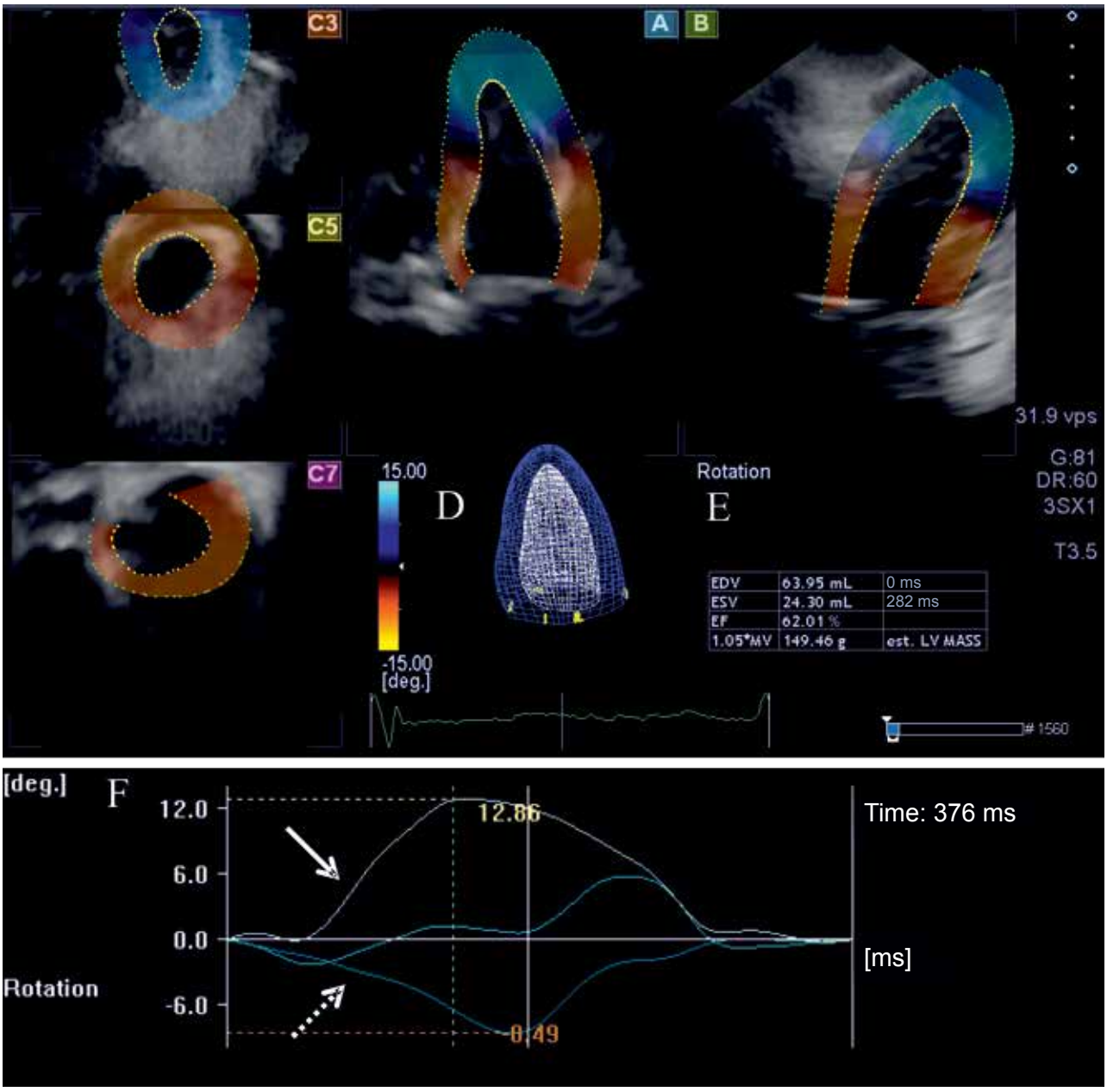

Figure 1. Apical 4-chamber (A) and 2-chamber (B) and short-axis views at different levels (C3, C5, C7) of the heart extracted from a three-dimensional (3D) echocardiographic dataset of the patient with *situs inversus totalis*. A 3D cast of the left ventricle (LV) (D) and calculated volumetric and functional LV parameters (EDV – end-diastolic volume; ESV – end-systolic volume; EF – ejection fraction; estimated LV mass) are also demonstrated (E). Counterclockwise rotation of the LV apex (white arrow, positive value) and clockwise rotation of the LV base (dashed arrow, negative value) are also shown, demonstrating normal rotational directions in this patient (F).

findings demonstrating that peak systolic LV twist is increased in aortic valve stenosis and is related to the severity of the stenosis and symptoms (angina) or electrocardiographic signs (strain) compatible with subendocardial ischemia.[6] However, further studies are warranted with a larger SIT study population to confirm our findings.

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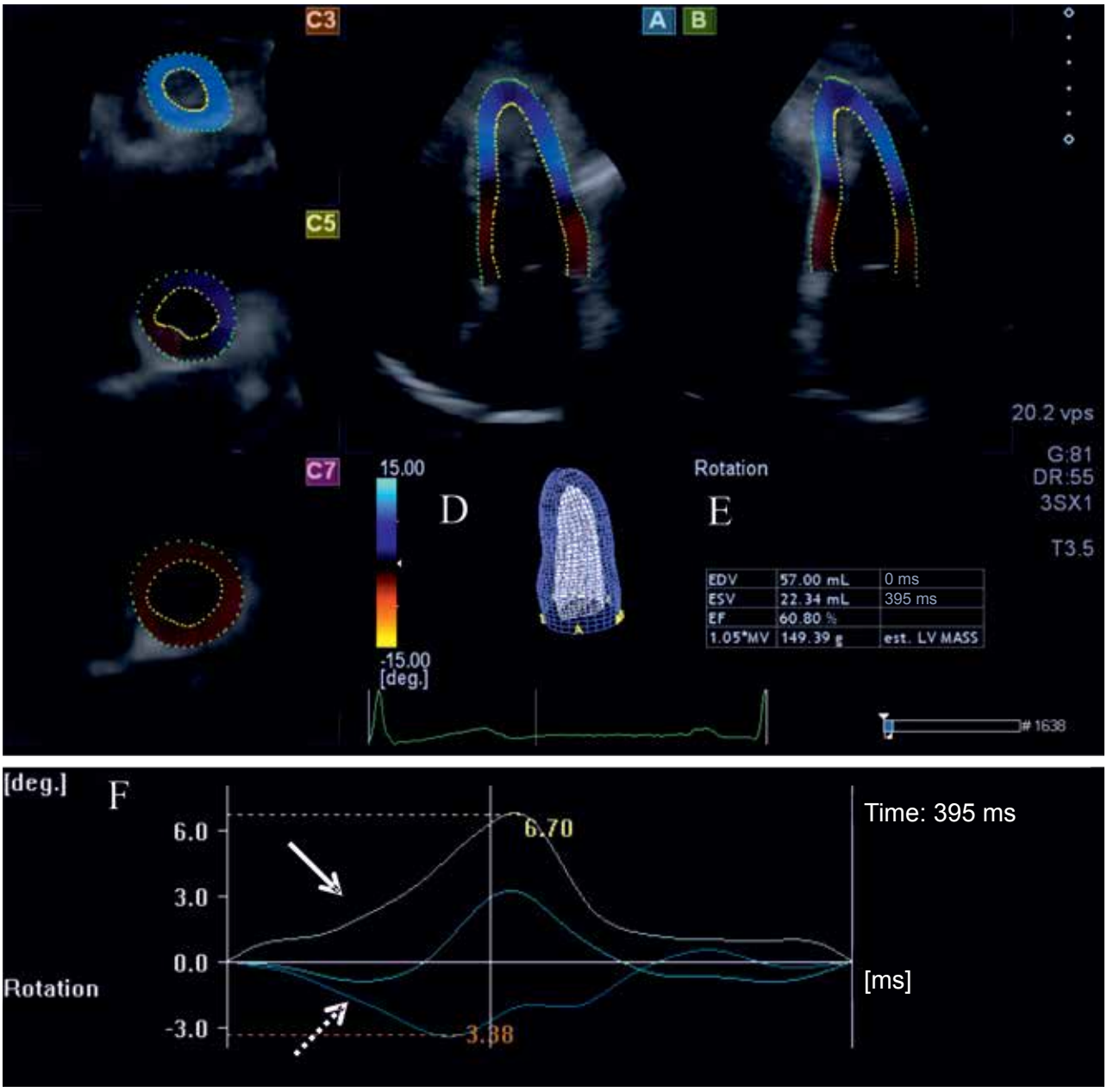

Figure 2. Apical 4-chamber (A) and 2-chamber (B) and short-axis views at different levels (C3, C5, C7) of the heart extracted from a 3D echocardiographic dataset of a healthy subject. A 3D cast of the LV (D) and calculated volumetric and functional LV parameters are also presented (E). Counterclockwise rotation of the LV apex (white arrow, positive value) and clockwise rotation of the LV base (dashed arrow, negative value) are also shown, demonstrating normal rotational directions in a healthy subject (F). Abbreviations as in Figure 1.

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