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COMMENTARY

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Myocardial strain analysis in infants with pectus excavatum: A subtle method to detect myocardial impairment?

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Pectus excavatum (PE) is the most common morphological anomaly of the chest wall, accounting for >90% of all congenital chest anomalies[1] and is characterized by posterior depression of the sternum and the adjacent costal cartilages.[2] Its severity can be quantified by computed axial tomography or chest x-ray, using the Haller index-the ratio of the width of the chest to the distance between the sternum and the spine.[2,3] A ratio <2.5 is considered normal and values >3.1 are usually considered severe. Children with PE undergo regular echocardiography to assess heart structure and function to rule out various echocardiographic abnormalities affecting predominantly the right ventricle (RV), less frequent valves or, congenital heart abnormalities.[2] Despite the difficulties often encountered in imaging these patients, special attention should be paid to the size, function, and contour of the RV.

To date, several studies tried to evaluate the role of myocardial strain in patients with PE using different imaging modalities, namely, intraoperative transesophageal echocardiography,[4] or cardiac magnetic resonance (CMR) imaging .[5,6] Recently Sonaglioni et al.[7] found in 30 healthy subjects with PE using modified Haller index (MHI) >2.5, that abnormal chest anatomy progressively reduced the myocardial strain, in their PE subjects, but not in controls. However, this impairment was explained not to be due to subclinical myocardial dysfunction, but rather to reflect intraventricular dyssynchrony.[7] But no studies to date evaluated the effects of chest wall conformation in infants with PE.

In this issue of *Journal of Clinical Ultrasound*, Sonaglioni et al.[8] in a prospective case-control study assessed the impact of the possible influence of chest wall conformation on myocardial strain parameters in a consecutive population of 16 infants with PE (MHI >2.5) and 44 infants with normal chest shape (MHI ≤2.5). All infants underwent evaluation by a neonatologist, transthoracic echocardiography with two-dimensional speckle tracking echocardiography (2D-STE) analysis of both ventricles and MHI assessment (ratio of chest transverse diameter over the distance between sternum and spine), at two-time points: within 3 days and at about 40 days of life. By doing so, they directed their focus beyond standard echocardiographic parameters of systolic dysfunction. The novelty of this study is that in comparison to controls (MHI = 2.01 ± 0.2) at 2.1 ± 1 days of life, PE infants (MHI = 2.76 ± 0.2) were diagnosed with significantly smaller cardiac chambers dimensions. Interestingly, the biventricular contractile function and hemodynamics were similar in both groups of infants. Moreover, the left ventricular (LV) global longitudinal strain (GLS) (−16.0 ± 2.8 vs. −21.7 ± 2.2%), LV-global circumferential strain (GCS) (−16.3 ± 2.7 vs. −24.0 ± 5.2%), LV-global radial strain (GRS) (24.2 ± 3.0 vs. 31.5 ± 6.3%) and RV free wall longitudinal strain (RVFWLS) (−16.0 ± 3.2 vs. −22.3 ± 4.4%) were significantly reduced in PE infants versus controls (all $p < 0.001$). Sonaglioni et al. highlight that a strong inverse correlation between MHI and LV-GLS ($r = -0.92$), LV-GCS ($r = -0.88$), LV-GRS ($r = -0.87$), and RVFWLS ($r = -0.88$) could be found in PE infants in the perinatal period and, importantly, the analogous results were obtained and confirmed repeatedly at 36.8 ± 5.2 days after birth.

Authors mention that radial deformation strain and strain rate parameters were considered to be unreliable in the neonatal population[9] and that their approach was to measure LV myocardial strain and strain rate parameters in all three main directions (longitudinal, circumferential, and radial). This is in our opinion is an important and highly interesting approach that might influence the further strain echocardiography research in the neonatal population. The authors found that the impairment in myocardial deformation indices was evident in all three directions and was particularly evident at the mid and basal levels of each direction. They believed that the increased LV apical rotation might represent a compensatory mechanism to enhance ventricular output against basal sternal compression.[6,8] While this is an interesting theory this clearly needs to be confirmed in further studies.

We completely agree with the findings of Sonaglioni et al. that the myocardial strain impairment observed in PE infants might be primarily related to intraventricular dyssynchrony due to extrinsic thoracic compression, rather than the intrinsic depression of cardiac contractility. It is worth mentioning that the Sonaglioni et al. group has initiated, validated, and promoted this "modified" MHI in recent years,[10,11] with this group being very active in developing innovative methods for children.

In the current study, Sonaglioni et al. stated that the anterior chest wall deformity should be considered as a factor that might limit 2D-STE analysis and interpretation. We want to support their statement and add that the authors' findings, after more research in this field, may be included in respective strain echocardiography guidelines.[12–14] This knowledge gain—in our opinion—is of importance for all (both adult and pediatric cardiologists) diagnosing and treating PE patients. 2D-STE may be established as a new, easily obtainable, echocardiographic measure of clinical PE relevance.[7] Such relevant evaluation by a neonatologist, transthoracic echocardiography (TTE) parameters are urgently needed.

While one could argue about the low number of patients we may state that PE is a rare condition, and this prospective study on 16 infants with PE and a sufficient ($n = 44$) number of non-PE controls can be considered "large" when compared with similar pediatric studies previously published.

Sonaglioni et al.[8] promote that strain echocardiography is a simple, highly reproducible, echocardiographic measure being able to identify reduced heart function in infants with PE. The latter statement should be taken with some caution, as some authors believe that no imaging modality can enable a comprehensive assessment of PE severity and cardiac impact within a single examination.[15] Moreover, for preoperative image acquisition and analysis, all imaging modalities (e.g., chest computed tomography, stress echocardiography, and CMR) should be used for the assessment of structural and functional abnormalities in order to define the surgical strategy. Additionally, 3D transthoracic echocardiography can provide the incremental value over standard 2D TTE in assessing compression of the right heart before surgery in selected patients.[16]

Nevertheless, we agree with the author's notion that myocardial strain analysis adds to the utility of echocardiography to clinically monitor PE patients. We foresee the findings by Sonaglioni et al. provide essential information for cardiologists to understand the specific features of pediatric/congenital PE. Taken together, this prospective study by Sonaglioni et al. highlights the importance of strain analysis in pediatric PE. However, further studies are required to validate this data.

CONFLICT OF INTEREST

Martin Koestenberger and Evgeny Belyavskiy indicate no conflict of interests related to the content of this article. Martin Koestenberger is the current chair of the European Pediatric Pulmonary Vascular Disease Network (http://www.pvdnetwork.org).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed.

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