Validation of an artificial intelligence-based tool for automated evaluation of RV size and function from ultrasound examinations

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Background: The assessment of the right ventricular (RV) function is an essential part of every transthoracic echocardiographic examination. It plays an important role in the diagnosis and management of many diseases and conditions. In covid-19 patients, there is evidence showing that enlarged RV and abnormal Free Wall Strain (FWS) correlate with high mortality. Assessment of the RV in the Point of Care settings can assist the differential diagnosis and provide important clinical information in early stages, close to the onset of symptoms, however, it is done qualitatively by visual estimation and thus subjective and requires high level of expertise. The presented study aims to validate the use of a novel artificial intelligence tool (LVivo RV by DiA imaging analysis) that uses deep learning and image processing algorithms to automatically evaluate RV size and function from apical 4 chamber (4CH) focused or modified ultrasound clips.

Methods: A retrospective study of 100 patients who underwent routine echocardiographic examination was conducted in three medical centers in US and Israel. The apical 4CH focused or modified clips were interpreted by experts to evaluate RV size and function. The End Diastolic Area (EDA) measured manually by two sonographers and the FWS measured by semi-automated Velocity Vector Imaging software (VVI by Siemens) were compared to the same parameters obtained automatically by the LVivo RV, using linear regression and Bland Altman analysis.

Results: 100 cases were included, 39% females and 61% males. Mean age was 64.7 [19-92]. Mean BMI was 28.1 [6.8-17.6]. 74% had pulmonary hypertension and 19% had lung disease. 36% were considered abnormal by their fractional area change values and 64% were considered normal. Three cases were non-interpretable by the physicians thus excluded from the analysis. The LVivo RV was able to process 99% of the cases. Excellent correlation was obtained for EDA between the sonographers" average of manual measurements and the automated EDA by LVivo RV with r = 0.92 ($p < 0.0001$, 95%CI 0.88-0.94). The bias and limits of agreement for EDA were 0.87 ± 5.76cm^2. For FWS, 4 cases were manually excluded due to insufficient image quality. The Bland Altman analysis for FWS showed small bias and limits of agreement of 0.7 ± 12.2%. A very good correlation of r= 0.78, (95% CI 0.69-0.85) was found, indicating good compatibility between the methods. The specificity and sensitivity for FWS were 80% and 77% respectively, using an optimal cutoff value of -16%, and the overall agreement was 79%.

Conclusions: The performance of LVivo RV demonstrated a very good agreement with manual and semi-automated quantitative methods for RV assessment. LVivo RV provides fast, accurate, objective and reproducible results and has the potential to be used at the Point of Care settings as a powerful tool for RV size and function evaluation.

Abstract Figure.