# A deep learning approach for automatic echocardiographic right ventricular strain measurements using a limited dataset

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**Background:** Speckle tracking echocardiography provides quantification of myocardial deformation and is useful in the assessment of myocardial function. Right ventricular (RV) strain has been suggested as a sensitive tool for diagnosing cardiomyopathies and assessing long term patient outcomes for patients with pulmonary hypertension, severe tricuspid regurgitation and COVID-19 infection. Recent advances in deep learning (DL) have made promising advances in automating the labour-intensive delineation of regions of interest (ROIs). However, compared to echocardiograms with left ventricular (LV) strain, RV strain data is scarce, making DL models difficult to train.

**Purpose:** To investigate whether annotated LV strain data could be beneficial in training a DL model for automatic RV strain when using a limited RV dataset.

**Methods:** The dataset consisted of anonymized still frames from 141 echocardiograms of the RV in the RV-focused 4 chamber view with corresponding cardiologist-defined ROI. Exams included healthy subjects and patients with heart failure, valvular disease, and conduction abnormalities. ROIs and still images were extracted at the mid-systole, and then quality assessed by an experienced cardiologist as high, medium, or low. The dataset was randomly split into 68%/17%/15% sets for training, validation, and testing. A convolutional neural network for image segmentation (U-Net) with a residual neural network (ResNet50) encoder was used, with a combination of binary cross entropy and Dice loss functions. Augmentation, predefined ImageNet weights and pre-training were also employed. For pre-training, 715 still images in the apical 4 chamber view with LV defined ROIs were used, both in their original and horizontally flipped view. Predicted ROIs were reintroduced into commercially available echocardiogram analysis software to automatically calculate longitudinal strain (LS) values.

**Results:** The model pre-trained with the flipped LV images achieved the highest performance with a mean absolute difference of 1.26 percentage points (95% confidence interval (CI): 0.62–1.89 percentage points) between manually measured and DL-assisted LS. Median absolute LS difference was 0.85 (95% CI: 0.28–1.57) percentage points. A Bland-Altman plot revealed two outliers and no obvious trends. In comparison, the mean and median absolute LS differences for the model without pre-training were 1.87 (95% CI: 0.73–3.00) and 1.09 (95% CI: 0.56–1.63) percentage points, respectively.

**Conclusions:** The current study demonstrates that DL-assisted, automated RV strain measurement is feasible even with a small dataset, and that performance can be increased by using images annotated for LV strain. While the majority of the predicted RV strain results were within the typical range of intra- and interobserver variability, a few outliers were observed. These outliers could possibly be avoided with the use of larger datasets.