Classification of HFrEF based on echocardiography using machine learning to predict future HFrecEF events

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Background: In recent years, there have been sporadic reports of heart failure with recovered ejection fraction (HFrecEF), wherein the left ventricular EF (LVEF) has been improved by considering temporal changes in the LVEF. Although patients with HFrecEF are known to have a better prognosis than other groups, the type of heart failure associated with reduced EF (HFrEF) that subsequently transitions to HFrecEF is yet to be determined.
Purpose: In this study, we examined whether it is possible to predict future HFrecEF events by stratifying the HFrEF using machine learning based on previously recorded echocardiographic indices.
Methods: For 162 patients, with HFrEF and a history of hospitalization owing to heart failure, who underwent echocardiography in a stable hemodynamic state, stratification was performed via machine learning. Regarding temporal changes in the LVEF, 73 patients who underwent another echocardiography under stable conditions were investigated (52 with continued HFrEF and 21 with HFrecEF, with a median follow up of 397 days). HFrEF was defined as a condition for patients with an LVEF of less than 50%, and HFrecEF was defined as a condition for patients who initially had an LVEF of less than 50% but later improved. Patients with severe valvular disease, acute myocardial infarction, acute myocarditis, acute pulmonary embolism, post-cardiac surgery, and pericardial disease were excluded from this group. The random forest method was used as a classification method for machine learning.
Results: When 162 patients with HFrEF were stratified using machine learning, 63 were classified into Cluster 1 and 99 into Cluster 2. Cluster 1 patients showed a significantly higher tendency to transition to HFrecEF than Cluster 2 patients (p=0.001). The Gini coefficient was calculated to identify echocardiographic indices that are important for the purpose of stratification. As a result, LVEF, left ventricular endo-diastolic volume (LVEDV), the thickness of interventricular septum (IVSth), E/A ratio, and the maximum diameter of the inferior vena cava were found to be particularly important. Compared to Cluster 2 patients, Cluster 1 patients exhibited a significantly higher LVEF (41.5±5.9% vs 27.0±7.6%, $p<0.001$), lower LVEDV (93.6±36.8 mL vs 141.1±51.7 mL, $p<0.001$), and a higher IVSth (10.8±2.6 mm vs 9.4±2.5 mm, $p<0.001$).
Conclusion: Stratifying HFrEF via machine learning based on echocardiographic indices can help predict temporal changes in the LVEF and deduce the echocardiographic indices useful for improving LVEF.