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Identification of novel risk profiles for ventricular arrhythmias in hypertrophic cardiomyopathy through clustering analysis including left ventricular strain data

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Aims: The excess mortality in hypertrophic cardiomyopathy (HCM) patients is mainly attributed to the occurrence of ventricular arrhythmias (VA) and sudden cardiac death (SCD). The prediction of VA remains challenging and could be improved. The aim of the study was to characterize VA risk profile in HCM patients through clustering analysis combining clinical and conventional imaging parameters with information derived from left ventricular longitudinal strain analysis (LV-LS).

Methods: A total of 434 HCM patients (65% men, mean age 56 years) were retrospectively included from two referral centers from two different countries and followed longitudinally (mean duration 6 years). Mechanical and temporal parameters were automatically extracted from the LV-LS segmental curves of each patient in addition to conventional clinical and imaging data. A total of 287 features were analyzed using a clustering approach (k-means). The first endpoint for ventricular arrhythmias (VA) included suspected SCD, aborted cardiac arrest, appropriate ICD therapy (AIT), sustained ventricular tachycardia (SVT) and non-sustained ventricular tachycardia (NSVT) during follow-up.

Results: 4 clusters were identified with a higher rhythmic risk for cluster 1 and 4 (VA rates of 26%(28/108), 13%(13/97), 12%(14/120), and 31%(34/109) for cluster 1,2,3 and 4 respectively) (Figure 1). These 4 clusters have been mainly separated based on LV strain parameters with severe and homogeneous decrease of myocardial deformation for cluster 4 (global longitudinal strain (GLS) -11%), a small decrease for cluster 2 and 3 (GLS -17.2 and -16.3%, respectively) and a marked mechanical and temporal dispersion for cluster 1 associated with a moderate decrease of the GLS (-15.3%; $p < 0.0001$ for GLS comparison between clusters) (Figure 2). Patients from cluster 4 had the most severe phenotype (mean LV mass index 123 vs. 112 g/m²; $p=0.0003$) with marked diastolic dysfunction (left atrial volume index (LAVI) 46.6 vs. 41.5 ml/m² for others clusters; $p=0.04$) and impaired exercise capacity (% predicted peak work 58.6 vs. 69.5%; $p= 0.025$). Patient from cluster 2 had the less severe phenotype (mean LV mass index 99.6 vs. 121 g/m²; $p=0.0001$ and LAVI 37.2 vs. 44.3 ml/m²; $p=0.04$). Patients from cluster 3 and 1 had a moderate phenotype and were older in cluster 3 (mean age 62.1 vs. 54.1 years; $p < 0.0001$) and had more obstructive form in cluster 1 (peak gradient LV outflow tract ≥ 30 mmHg for 36 vs. 23% of patients; $p=0.046$) with a larger left atrium size (LAVI 45.8 vs. 41.7 ml/m²; $p=0.0023$).

Conclusion: Using a clustering approach processing LV-LS parameters in HCM patients identified 4 clusters with specific LV-strain patterns and different rhythmic risk level. In the future, the automatic extraction and analysis of LV strain parameters could help to improve the risk stratification for SCD in HCM patients.

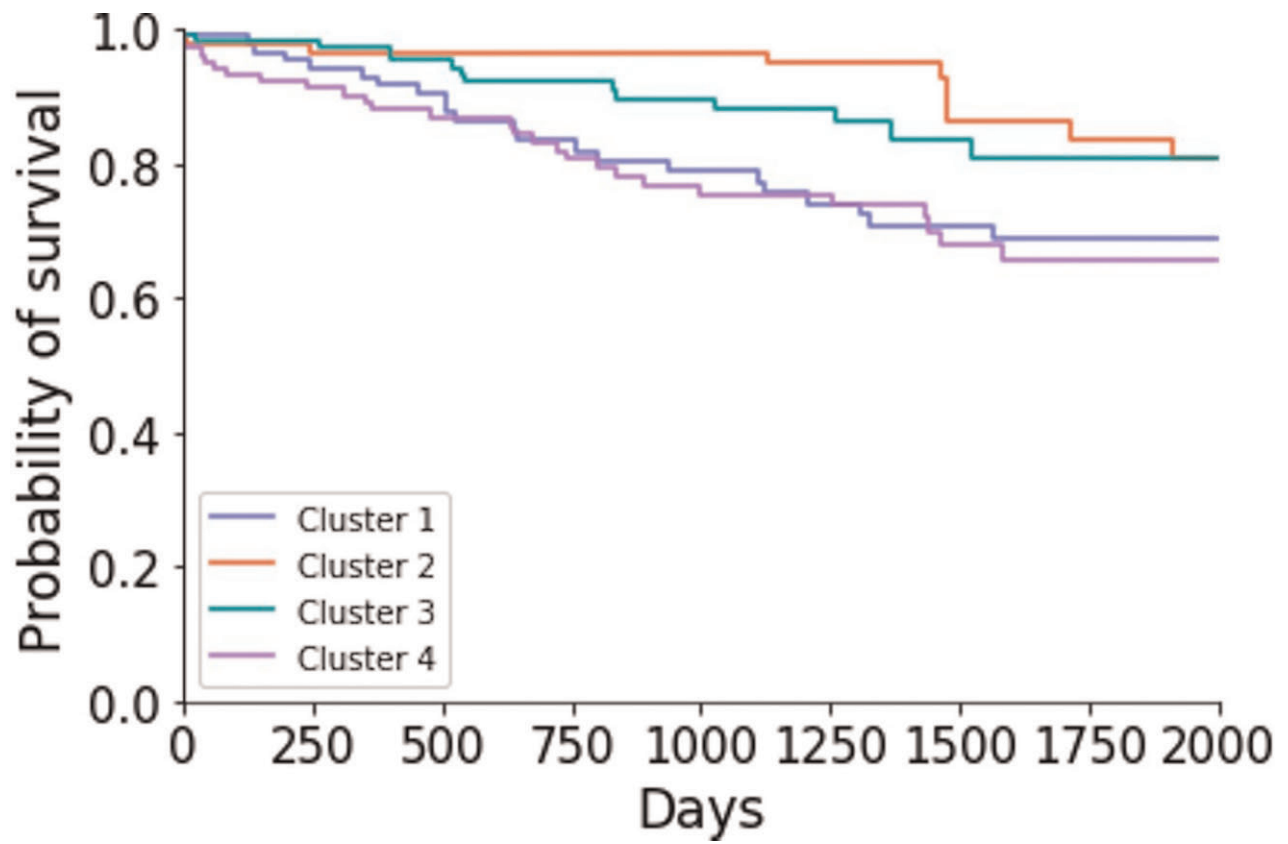


Figure 1: Survival curves

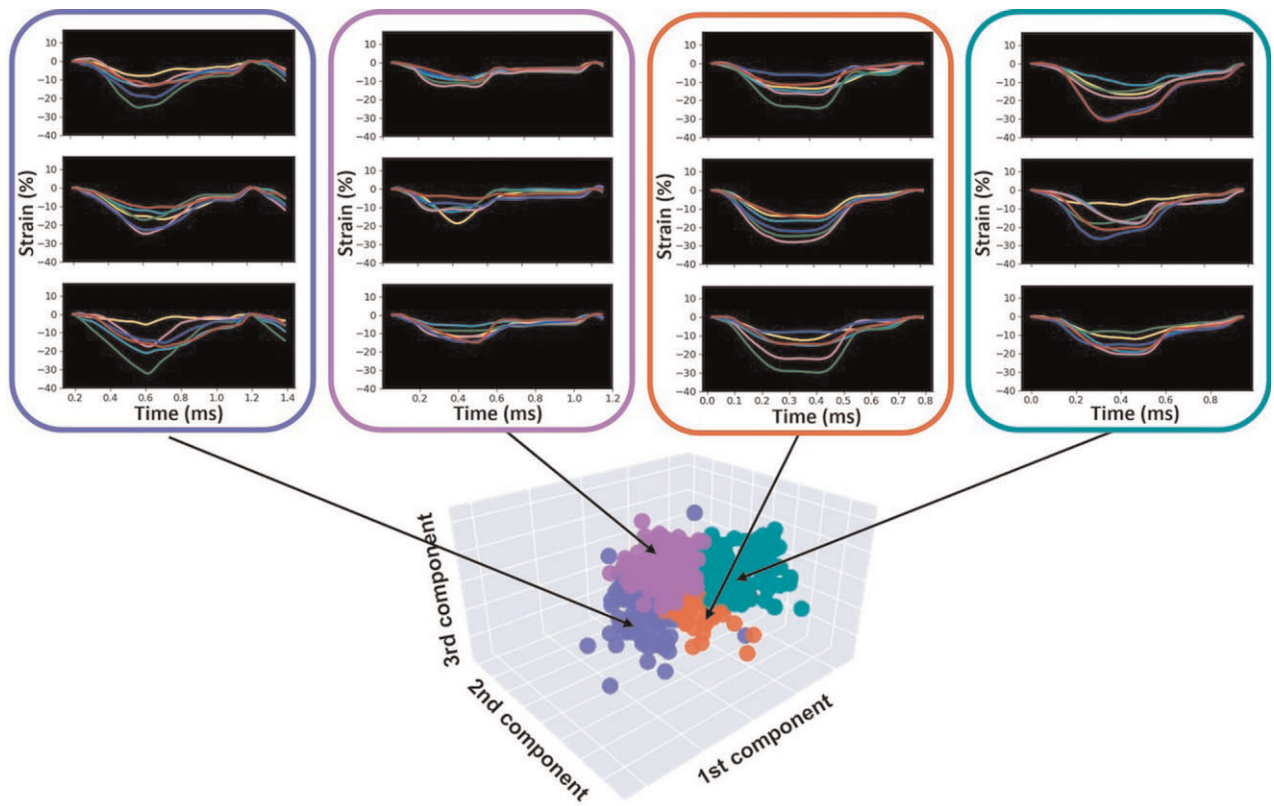


Figure 2: Different strain patterns