Exploring The Impact of Left Ventricular Mass Increase on ECG pattern Through Computational Modeling

Mohammadreza Kariman*, Karli Gillette, Matthias Gsell, Anton J Prassl, Gernot Plank, Christoph Augustin

Medical University Graz
Graz, Styria, Austria

Introduction: Left Ventricular Hypertrophy (LVH) is a condition characterized by an increase in the mass and volume of the left ventricle, typically manifesting as thickening of the ventricular wall or dilation. Given that prolonged LVH can lead to life-threatening complications, ongoing research continues to prioritize understanding its underlying mechanisms.

Objective: This study explored the impact of anatomical changes on electrocardiogram (ECG) patterns in LVH. It aimed to determine whether observed ECG characteristics in LVH primarily arise from anatomical modifications such as wall thickening and ventricular dilation, or if shifts in electrophysiological properties play a pivotal role in defining these patterns.

Method: Various stages of eccentric and concentric hypertrophic cardiac model, characterized by wall thickening and ventricular dilation, were generated using Finite Element Analysis (FEA). Activation sequences in these models were simulated using an electrophysiology simulator, leading to the generation of ECGs. These ECGs from models exhibiting hypertrophy were analyzed against the baseline ECG from the healthy model, facilitating a comprehensive analysis of the changes induced by hypertrophy.

Result: Activation sequences in dilated ventricle models closely resembled those of healthy models, while those from models with thickened walls notably differed. Both types of hypertrophy demonstrated extended QRS durations. ECG characteristics in eccentric hypertrophy closely aligned with established diagnostic criteria for LVH, contrasting with the distinct patterns observed in concentric hypertrophy, which did not meet these clinical markers.

Conclusion: Results indicate that the increased QRS duration observed in both eccentric and concentric hypertrophy models reflects extended depolarization time in the left ventricle. While the ECGs from ventricular dilation in eccentric hypertrophy align with clinical markers, the wall thickening in concentric hypertrophy does not primarily account for the ECG characteristics identified in standard criteria for diagnosing LVH. This suggests a significant role for electrophysiological adaptations in concentric hypertrophy.