Multidimensional Vectorcardiography. Is More Better?

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Aims: Vectorcardiography (VCG) is generated by projecting signals from several leads onto three main orthogonal axes. There is evidence that by doing this projection, some relevant diagnostic information may be lost. We investigated a new way to reduce this information loss. We generated a 12-dimensional VCG (VCG₁₂D) from the standard 12-lead ECG system and compared its performance in diagnosing myocardial infarction (MI) with standard Frank VCG (VCG_Frank) and with a three-dimensional projection of the 12-lead ECG obtained with principal component analysis (VCG_PCA).

Methods: All 148 MI patients and 52 healthy controls from the PTB Diagnostic ECG Database were selected. Standard 12-lead ECG and VCG_Frank were available for all subjects. We generated VCG₁₂D using all the leads of the standard 12-lead ECG and associating them with coordinates in a 12-dimensional space. A set of standard parameters in the VCG literature (loop-area, loop-perimeter, etc.) were computed for VCG₁₂D, VCG_Frank, and VCG_PCA. Then, single feature logistic regression was used to assess performance of each individual parameter in diagnosing MI, for VCG₁₂D, VCG_PCA and VCG_Frank, respectively. Additionally, a multivariate lasso regression model was generated for VCG₁₂D, VCG_PCA and VCG_Frank, respectively, by using all parameters as initial input.

Results: When diagnosing the MI condition with single feature logistic regression, the best single feature performances for VCG_Frank and VCG₁₂D were comparable, having AUC of 0.94 and 0.95 respectively. Performance for VCG_PCA was poorer, with AUC of 0.81 for its best feature. When using lasso, AUC was 0.93 for VCG_Frank, 0.97 for VCG₁₂D and 0.90 for VCG_PCA.

Conclusion: VCG₁₂D performs better than VCG_PCA and not significantly better than VCG_Frank. This partially confirms that projecting information into 3D may cause a loss of diagnostically relevant information. Nonetheless, differences between VCG₁₂D and VCG_Frank are not significant and more research is needed to investigate potential benefits of a multidimensional VCG.