Strain Curve Classification Using Supervised Machine Learning Algorithm with Physiological Constraints

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Background, Motivation, and Objective

Echocardiography is the most-widespread modality for cardiac imaging. Global left ventricular function is commonly evaluated by measurement of the ejection fraction, whereas regional function is evaluated by visual assessment of wall thickening. The latter qualitative analysis is physician-dependent and is prone to the assessment variability. Strain imaging is an established method, based on speckle tracking echocardiography (STE) that enables quantification of myocardial deformation by generation of spatiotemporal strain curves.

Currently, only the assessment of the peak global longitudinal strain is employed in clinical practice. This is due to the uncertainty about the accuracy of separating physiological (normal or pathological) curves from artefactual curves, caused by poor tracking. Thus, the fundamental principle of this study is to ensure the high reliability of the classification of curves as 'physiological'.

Statement of Contribution/Methods

We present a supervised machine learning, physiologically-constrained, fully automatic algorithm, trained with a labeled data, for classification of strain curves into physiological or artefactual classes. Data set of 415 healthy subjects, with 3 cineloops each, corresponding to the 3 standard 2D longitudinal views, was processed by a previously published, in-house STE software, termed *K-SAD*. As a result, we obtained 14940 strain curves, originated from endocardial and epicardial layers, in each of the 6 myocardial segments. The strain curves were independently labeled by two experts and used for training and testing with cross-validation.

Results/Discussion

We report on average accuracy of 98% with a standard deviation of 3.2% for the classification of physiological curves. The positive predictive value for a physiological strain curve is 91.2 %.

The pipeline of echocardiographic clip acquisition and analysis consists of several stages, each of which has the potential to create a non-physiological curve. This study presents a generalized algorithm that provides the clinicians with an objective indication of whether the segmental strain curves are physiological or artefactual. This is as a necessary step for a similar separation in pathological conditions, to allow full utilization of the temporal information concealed in layer-specific segmental strain curves.

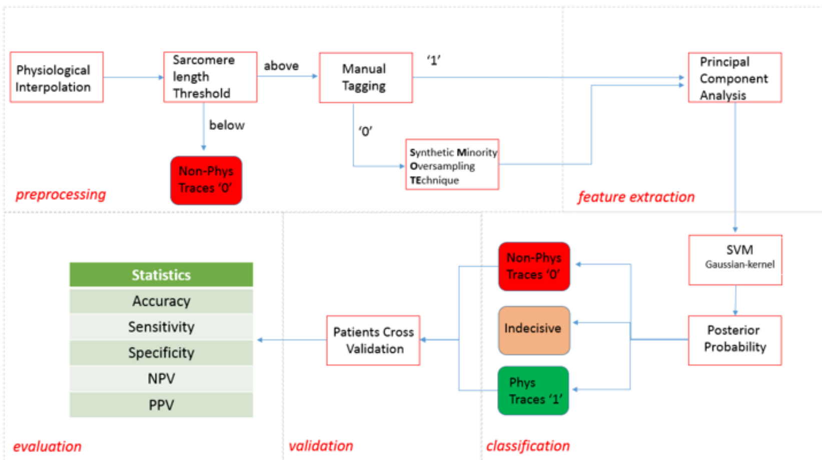

Fig 1. **Flowchart of the Training Algorithm**