Computer Atlas of the Dipole Electrocardiotopography

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Abstract. *Computer Atlas of the dipole electrocardiotopography (DECARTO-Atlas) contains decartograms, vectorcardiograms, and clinical data for more than 80 different pathological states of the heart. DECARTO-Atlas is equipped with interactive tools for navigating through the database of precedents. The decartograms of major pathological categories have representative, physiologically meaningful, and easy to remember patterns. This greatly simplifies the process of making informed and reasonable diagnostic decisions, especially when analyzing complicated combined pathology.*

Keywords: Electrocardiotopography, Vectorcardiography, Cardioelectric Potential Visualization, Diagnostic Methods

1. Introduction

Generally accepted standard electrocardiography does not always provide necessary reliability and diagnostic accuracy, especially at early stages of cardiovascular diseases. A more exact description of the electrophysiological state of the heart can be obtained through efficient mathematical processing and analysis of electrocardiographic data.

The DECARTO method proposed in [1] can significantly increase the diagnostic efficiency of electrocardiology. Theoretical background and the results of clinical and statistical studies of this method are described in a series of articles and monographs [2, 3]. New methods and criteria have been developed for the diagnosis of pathological states of the heart. The use of new decartography criteria has been shown to increase the diagnostic efficacy of the DECARTO in the clinical studies (e.g. [4, 5]). Compilation of the DECARTO-Atlas is a necessary step for summarizing the data previously obtained and further development and practical application of the method.

2. Subject and Methods

The Dipole ElectroCardioTopoGraphy (DECARTO) is mapping of electrophysiological processes and characteristics of the heart with reference to anatomical landmarks based on simple models containing background information obtained from three components of the heart vector (measured directly by the vectorcardiographic leads or synthesized from the 12 standard leads). Components of the heart vector are transformed into decartograms, i.e., maps of main states and electrophysiological characteristics of the myocardium projected onto a sphere tightly surrounding the heart. The main types of decartograms are listed below.

Instantaneous maps of depolarization – the distribution of the three major states of the myocardium: rest, activation (depolarization wave front spread), and total depolarization. Animation of these states allows visualization of spatial-temporal distribution of excitation.

Instantaneous maps of repolarization – the distribution of the myocardium polarization level at the consecutive time points of the repolarization process. These maps allow identification of vulnerability to arrhythmias.

Isochronous maps of depolarization – the distribution of time of arrival and departure of myocardial activation; these maps reflect the movement of the wave front of depolarization in the tangential direction to the wall of the heart; provide recognition of ventricular blockades, syndrome of pre-excitation of ventricles, and areas of postinfarction necrosis.

Activation duration maps – the distribution of the activation state duration, reflect the movement of the wave front of depolarization in the radial direction to the wall of the heart. These maps provide recognition of ventricular hypertrophy and blockades.

Atrial decartograms – show the distribution of isochrones of depolarization and size of the atrial wall; they are useful in recognizing the atrial enlargement.

3. Results

Reliably verified pathological cases were selected and included into the computer dipole electrocardiotopography DECARTO-atlas. The atlas presents decartograms, vectorcardiograms, and clinical data for various pathological states of the heart, such as left ventricular hypertrophy, right ventricular hypertrophy, left atrial enlargement, right atrial enlargement, biatrial enlargement, myocardial infarctions of different locations, conduction disturbances, etc.; normal cases are also presented. A short list of categories of pathological heart states contained in the atlas is shown in Fig. 1.

- Norm
  - Horizontal heart position
  - Vertical heart position
- Chamber hypertrophy and enlargement
  - Left ventricular hypertrophy
  - Right ventricular hypertrophy
  - Biventricular hypertrophy
  - Left atrial enlargement
  - Right atrial enlargement
  - Biatrial enlargement
- Myocardial infarction
  - Anterolateral
  - Inferolateral
  - Lateral
  - Inferior
  - Posteroinferior
  - Inferoposterior
- Intraventricular block
  - Right bundle branch block
  - Left bundle branch block
  - Left anterior fascicular block
  - Left posterior fascicular block
  - Bifascicular block
- Wolf-Parkinson-White preexcitation
- Cardiomyopathy
  - Hypertrophic
- Combined pathology
  - Block & Infarction
  - Block & Hypertrophy
  - Block & Hypertrophy&Infarction
  - …

Fig. 1. DECARTO-atlas. List of the main categories of pathological heart states.

4. Discussion

The decartograms of major pathological categories have representative, physiologically meaningful, and easy to remember patterns. This greatly simplifies the process of making

informed and reasonable diagnostic decisions, especially when analyzing complicated combined pathology.

Figure 2 shows decartograms for various complicated combined pathological states. Decartograms of the two consecutive ECGs with a considerable time interval between records are presented above; normal decartograms are given for comparison. Below the decartograms typical for individual components of the combined pathology are presented. The typical patterns are clearly seen on the first record: the right bundle branch block (a considerable delay of the activation arrival in the area marked with circle); the left anterior fascicular block (the activation moves right-up, as marked by the arrow). The second record reveals new pathological changes: left ventricular hypertrophy (increased activation duration in the left ventricle, seen as light grey area surrounded by dark grey on the activation duration decartogram); extensive myocardial injury scar of posterior location spreading to the lower left ventricular wall (the activation area is significantly decreased, as if there is a barrier to the spread of excitation appears; it is marked by the double black line).

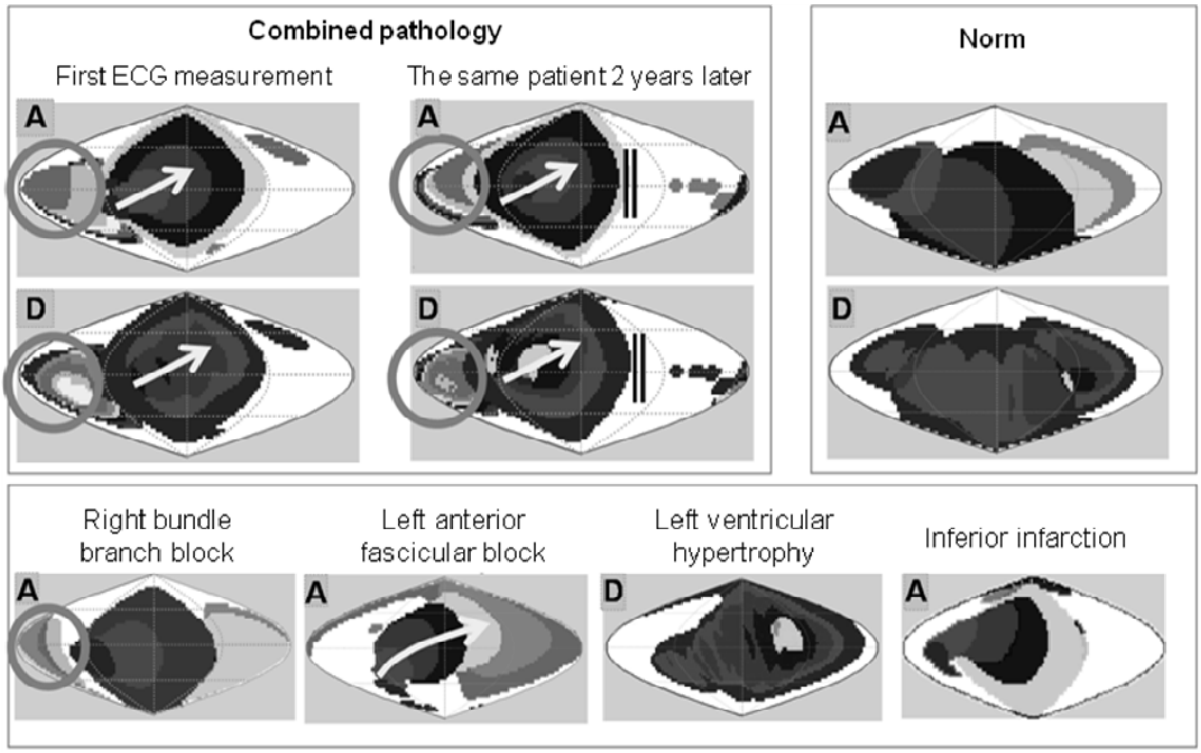

Fig. 2. Decartograms in complex combined pathology. A, activation arrival; D, activation duration.

5. Conclusions

The computer DECARTO-Atlas is a useful tool for making diagnostic conclusions. It will contribute to further accumulation of clinical experience and electrocardiographic statistical research. DECARTO-Atlas is designed for professionals and students, and for those interested in further improvement and development of the dipole electrocardiotopography.

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