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New micro waveforms firstly recorded on electrocardiogram in human

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ABSTRACT

In our study, not only the P-QRS-T waves but also the micro-wavelets before QRS complex (in P wave and PR segment) and after QRS complex (ST segment and upstroke of T wave) were first to be identified on surface electrocardiogram in human by the "new electrocardiogram" machine (model PHS-A10) according to conventional 12-lead electrocardiogram connection methods. By comparison to the conventional electrocardiogram in 100 cases of healthy individuals and several patients with arrhythmias, we have found that the wavelets before P wave theoretically reflected electrical activity of sinus node and the micro-wavelets before QRS complex may be related to atrioventricular conduction system (atrioventricular node, His bundle and bundle branch) potentials. Noninvasive atrioventricular node and His bundle potential tracing will contribute to differentiation of the origin of wide QRS and the location of the atrioventricular block. We also have found that the wavelets after QRS complex may be associated with phase 2 and 3 repolarization of ventricular action potential, which will further reveal ventricular repolarization changes.

Introduction

Einthoven [1] firstly recorded the electrocardiogram in a clinically applicable fashion with a string galvanometer in 1903. Since then, it has endured more than one century of uninterrupted and flourishing use. The ECG technique has been continuously transforming from the very beginning. The computer has been widely used in analysis and storage for electrocardiogram. The network consultation and remote telemetry have been introduced to clinical diagnosis. The derivative ways of electrocardiogram has been increased. Consequently new analysis index surges frequently. The electrocardiogram theory has been evolving continuously through history and its clinical use has been expanding gradually. The theory has been transformed from the cell level of action potential to molecular biology. It is used to interpret electrocardiogram changes through theories of ion channel and genetic modification, and to diagnose inherited arrhythmia [2–4]. Although electrocardiogram has been used and improved for so many years, it has developed zero meaningful breakthroughs on the basic information (P-QRS-T wave) throughout the years. The development of the clinical medicine demands more electrocardiogram signal from electrocardiogram in disease diagnosis. (1) Regarding the arrhythmic analysis, the conventional electrocardiogram can only record the P-QRS-T wave, while unable to record the micro waveform of specialized conduction system. The missing information may have effect on direct function calculation of sinus node and the location of the atrioventricular block. It is difficult to diagnose and verify a wide or narrow QRS complex tachycardia because of the tiny P wave hid in the fast QRS-T wave. (2) The most common and complicated modification among the electrocardiogram change is ventricular repolarization (ST-T change). Clinicians are trying to discover myocardial ischemia manifestations and new predictors of malignant arrhythmia which are more sensitive than the ST-T change in analysis of ventricular depolarization. (3) The research for the mechanism and pharmaceutical treatment of inherited arrhythmia has entered into the molecular biology field. So it requires recording more detailed micro electrical changes from electrocardiogram to reflect this level.

With these confused clinical problems, we have devoted ourselves to the electrocardiogram study for many years. With the help of Physio Sign research team, we used the "new electrocardiogram" (model PHS-A10, number of market access: CE/13485) designed and developed by the Physio Sign Company. Not only the P-QRS-T waves but also the micro-wavelets (before P wave, in P wave, PR segment, ST segment and upstroke of T wave) can be recorded according to conventional 12-lead electrocardiogram connection methods. We have tested 100 cases of healthy individuals and several patients with arrhythmias. By comparison to the conventional electrocardiogram (Fig. 1), the micro waveform have

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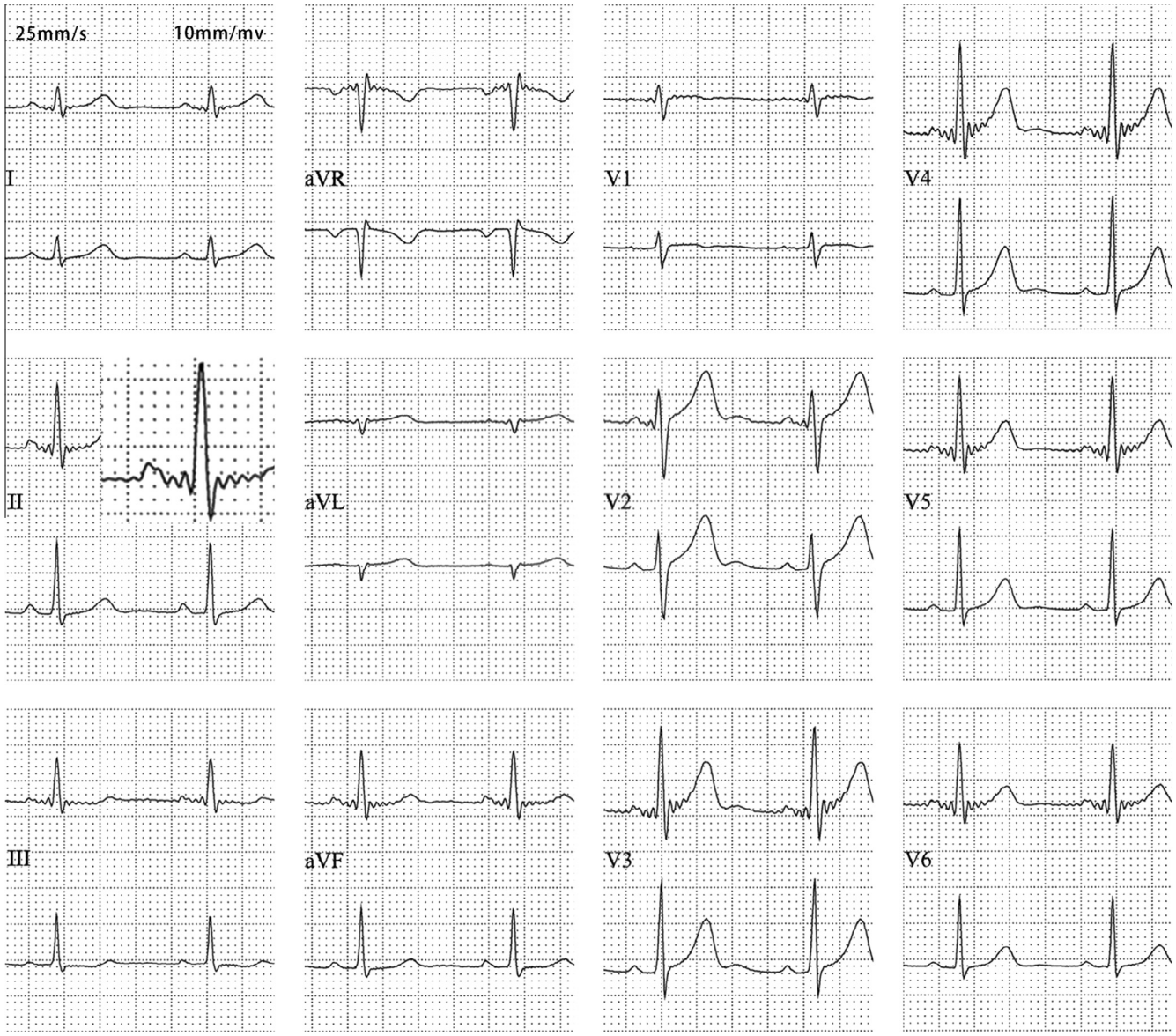

Fig. 1. Simultaneous tracing of a new electrocardiogram (upper trace) and traditional electrocardiogram (lower trace). Upper tracing recorded the new micro waveform.

been verified that these are reality and do indeed present a specific clinical meaning.

Hypothesis

(1) The micro-wavelets before P-wave may be related to electrical activity of sinus node. At present, the TP segment before P waves on surface electrocardiogram is characterized by baseline. However, sinus node electrogram have recorded sinus node potentials before P waves [5–8]. So the wavelets before P waves on "new electrocardiogram" theoretically reflect electrical activity of sinus node.

(2) The wavelets before QRS complex may be related to atrioventricular conduction system (atrioventricular nodal, His bundle, bundle branch) potentials. P wave on surface electrocardiogram presents atrial depolarization, and the micro waveform of atrioventricular conduction system (atrioventricular nodal, His bundle, bundle branch) potentials can't be recorded yet. Intracardiac electrophysiology study can record His bundle and bundle branch potentials [9–18], suggesting the wavelets before QRS complex (in P wave and PR segment) on "new electrocardiogram" may be related to atrioventricular nodal, His bundle, bundle branch potentials.

(3) The wavelets after QRS complex (ST segment and upstroke of T wave) may further reveal ventricular repolarization changes. On the conventional electrocardiogram, ST segment and T wave are smooth, corresponding to early phase 2 and 3 repolarization of ventricular action potential, respectively. They are associated with many ions (sodium, calcium, potassium and so on) current. The wavelets after QRS complex (ST segment and upstroke of T wave) increase new repolarization indictors, which help for further revealing ventricular repolarization changes.

Basis for the hypothesis

Why "New electrocardiogram" can record the micro waveform which conventional electrocardiogram couldn't?

The PHS-A10 electrocardiogram is a new device created by EmCG US company using the latest technology of the international