Detection of the Ca$^{2+}$ overload in patients presenting with delayed afterdepolarization using cardiac magnetic field mapping at rest

VM. Sosnytskyy, LA. Stadnyuk, TV. Sosnytska
National Scientific Center "M.D. Strazhesko Institute of Cardiology " MAS of Ukraine
P.L. Shupik Medical Academy for Postgraduate Education, Kiev, Ukraine

Background
- The heterogeneity of cardiac action currents should be measured in diseased myocardial segments under physiological conditions by means of non-invasive imaging of cardiac electrogensis with magnetic field mapping.
- Magnetocardiography (MCG) is a novel device capable of noninvasive recording of the magnetic field generated by the heart's action currents.

Aim of the study
- The overall objective of the present study was to demonstrate the efficacy of magnetocardiography in the diagnosis of the Ca$^{2+}$ overload in an area of the heart in patients presenting with delayed afterdepolarizations (DADs).

Methods
- Standard clinical examination (e.g. Tissue Doppler echocardiograms, 12-channel ECG, 24-h Holter monitoring) and MCG were performed in 24 patients (age 27 1.9) affected by DADs and 22 (age 25 2.5) healthy controls.
- MCG was recorded by means of 4x3-channel MCG system in an unshielded setting.
- Magnetic field maps were plotted in the course of the ventricular repolarization interval between the peak (T(peak)) and the end (T(end)) of the T wave (Tpeak-end) and electric diastole intervals.

The MCG 7-Channel Device

MCG Measurements
- Current density vector (CDV) maps were plotted by the magnetic moments method of the "inverse problem solution".
- MCG based indices, namely direction of the largest CDV, current density total sum and maximum value of current density vectors during Tpeak-Tend and electric diastole interval were performed utilizing an automated MCG analysis program.

Results
Two MCG based indices showed a significant difference between patients and the control group.

Subject 1: patient with DADs

Subject 2: patient without DADs (control)

Conclusions
- Although Tpeak-Tend interval was shortened in patients presenting with DADs they had additional current density peak during electric diastole interval. We localized and visualized the current source distribution corresponding to the Ca$^{2+}$-activated currents successfully. If such current reaches threshold, it induces the onset of a focal extrasystole. We also found effect of verapamil, the prototype calcium-channel blocker, on these indices in DADs patients.
- MCG is a quick and easy tool to detect transmural heterogeneity of cardiac action currents in patients with VE.
- We conclude MCG is a promising procedure for a noninvasive testing as well as screening method as for localization of an area of the heart with the Ca$^{2+}$ overload which provides a substrate that favors electrical abnormalities and might initiate a focal extrasystole.