

Detection of the Ca²⁺ overload in patients presenting with delayed afterdepolarization using cardiac magnetic field mapping at rest

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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 electrogenesis 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 Ca²⁺ 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 (T_{peak-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 T_{peak}-T_{end} and electric diastole interval were performed utilizing an automated MCG analysis program.

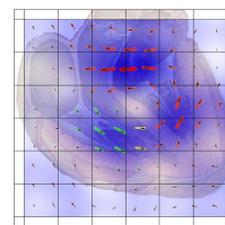
Results

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

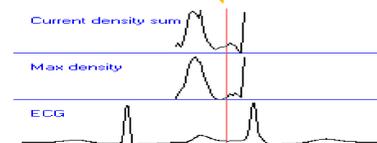
Subject 1: patient with DADs

MCG

ECG



CDV map

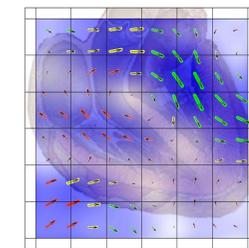


- Although T_{peak}-T_{end} interval was shortened in patients presenting with DADs they had additional current density peak during electric diastole interval. We localized and visualized the current source distribution corresponding to the Ca²⁺-activated currents successfully. If such current reaches 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.

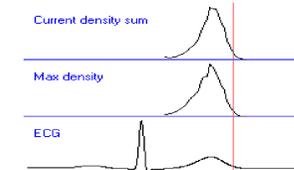
Subject 2: patient without DADs (control)

MCG

ECG



CDV map



- Typical MCG based indices (current density sum and maximum value of current density vectors) behavior during the T_{peak}-end and electric diastole interval in patients without VE.

Conclusions

- 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 non-invasive testing as well as screening method as for localization of an area of the heart with the Ca²⁺ overload which provides a substrate that favors electrical abnormalities and might initiate a focal extrasystole.