Abstract: P3748
Reproducibility of magnetocardiographic imaging of atrial electrophysiology in patients with paroxysmal atrial fibrillation and healthy subjects

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Since tangential currents are better detectable as magnetic than electric signals at the body surface, magnetocardiographic mapping (MCG) can be more sensitive than ECG to atrial electrophysiologic alteration, such as abnormal interatrial conduction and/or dispersion of atrial repolarization, as mechanisms underlying the occurrence of paroxysmal atrial fibrillation (PAF). We had previously reported that visual analysis of the magnetic field distribution (MFD) dynamics may evidence an inversion of atrial MFD early during the P-wave suggesting atrial repolarization overlapping depolarization along the descending limb of the P-wave (Guida et al 2018). Aim of this study was to systematically evaluate the reproducibility of such observation and to evaluate the reliability of non-invasive MCG imaging of atrial electrophysiology carried out in our unshielded hospital laboratory.

Methods: MCG was recorded, in sinus rhythm (SR), with an unshielded 36-channel SQUID-system providing about 30–40 fT/√Hz sensitivity in bandwidth DC-250Hz (sampling frequency 1kHz). MCG data of 40 patients with PAF (PAFp) and 40 age-matched healthy controls (HC), with at least two subsequent recordings to evaluate reproducibility and optimal S/N ratio, were retrospectively analyzed. The dynamics of atrial MFD was studied, at 1 ms time resolution, to identify the onset of atrial repolarization (AR), in respect of the P-wave and PR interval duration. To localize atrial sources, the inverse solution was calculated with the Effective Magnetic Dipole (EMD) model, also after subtraction of the atrial repolarization. MCG parameters of atrial electromagnetic vector (EMV) were also calculated. The reproducibility was evaluated with the intraclass correlation coefficient (ICC).

Results: High resolution analysis of atrial MFD dynamics confirmed that atrial repolarization field overlaps atrial depolarization during the last third of the P-wave in most investigated subjects. Thus, subtraction of average AR MFD is necessary to discover and image the left atrial depolarization pathway. The reproducibility of MCG estimate of atrial MFD and of EMV parameters was good (average ICC > 0.7). In PAFp, MCG evidenced abnormality of AR MFD consistent with dispersion of atrial repolarization (Figure 1), as previously reported with simultaneous MCG and MAP recordings (Fenici & Brisinda, 2007); however, such evaluation is reliable only with optimal S/N ratio during the PR interval.

Conclusions: Unshielded MCG in SR is sensitive enough to non-invasively image atrial electrophysiology. Visual analysis of atrial MFD dynamics with high temporal resolution reproductively confirmed that AR MFD initiates early, within the descending limb of the P-wave, masking the deeper magnetic field generated by left atrial depolarization currents. MCG can image abnormality of AR MFD in PAFp, suggestive of dispersion of atrial action potential duration. Quantitative estimate of atrial EMV parameters differentiates PAFp from HC.
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Conclusions: Unshielded MCG in SR is sensitive enough to non-invasively image atrial electrophysiology. Visual analysis of atrial MFD dynamics with high temporal resolution reproducibly confirmed that AR MFD initiates early, within the descending limb of the P-wave, masking the deeper magnetic field generated by left atrial depolarization currents. MCG can image abnormality of AR MFD in PAFp, suggestive of dispersion of atrial action potential duration. Quantitative estimate of atrial EMV parameters differentiates PAFp from HC.