Detection of Rapid Atrial Arrhythmias in SQUID Magnetocardiography

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To detect atrial arrhythmias (AA) is one of challenging subjects in magnetocardiography (MCG). As the atrial arrhythmias such as atrial fibrillation (Afb) and atrial flutter (Afl) generally have irregular rhythm and atrio-ventricular conduction, the MCG signal cannot be improved by QRS averaging; therefore a SQUID MCG system having a high SNR is required to measure informative atrial excitation with a single scan. In the case of Afb, diminished f waves are much smaller than normal p waves because the sources are usually located on the posterior wall of the heart. In this study, we utilize an MCG system measuring tangential field components, which is known to be more sensitive to a deeper current source. The total noise level of the whole system in a magnetic shielded room was 10 fT/$\sqrt{\text{Hz}}$ @ 1 Hz and 5 fT/$\sqrt{\text{Hz}}$ @ 100 Hz. We measured the MCG signals of patients with chronic Afb and Afl. Clinical potential of AA measurement in MCG is to find an aspect of a reentry circuit and to localize the abnormal stimulation. Surgical procedures such as the Cox maze III are not guided by electro-physiologic (EP) examination of individual patients. Therefore, they might contain unnecessary incisions or be inappropriate for certain patients. Even if a surgeon would conduct an EP examination, the test would be an invasive one. To give useful information about the abnormal excitation noninvasively, we propose a separative synthetic aperture magnetometry (sSAM) method. The basic idea of sSAM is to visualize current source distribution corresponding to the rhythmic Afb or Afl fields, which are separated from the ventricular signals and the Gaussian sensor noises. The comparison between the measurements in supine and prone positions for f waves has been conducted as well.

keywords : SQUID, magnetocardiography, atrial arrhythmia, synthetic aperture magnetometry, reentry tachycardia