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Assessing the Utility of Using Signal-Averaged Electrocardiography as a Screening Tool for Fibrosis Detection in Cardiac Magnetic Resonance Imaging

BACKGROUND: Myocardial fibrosis can contribute to ventricular arrhythmias and is a common feature in heart failure and cardiac morbidity.¹ A signal-averaged electrocardiogram (SAECG) is a non-invasive test used to detect late potentials, which are manifestations of delayed myocardial depolarization with slow conduction that can result in monomorphic ventricular tachycardia in high-risk patients. These late potentials often characterize areas of myocardial fibrosis.² However, the cardiac magnetic resonance imaging (cMRI) is the preferred technique for detecting fibrosis, using late gadolinium enhancement (LGE) and T1 mapping, as well as characterizing myocardial tissue and risk stratification for ventricular arrhythmias.³ Nonetheless, cMRI has limitations due to its limited access, logistical concerns such as time and cost, and its contraindication for certain patients. Currently, there is minimal data evaluating how SAECG findings correlate with cMRI imaging in fibrosis detection.⁴

PURPOSE: This study investigates whether positive SAECGs, as defined by late potentials, correlate with the fibrosis identified in cMRI, potentially establishing a more convenient method for risk stratification in patients at high risk for ventricular arrhythmias.

METHODS: SAECGs were performed on 36 patients scheduled for cardiac MRI. Patients with significant cMRI artifacts or a standard ECG showing a wide QRS complex (>120 milliseconds(ms)) were excluded from data analysis. A positive SAECG is defined as meeting at least one of three standard abnormal criteria: 1) QRS complex ≥ 114 ms, 2) root mean square voltage of the terminal 40 ms of the QRS complex ≤ 20 μ V, and 3) duration of the terminal QRS complex amplitude signals < 40 μ V to be > 38 ms. SAECG and cMRI were then compared. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, positive likelihood ratio (LR+), negative likelihood ratio (LR-), and the correlation coefficient of SAECG in detecting fibrosis as identified on cMRI were calculated.

RESULTS: Sixty-nine percent of patients had fibrosis on cMRI while 46.2% of patients had a positive SAECG. The sensitivity and specificity of SAECG were 66.7% and 100%. The PPV and NPV were 100% and 57.1%. The accuracy was 76.9% with an infinite LR+ and a LR- of 0.33.

CONCLUSION: SAECG is highly specific in identifying patients with myocardial fibrosis on cMRI, but has a lower sensitivity, indicating that this method may be a suboptimal method for risk stratification. A positive SAECG may better correlate with risk of ventricular arrhythmia.

1 Mewton, Nathan et al. "Assessment of myocardial fibrosis with cardiovascular magnetic resonance." *Journal of the American College of Cardiology* vol. 57,8 (2011): 891-903. doi:10.1016/j.jacc.2010.11.013.

2 Gatzoulis, Konstantinos A et al. "Signal-averaged electrocardiography: Past, present, and future." *Journal of arrhythmia* vol. 34,3 222-229. 28 May. 2018. doi:10.1002/joa3.12062

3 Ambale-Venkatesh B, Lima JA. Cardiac MRI: a central prognostic tool in myocardial fibrosis. *Nat Rev Cardiol*. 2015;12(1):18-29. doi:10.1038/nrcardio.2014.159.

4 Saad S., Ahmed J., Drutel R., Clark D., Danrad R., Leloir P. (2021). Correlation of signal averaged electrocardiography findings with fibrosis on cardiac magnetic resonance imaging, European Society of Cardiology Congress, ESC 2021. *European Heart Journal*. <http://dx.doi.org/10.1093/eurheartj/ehab724.311>