



CMR parametric mapping of T1, T2, T2* and extracellular volume: A consensus statement



Parametric mapping techniques provide a non-invasive tool for quantifying tissue alterations in myocardial disease in those eligible for cardiovascular magnetic resonance (CMR). Parametric mapping promises improvements in patient care through advances in quantitative diagnostics, inter- and intra-patient comparability, and relatedly improvements in treatment, according to an expert consensus document published in the *Journal of Cardiovascular Magnetic Resonance*.

CMR parametric mapping now permits the routine spatial visualisation of quantitative changes in myocardium based on changes in myocardial parameters T1, T2, T2* and extracellular volume (ECV). These changes include specific disease pathways related to mainly intracellular disturbances of the cardiomyocyte (e.g., iron overload, or glycosphingolipid accumulation in Anderson-Fabry disease); extracellular disturbances in the myocardial interstitium (e.g., myocardial fibrosis or cardiac amyloidosis from accumulation of collagen or amyloid proteins, respectively); or both (myocardial oedema with increased intracellular and/or extracellular water).

Considering the rapidly increasing interest in mapping-based myocardial tissue characterisation, the Consensus Group on Cardiac MR Mapping developed this document to provide 1) an update on the available experimental and clinical evidence, 2) an updated list of clinical indications, 3) practical recommendations for state-of-the-art protocols and techniques, and 4) guidance for research.

The group says there is abundant evidence demonstrating that parametric mapping appears robust under many conditions in its present form. "CMR parametric mapping goes beyond nonspecific functional surrogate markers of cardiovascular disease such as LVEF [left ventricular ejection fraction]. Rather, CMR parametric mapping offers the potential to examine specific disease pathways that affect myocardial tissue composition," the authors write.

Notably, CMR mapping methodology has left behind the early stages of principal implementation and validation, and robust techniques are available for commercial CMR systems. According to the consensus document, iron overload, amyloidosis, Anderson-Fabry, and myocarditis are clinical scenarios where cardiac mapping provides unique information and should be applied to guide clinical care. "Due to its additional diagnostic and prognostic value in the assessment of diffuse myocardial disease, parametric mapping should be considered in the diagnostic evaluation of all patients with heart failure," the authors write.

Building on the 2013 Consensus statement on myocardial T1 mapping and ECV quantification, which primarily provided guidance on technical aspects, the present recommendations intend to introduce

the concept of development steps towards the clinical application of T1, ECV, T2, and T2* mapping. These steps, the authors say, are defined by the available evidence supporting the clinical use of particular mapping sequences for the assessment of distinct disease patterns.

Where they overlap, the recommendations of this document are in agreement with those of the previous consensus statement with the two exceptions that a waiting time of 10 minutes after contrast application for post-contrast T1 mapping is now regarded sufficient (formerly 15 minutes) and that ECV should be given as a percentage, according to the authors.

"CMR parametric mapping has seen many innovations over the last decade and continues to attract interest from both basic and clinical researchers. Thus, any consensus document can only attempt to reflect the state of evidence at a single point in time, and will invariably start to be incomplete by the time of publication. Nevertheless, this document is meant to give guidance for CMR clinicians who would like to provide state-of-the-art tissue characterisation for patients with myocardial disease," the authors write.

Future developments in cardiac mapping will likely focus on standardisation of data acquisition and post-processing, as well as on optimising workflows. The robustness of mapping protocols and results will play an important role in its acceptance for clinical decision-making. Challenges include proprietary approaches of CMR system manufacturers, cost for software packages and the need for calibration of hardware and sequence settings.

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Published on : Wed, 25 Oct 2017