Reduction of Device Artifacts using Wideband Late Gadolinium Enhancement (LGE) MRI for Patients with Implanted Cardiac Devices: A Two-Center Study
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Target Audience. Cardiologists, electrophysiologists, radiologists involved in CMR.

Purpose. Late gadolinium enhancement (LGE) cardiac MRI is the clinical gold standard for non-invasive characterization of myocardial scar [1]. However, many patients who may benefit from LGE MRI have preexisting implanted cardiac devices such as implantable cardioverter defibrillators (ICD) and pacemakers (PM) [2]. The presence of an ICD produces hyper-intensity image artifacts in LGE (Fig. 1) and can prevent assessment of myocardial scar. We recently proposed a wideband LGE MRI technique that removes these artifacts in ICD patients [3-4]. In this abstract, we present our two-center experience of using this wideband LGE sequence on a cohort of patients with ICDs who were referred to cardiac MRI.

Methods. The hyper-intensity artifacts in LGE images of ICD patients are caused by severe off-resonance produced by the ICD. Spins in the affected myocardium are not inverted by the IR pulse and give rise to the hyper-intensity artifacts. In the new sequence, a wideband (3.8 kHz) IR pulse was implemented to replace the standard pulse with 1.1 kHz spectral bandwidth, thereby eliminating the hyper-intensity artifacts [3-4]. The wideband LGE technique was implemented at the medical centers of the University of California, Los Angeles (UCLA), and the University of Pennsylvania (Penn). A total of 25 patients with ICDs and PMs (UCLA: 19 (2 PM), Penn: 6 (1 PM)), were imaged using the conventional and the wideband LGE technique. In each image set, the left ventricle was divided into 13 segments (basal, mid-ventricular, and apical, each having posterior, lateral, anterior and septal segments, and an individual apex segment). Artifact-containing segments in each patient were identified by two attending radiologists.

Results. No hyper-intensity artifacts were present in the conventional LGE images of the 3 PM patients included in the study, as well as 2 ICD patients owing to large distance of the ICD from the heart. In the remaining 20 ICD patients, hyper-intensity artifacts were present in 5.6 ± 2.4 segments per patient in the conventional LGE images. All artifacts were completely eliminated in the wideband LGE images. Fig. 1 shows examples of LGE images from the conventional and wideband LGE technique. Each patient in the conventional LGE images. All artifacts were completely eliminated in the wideband LGE images. Fig. 2 shows the number of patients that had hyper-intensity artifacts in each of the 13 segments. The three segments with the largest number of artifacts are the apex, the apical lateral and the mid-ventricular anterior segment. The three segments with the fewest number of artifacts are the basal posterior, mid-ventricular posterior and basal lateral segments.

Discussion. The regions in which hyper-intensity artifacts occur in the conventional LGE sequence depend on proximity to the ICD: regions closer to the ICD experience higher off-resonance and present hyper-intensity artifact(s). Because of the orientation of the heart and the general location of the ICD at the left shoulder, hyper-intensity artifacts are usually produced at the apical and anterior regions and not at the posterior regions of the heart. Location of the hyper-intensity artifacts varies from patient to patient primarily because of variation in the exact location of the ICD.

Conclusion. We have developed a wideband LGE technique to eliminate the hyper-intensity artifacts seen in LGE MRI of patients with ICDs. This technique was implemented at two centers and successfully evaluated on 25 patients, leading to prominent reduction of the hyper-intensity artifacts. The wideband LGE technique may enable widespread utility of LGE MRI in patients with implanted cardiac devices, in whom LGE MRI otherwise could not be used for diagnosis.