Conductive Channel Identified by Contrast-Enhanced Magnetic Resonance Imaging Predicts Ventricular Tachyarrhythmia in Patients with Systolic Heart Failure

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Introduction

Patients with congestive heart failure (HF) carry an excess risk of morbidity and mortality (1). It is of clinical importance to identify high risk patients since optimal medical and device therapy could substantially lower the risk (2). One recent study demonstrated that the conductive channel (CC) formed by heterogeneous tissue within the core scar could be detected by late gadolinium-enhanced cardiac magnetic resonance (LGE-CMR) image and is responsible for clinical ventricular tachyarrhythmia (VT) (3). In this study, we aimed to investigate whether the CC identified by LGE-CMR could be used as a risk predictor for patients with systolic HF.

Materials and Methods

A total of 63 patients from our MRI database with left ventricular ejection fraction (LVEF) below 50% were included. All subjects received both cine and LGE-CMR studies on a 1.5T MR system (Siemens, Erlangen, Germany). Cine MRI was first performed using an EKG-trigger multiphase segmented TrueFISP (TR/TE/FA = 49ms/1.6ms/70°, slice thickness = 7 mm, gap = 3 mm and spatial resolution = 1.3mm). Contiguous short-axis slices were prescribed from the left atrium top to the LV apex and thirty cardiac phases were reconstructed for each slice level. The LGE-CMR study was performed by giving a gadolinium-DTPA with slow infusion (0.5 cc/sec) amounting to a total dose of 0.15 mmole/kg body weight. Ten minutes after the infusion of the contrast medium, LGE image was acquired by using an EKG-triggered phase-sensitive inversion-recovery (PSIR) prepared segmented TurboFLASH (TI/TR/TE/FA = 250ms/9.6ms/4.2ms/25°, spatial resolution = 1.37mm) at the same short-axis slices as those in the cine study. The cine images were analyzed to derive the LV function and mass for each patient. From LGE-CMR images, the infarct zone was defined as the sector of the LV wall that contained hyperenhancement of any transmurality, and the remote zone was defined as the remaining LV wall without any hyperenhancement. We used signal intensity (SI) thresholds to quantify 2 different areas within the infarct zone. A core scar area was defined by a SI higher than 3 standard deviations (SDs) above the mean SI of the remote zone. A gray zone or heterogeneous tissue was defined by a SI between 2 and 3 SDs. The CC in the ventricular wall was identified and defined as a corridor of the gray zone surrounded by the scar and connected to the normal myocardium. The outcomes, including VT/ventricular fibrillation (VF) attacks and mortality, were obtained by reviewing medical records. Continuous variables were expressed as mean±SD and categorical variables were expressed as percentage. The demography, etiology for HF, medication usage and image variables were compared between patients with and without outcomes by Student's t test for continuous variables and by Mann-Whitney U test for categorical variables. The predictors for outcomes including VT/VF and mortality were analyzed by a Cox regression model. The hazard ratio (HR) was calculated for each variable. For Kaplan-Meier survival analysis, patients were divided into 2 groups stratified according to the existence of the CC, and between-group differences in survival were tested by log-rank statistics. A P value < 0.05 was considered statistically significance.

Results

After 1180.7±848.7 days of follow, 8 patients had VT/VF attack and 14 patients died. As compared with patients without VT/VF, patients with VT/VF showed lower LVEF (29.5±5.4 % vs. 35.0±9.4 %, P = 0.029) and higher rate of identifying the CC by LGE-CMR (75.0% vs. 16.4%, P < 0.001). Furthermore, the rate of the CC identification was also higher in the mortality group than the survival group (50.0 % vs. 16.3, P = 0.010). Other LGE-MRI variables were not different between the two groups. The Cox regression model showed that only the CC identification predicted VT/VF attack during follow-up (HR = 31.877, 1.830-554.254, P = 0.018). The region of core scar (HR = 1.065, 1.017-1.115, P = 0.007) and the CC identification (HR = 4.696, 1.084-20.350, P = 0.039) were predictors for excess mortality. Kaplan-Meier survival curves showed that patients with a CC had a significantly poorer prognosis than those without a CC (P < 0.001 and P = 0.007 for VT/VF and total mortality, respectively).

Conclusion

Many studies have demonstrated that the extension of the scar measured by LGE-CMR is superior to traditional risk predictor such as LVEF and LV volumes in prognosticating the future cardiac events (4). In the present study, we confirmed this finding and further found that the region of core scar and the CC identification could predict mortality while the traditional global LV function and volumetric parameters could not. We also found that only the CC, not the core scar, predicted future VT/VF events. Therefore, we concluded that the CC identified with the LGE-CMR imaging can help identify HF patients at risk of VT/VF or mortality.

References

1. Schocken DD et al., J Am Coll Cardiol 1992;20:301-306.
2. Moss AJ et al., N Eng J Med 2002;346:877-883.
3. Perez-David E et al., J Am Coll Cardiol 2011;57:184-194.
4. Assomull RG et al., J Am Coll Cardiol 2006;48:1977-1985.