Quantitative Assessment of Microscopic Fibrosis in Patients with Primary Aldosteronism Using Dynamic Contrast Enhancement

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Introduction

Primary aldosteronism (PA) is characterized by autonomous production of aldosterone by the adrenal cortex and is considered to stimulate myocardial fibrosis (1). Late gadolinium enhancement (LGE) MRI has been widely used to show the fibrosis of the myocardium in various cardiac diseases (2). Comparing to bulky fibrosis which is readily discernable by focal myocardial regions with vivid hyperenhancement, the myocardial fibrosis in PA is diffuse and microscopic and is difficult to be detected on the images of LGE. To assess the myocardial fibrosis, we proposed a dynamic contrast enhancement method to detect the presence of microscopic fibrosis.

Materials and Methods

Study protocol Fourteen patients with PA (age 49.6 ± 14.0 years) and eight age-matched healthy volunteers (48.3 ± 15.0 years) were enrolled in a CMR study on a 1.5T system (Sonata, Siemens, Erlangen, Germany). All subjects underwent a dynamic gadolinium enhancement study. The first time point of the dynamic study was before gadolinium injection and served as a baseline. The following 7 time points were acquired every 2 minutes after the gadolinium injection.

Imaging acquisition The imaging was performed using an EKG-triggered phase-sensitive inversion-recovery (PSIR) prepared segmented TurboFLASH (TI/TR/TE/FA=250ms/800ms/4.18ms/25°, spatial resolution=1.33mm). Three short-axis planes were acquired at basal, mid left ventricular (LV) and apical levels. After the baseline study, gadolinium-DTPA was given by slow infusion (0.5 cc/sec) amounting to a total dose of 0.2 mmole/kg body weight. After the Gd administration, 7 studies were performed, every 2 minutes consecutively, at the same short-axis slices as those in the baseline study.

Image analysis The cavity and myocardium of the LV were segmented manually in the central area of the LV cavity and the septal myocardium on each image. The averaged signal intensities of the segmented regions were then computed. After subtraction from the baseline signal, the time curves of dynamic enhancement in the LV cavity and in the myocardium were obtained. Linear fitting was performed on each dynamic curve by taking the natural logarithm of the data. Three indices (down-slope, peak value and end-point value) were computed from the fitted enhancement curves, and normalized by the respective indices in the LV cavity. We averaged each fibrosis index over three short-axis slices for each subject, and compared each index between the patient and control groups.

Statistical Analysis Data were presented in mean ± SD. The differences of each fibrosis index obtained from patients and control volunteers were tested using unpaired t test. Statistical significance was considered if $p<0.05$.

Results

Patients with PA showed significantly higher systolic blood pressure than the normal subjects (142± 15 *vs.* 121±10mmHg; $p<0.005$). In dynamic contrast enhancement studies, our results showed a significantly lower down-slope index (1.10±0.16 *vs.* 1.29±0.21; p=0.02) and a significantly higher end-point value index (0.88±0.02 *vs.* 0.85±0.03; p=0.04) in the patient group. No significant difference in peak value index was found between the two groups (0.89±0.01 *vs.* 0.88±0.03; p=NS) (Fig.1).

Conclusion

In this study, we found a lower down-slope index and a higher end-point value index in patients with PA. These findings indicate the delayed wash-out and prolonged retention of the contrast medium in the myocardium, and suggest that there is increased amount of microscopic fibrosis in the myocardium. Our results are consistent with the post-mortem and endomyocardial biopsy studies of the myocardium in patients with PA which demonstrated heterogeneous texture and increased collagen volume fraction in the myocardium (3). Therefore, we conclude that the proposed dynamic contrast enhancement method is capable of detecting the presence of microscopic fibrosis.

References

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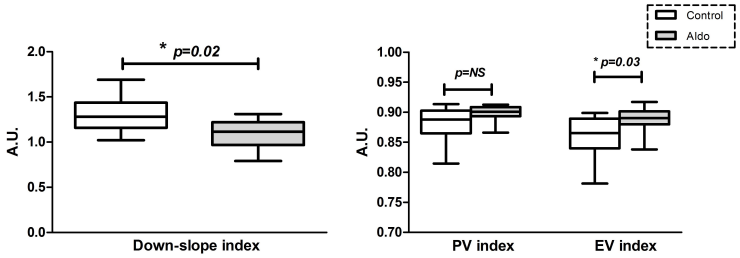

Fig 1. Comparisons are made between the patients with primary aldosteronism and control subjects in down-slope index (left) and peak value (PV) index and end-point value (EV) index (right).