

Dynamic changes of myocardial salvage index after reperfusion: A rat study at 7T

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Target audience: Radiologists, Cardiologists

Purpose

Reperfusion could induce myocyte damaging processes known as reperfusion injury which may limit the benefit of reperfusion.¹ T₂ mapping method offers the potential for accurate detection of myocardial edema.²⁻³ This study was to dynamically detect myocardial edema and myocardial salvage index in reperfused myocardial ischemic rat within 24h with a simplified T₂ mapping method in a 7.0T MR scanner.

Methods

Six rats with 30min myocardial ischemia followed by different reperfusion time(3h, 6h, 12h, 24h) were investigated. The simplified T₂-mapping method (TR/TE=1500ms/10,20,30ms, MTX=192×192, FOV=50×50mm, slice thickness=1.5mm) was implemented at a 7.0T MRI system (BRUKER BIOSPEC 70/30), which was acquired on the short axis slices during mid-diastolic phase in each end-inspiratory period using both ECG and respiratory gating systems.

After the acquisition of T₂-mapping at 6h and 24h, Late gadolinium enhancement(LGE) imaging was performed by FISP(TR/TE=5.2ms/1.8ms, FA=25°, MTX=256×256, FOV=50×50mm, slice thickness=1.5mm) to evaluate the extent of myocardial infarction after an injection of Gd-DTPA.

After 24h MRI scan, rats were sacrificed with potassium chloride and the hearts were rapidly excised. Each heart was cut into five or more transverse slices from apex to base, each approximately 1.5 mm thick. These slices were then incubated with 1% TTC (Sigma, Saint Louis, USA) for 15 min at 37°C, so that the viable myocardium was stained red and the infarcted area was stained white.

The T₂-maps were calculated using a custom made software. The T₂ values in edema regions were normalized by the T₂ values in the remote normal tissue regions ($T_{2\text{edema}}/T_{2\text{remote}}$). Edema area (> mean ± 2SD in remote normal tissue area) in T₂ mapping and infarction area (> mean ± 5SD in remote normal tissue area) in LGE images were measured on ImageJ Software. Myocardial salvage index was calculated by formula: (Edema Area-Infarction Area) / Edema Area. The areas were added slice-by-slice respectively and expressed as a percentage of the whole myocardial tissue of left ventricle (%LV).

Results

The normalized mean T₂ value in myocardial edema areas to the remote area increased from 3h (1.67±0.07) to 6h(1.71±0.12), and then decreased at 12h(1.64±0.3) and 24h(1.53±0.08). The total size of myocardial edema at 3h(26±7.4%) was significantly higher than that at 6h, 12h, and 24h(6h 21.2±8.9%, 12h 20.8±7.7%, 24h 20.9±8.4%, p<0.05). There was no significant difference between the edema area at 6h (21.2±8.9%) and 24h (20.9±8.4%, p>0.05). However, infarction area at 6h (20±3.9%) was significantly higher than that of 24h (17.7±6.1%, p<0.05). Myocardial salvage index of 24h (15.7±6.4%) was significantly higher than that of 6h (5.5±4.8%). No significant difference was found for the infarcted area defined by LGE(17.7±6.1%) and TTC staining(17.2±4%, p>0.05) at 24h.

Discussion

After reperfusion, myocardial edema size decreased from 3h to 6h. And the longer reperfusion time will increase myocardial salvage index between 6h and 24h in the acute myocardial ischemia. So reperfusion may be a useful treatment for the early phase of acute myocardial ischemia. And the increase of T₂ value between 3h and 6h may be due to reperfusion injury.

Conclusion

The simplified T₂-mapping can serially follow the changes of myocardial edema in acute myocardial ischemia rats after reperfusion. The edema size decreased from 3h to 6h, and kept the same between 6h and 24h. Myocardial salvage index increased while infarction size decreased from 6h to 24h. The T₂ value increased before 6h and decreased after that.

Reference

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