Myocardial Perfusion Recovery after Percutaneous Coronary Intervention Using First-pass Contrast-Enhanced MRI

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Introduction

Percutaneous coronary intervention (PCI) has been used to restore myocardial blood flow in the stenotic coronary arteries. Conventional methods such as coronary angiography and nuclear tracer imaging are limited in the assessment of the magnitude and timing of recovered myocardial perfusion after PCI. In this study, we performed first-pass contrast-enhanced myocardial perfusion MRI (CEMR) at 3T MR system to determine the timing and magnitude of perfusion recovery by evaluating the change in myocardial perfusion reserve (MPR) index in a serial follow-up.

Materials and Methods

Study protocol Five patients (N=5) with angiographically-documented coronary artery stenosis were enrolled in this study (Table 1). All subjects underwent both rest and stress first-pass CEMR studies on a 3T MR scanner (Tiro, Siemens, Germany). All patients received MR studies before PCI treatment and repeated MR studies by 24 hr, one week and one month after the PCI treatment.

Image acquisition Three short-axis planes at basal, mid left ventricle (LV) and apical levels were acquired using SR-Turbo FLASH pulse sequence. Right after the scanning started, Gd-DTPA(0.05mmole/kg) was bolus injected via left antecubital vein at a rate of 4~6ml/sec. The stress study was performed approximately 10 min after the rest study. Vasodilator (dipyridamole, 140μg/kg/min) was infused intravenously for 4 min and the image acquisition began at the 7th min when the maximal vasodilatation was achieved.

Image analysis LV myocardium were segmented semi-automatically and divided into 16 equiangular segments according to the definition of coronary artery territories (2). After the baseline signal correction, myocardial perfusion was quantified by measuring the maximum upslope of first pass signal intensity curve from the LV myocardium, normalized to that from the LV cavity. MPR index was calculated by dividing the results at maximal vasodilatation by the results at rest. The MPR of ischemic segments and non-ischemic segments were compared at baseline as well as at 24 hrs, 1 week and l month following PCI treatment. The paired MPR change of each segments were also analyzed at the same time points.

Statistical Analysis

Data were presented as mean±SD or as numbers and percentages. Paired pre- and post-PCI segment MPR index differences were tested by paired Kolmogorov-Smirnov test at 24 hrs, 1 week and l month after treatment. The differences of MPR between ischemic and non-ischemic segments were also analyzed using 2 sample Komogorov-Smironv test. Statistical significance was considered if $p<0.05$.

Results

Among the recruited 5 patients, a total of 64 segments of the myocardium were successfully analyzed, 21 ischemic segments and 43 non-ischemic segments (remote segments). The MPR index of the ischemic segments (0.77±0.39) were significantly lower than that of non-ischemic segments (1.46±0.82, p=0.003) before PCI. The differences of MPR between these two groups disappeared at 24 hrs, 1 week and 1 month following successful PCI procedure for the ischemic segments (Fig. 1). The MPR of the ischemic segments significantly improved at 24 hrs after PCI. The improvement of MPR lasted at 1 week and tended to persist at 1 month following PCI (Table 1). The MPR in non-ischemic segments increased at 24 hrs (1.99±0.96, p=0.04) and then returned to baseline at 1 week and 1 month following PCI (Table 1).

Conclusion

Our study indicates that the myocardial perfusion in ischemic segments can be restored as early as 24 hours after successful PCI. The improvement of myocardial perfusion can last at least for one week and tend to persist at one month following PCI. The myocardial perfusion in non-ischemic segments can be transiently increased at 24 hour following PCI, which may indicate a hyperemic response in remote segments after coronary intervention. This hyperemic change disappears at 1 week following PCI.

References

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PCI segments (n=21)				Non-PCI segments (n=43)			
Pre-PCI MPR	Post-PCI MPR		P value	Pre-PCI MPR	Post-PCI MPR		P value
0.77±0.39	24hour	2.41±1.50	0.001	1.46±0.82	24hour	1.99±0.96	0.041
	1 week	1.57±0.61	0.010		1 week	1.69±0.79	0.086
	1 month	1.71±1.10	0.205		1 month	1.53±1.25	0.602

Table 1. Pre and post-PCI MPR changes in ischemic segments and non-ischemic segments

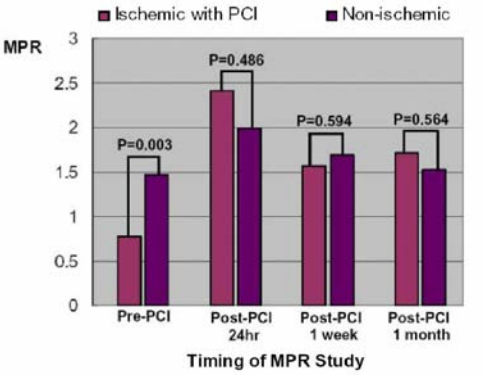

Figure 1. MPR differences between ischemic and non-ischemic segments at baseline, 24 hrs, 1 week and 1 month following PCI.