# 3D Dynamic MR Perfusion imaging: Quantitative Assessment of Disease Severity in Primary Pulmonary Hypertension Patients

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**Synopsis:** Primary pulmonary hypertension (PPH) is a progressive disorder characterized by raised pulmonary vascular resistance (PVR). However, on clinical situation, perfusion scintigraphy has been only method for qualitative assessment of regional PVR changes. Recently, dynamic MR perfusion imaging have been suggested as useful for assessment of regional perfusion abnormalities (1-3). In the present study, we hypothesized that quantitative analysis of 3D MR perfusion imaging may evaluate the regional PVR changes in PPH patients as disease severity. The purpose of this study is to determine the capability of 3D MR perfusion imaging for quantitative assessment of disease severity in PPH patients.

**Materials and Methods:** 3D dynamic contrast-enhanced MR perfusion imaging (TR 2.7ms/ TE 0.6 ms/ Flip angle 40°, 100-240 mm slab thickness, 10-12 partitions) was performed in 14 normal volunteers and nine consecutive PPH patients. All PPH patients underwent catheterization of the right side of the heart. From the signal intensity-time course curves, pulmonary blood flow (PBF), pulmonary blood volume (PBV) and mean transit time (MTT) maps were generated using deconvolution analysis, indicator dilution theories and the central volume principle on a pixel-by-pixel basis. From all pulmonary perfusion parameter maps, regional PBF, PBV and MTT of each lung field were determined in 6 spatially defined regions of interest (ROIs) in both lungs.

To evaluate the difference of regional pulmonary perfusion parameters between normal and PPH subjects, mean regional PBF, PBV and MTT were statistically compared by Student's t-test.

To determine the capability of quantitative pulmonary perfusion parameters for assessment of the severity of PPH and estimation of disease severity, pulmonary perfusion parameters, which had significant difference between normal and PPH subjects, were correlated with PVR.

A p value less than 0.05 was considered significant in all statistical analyses.

**Results**: All 3D dynamic contrast-enhanced MR perfusion imaging examinations were successfully completed. PBF, PBV and MTT maps of representative cases of normal and PPH subjects are shown in Figure 1 and 2.

Comparison of mean regional PBF, PBV and MTT between normal volunteer and PPH patient is shown in Table 1. Mean regional PBF and MTT of normal volunteer had significant difference with that of PPH patient ($p<0.0001$).

On correlation between PVR and PBF, PBF had excellent negative-correlation with PVR ($r=-0.89$, $r^2=0.79$, $p=0.0015$).

On correlation between PVR and MTT, MTT had good positive-correlation with PVR ($r=0.82$, $r^2=0.67$, $p=0.0067$).

**Conclusion**: 3D dynamic MR perfusion imaging has the potential for assessment of disease severity in PPH patients. Moreover, this technique may offer the opportunity to noninvasively evaluate the pathophysiology of PPH patients with high spatial resolution and no radiation exposure.

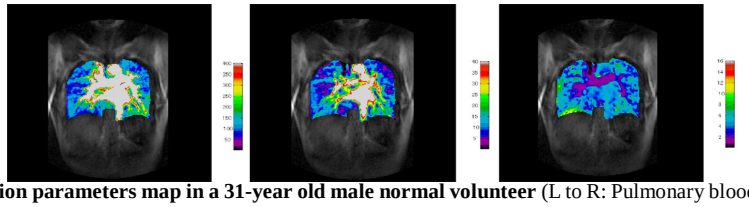

**Figure 1. Quantitative regional perfusion parameters map in a 31-year old male normal volunteer** (L to R: Pulmonary blood flow (PBF) map, Pulmonary blood volume (PBV) map, and mean transit time (MTT) map)

All quantitative regional perfusion parameter maps clearly demonstrate the regional difference of perfusion parameter in each lung field.

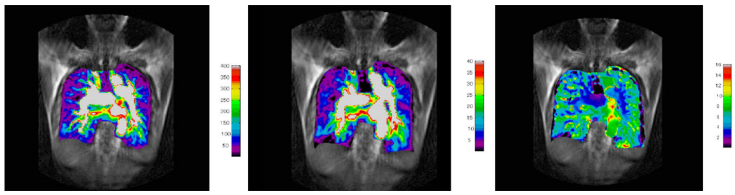

**Figure 2. Quantitative regional perfusion parameters map in a 51-year old male primary pulmonary hypertension patient** (L to R: Pulmonary blood flow (PBF) map, Pulmonary blood volume (PBV) map, and mean transit time (MTT) map)

All quantitative regional perfusion parameter maps clearly demonstrate the heterogeneity of regional perfusion parameter in each lung field. Due to the increased pulmonary vascular resistance, regional perfusion parameters are decreased on PBF and PBV maps, and regional MTT are prolonged on MTT map.

**Table 1. Comparison of regional perfusion parameters between normal subjects and primary pulmonary hypertension (PPH) patients.**

| | Normal | PPH | p value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| **PBF (ml/100ml/min)** | 129.6±14.6 | 71.4±11.5* | <0.0001 |
| **PBV (ml/100ml)** | 10.1±2.6 | 8.6±1.2 | 0.11 |
| **MTT (s)** | 4.7±0.9 | 7.4±1.0* | <0.0001 |

Normal: normal subject group, PPH: primary pulmonary hypertension patient group, SD: standard deviation, PBF: pulmonary blood flow, PBV: pulmonary blood volume, MTT: mean transit time

*: Significant difference with normal subject group ($p<0.05$)

**Reference:**

1. Hatabu H, et al. Magn Reson Med. 1999; 42: 1033-1038

2. Levin DL, et al. Magn Reson Med. 2001; 46:166-171

3. Ohno Y, et al. AJR Am J Roentgenol. 2004 (in press).