Comparison of pulmonary perfusion measurement by dynamic contrast-enhanced MRI versus perfusion scintigraphy: disagreement and solution

Y-R. Lin[1], M-T. Wu[2,3], S-Y. Tsai[1], H-W. Chung[1], K-S. Hsieh[3,4], N-J. Peng[3,5]

[1]Dept. of Electrical Engineering, National Taiwan University, Taipei, Taiwan, [2]Dept. of Radiology, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan, [3]Faculty of Medicine, School of Medicine, National Yang Ming University, Taipei, Taiwan, [4]Dept. of Pediatrics, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan, [5]Dept. of Nuclear Medcine, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan

Introduction

Dynamic contrast-enhanced MRI (DCE-MRI) of the lung via injection of paramagnetic contrast agents has been used to obtain quantitative perfusion parameters [1][2] and compared with perfusion scintigraphy (PS) [3]. The standard perfusion parameters are computed from the entire signal intensity-time curve. However, the fact that the large-size Tc99m-MAA used in perfusion scintigraphy principally entrap in the pre-capillary intravascular space, implies that PS method may provide only the wash-in information of contrast agent. We hypothesized that disagreement between DCE-MRI and PS may be found in patients with substantial uneven bilateral lung perfusions, such as congenital heart disease (CHD). We proposed a new algorithm to compute perfusion parameter, in which only the wash-in of the curve is considered. In this study, two kinds of definition of blood flow were computed, one as the integration of the entire curve, the other one as the integration of signal change to the peak of curve. The perfusion ratio between left and right lungs were measured and compared with data derived from PS.

Methods and Materials

13 patients of Tetralogy of Fallot (aged 1-14 yr) after surgical correction with suspected residual peripheral pulmonary stenosis undergoing both DCE-MRI and PS were included in our study. DCE-MRI were performed on a 1.5 Tesla MRI system (GE Signa CVi, Milwaukee, WI), images was accomplished by an inversion-recovery-prepared segmented EPI technique (TI/TW/TE/ETL= l80/6.5/1.2/4, *40-60* frames, matrix:128x128, 3~8 Slices, Slice thickness:8-10mm,cardiac gated, total scan time is about 60 seconds).

A dedicated program was developed to define each lung of each slice as an unit of ROI. The heart and major vasculature in the lung was excluded. The signal intensity (SI)-time curves of each ROI were computed by averaging pixel values over all slices of a whole series. The SI-time curves were gamma-fitted to obtain the first-pass perfusion curve for each region. The total blood volume to the left (or right) lung is defined by two algorithms. In the first method, integration of the fitted curves was done from beginning to end multiplies the total pixel numbers in the ROI. In the second method, integration range was from beginning to the first peak of curves from both lungs (Figure 1). The ratios of perfusion to the left versus right lungs of each algorithm were calculated, respectively.

For lung scintigraphy, radioactivity of technetium-99 macroaggregated albumin accumulated in the right and left lung fields were quantitated respectively, and the ratio was calculated. The perfusion ratios obtained by these two methods were compared by correlation coefficient.

Results

The correlation between the perfusion ratios of left lung derived from PS and MR is shown in Figure 2. The ratios correlate well between PS method and DCE-MRI method 2 (Integral to peak), the correlation coefficient is 0.96 ($p<10^{-6}$). Nevertheless, method 1, when the integration range expand to the entire curve, the correlation is substantially decreased with r = 0.67, p>0.05.

Discussions and Conclusions

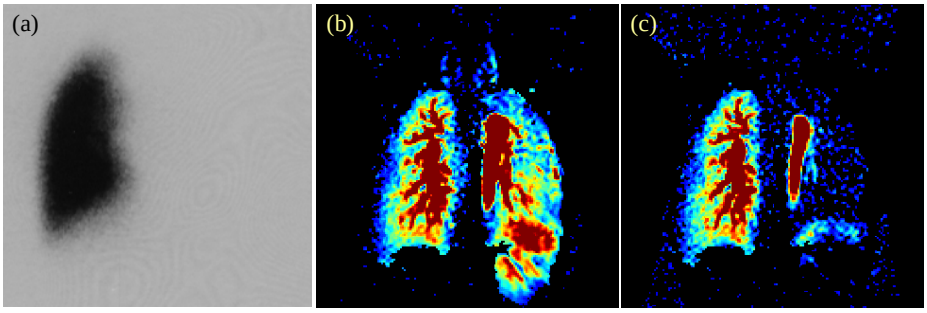
Our results support the hypothesis that discrepancy exists between PS and DCE-MRI, and PS only offers the wash-in information of the perfusion. With our new algorithm, DCE-MRI may replace PS for calculation of right-to-left ratio in pulmonary perfusion. Besides, more information can be provided by DCE-MRI since wash-out is also important in physiological sense, which needs further study in the future.

Reference

1.Hatabu H, et al, *MRM*, 42:1033-1038, 1999

2. Levin DL, et al, *MRM*, 46:166-171, 2001 3. Iwasawa T, et al, *JMRI*, 15:685-692, 2002

Acknowledgment Kaohsiung Veterans General Hospital Research Grant: VGHKS92-94



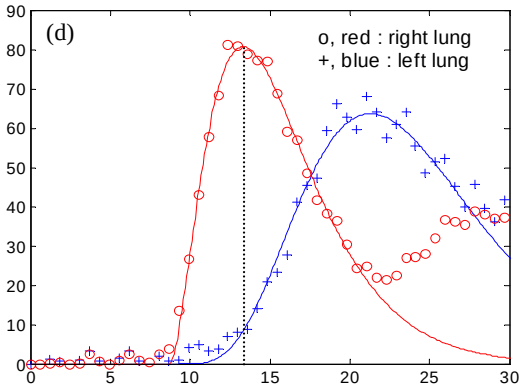


Fig 1. Perfusion map derived by (a) PS, (b) method 1 of DCE-MRI, (c) method 2 of DCE-MRI. SI-time curves of left lung and right lung of the same patient were shown in (d). Gamma variate function fitting of the first-pass were shown in blue and red line. Method 1 calculated the whole area under fitted curves while method 2 calculated area before the dotted black line.

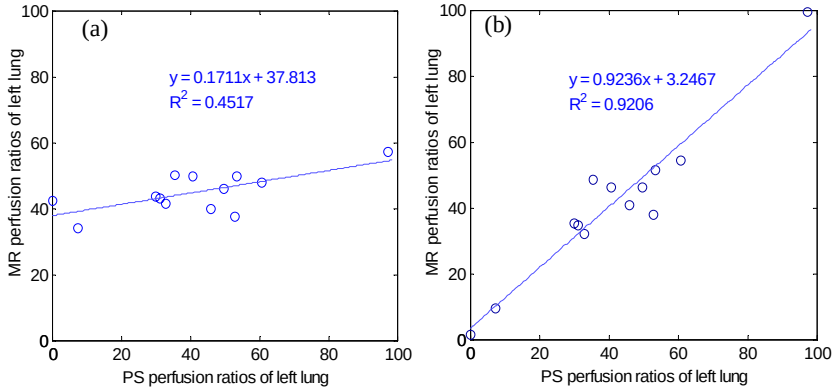


Fig 2. Relationship between PS perfusion and MR perfusion ratio in the left lung, (a) method 1, (b) method 2. Ratios of the right lung are omitted since it contains the same results