PC VIPR: Time-resolved 3D Undersampling Phase Contrast

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INTRODUCTION

2D cine PC is usually used to measure in-vivo flows. Although a single 2D cine PC requires only about 1-2 minutes, it can be very time consuming if multiple locations are to be studied. A 3D cine method was reported with anisotropic spatial resolution [1] We have previously demonstrated that non-gated PC VIPR, with high isotropic spatial resolution, can provide accurate retrospective measurement of average flow for vessels of arbitrary position and orientation in a large FOV using only one short scan [2]. With ECG gating, time-resolved flow waveforms can be acquired retrospectively anywhere within the FOV.

MATERIALS AND METHODS

Retrospectively gated PC VIPR projections were grouped into different cardiac phases according to the subject's cardiac cycle. Projections of each cardiac phase were evenly distributed on the k-space sphere and reconstructed to provide anatomical images as well as quantitative information for each phase. Axial 2D cine PC was used to validate the time-resolved PC VIPR sequence in the right ICA. In this case only S/I flow was sensitized. Both sequences were scanned 5 times. 20 phases were acquired for 2D PC and 15 phases for PC VIPR, Mean and standard deviation of the flow rate of each cardiac phase were calculated for each method. PC VIPR had isotropic 0.94mm pixel dimensions and required 7 minutes to image a spherical 24 cm diameter FOV. 2DPC dimensions were 094 x 0.94 x 3 mm. To show its ability to acquire flow at multiple locations, another PC VIPR volunteer study was performed using three flow directions and required 10 minutes. Flow waveforms of multiple locations were measured. However, non-axial 2D cine PC validation was not performed in this study. The sequence was applied on a GE 1.5 T scanner.

RESULTS AND DISCUSSION

Figure 1 (a) shows the in vivo flow waveform of the right ICA acquired using the time-resolved PC VIPR and 2D cine PC. One standard deviation is used as the error bar on each phase, which is less than 10% for most points. The temporal resolution is 50 ms for PC VIPR and 36 ms for 2D PC. Within one standard deviation, results from these two methods match very well. Basilar and PCA flow waveforms from another volunteer are shown in (b), acquired using the same sequence sensitized to flow along all three Cartesian directions. The temporal resolution is 80 ms. The composite image combining all the cardiac phases is shown in (c) with the measuring locations indicated by arrows. The sequence can also be used to scan the cardiac vessels, however it is not sure how the motion effects affect the accuracy.

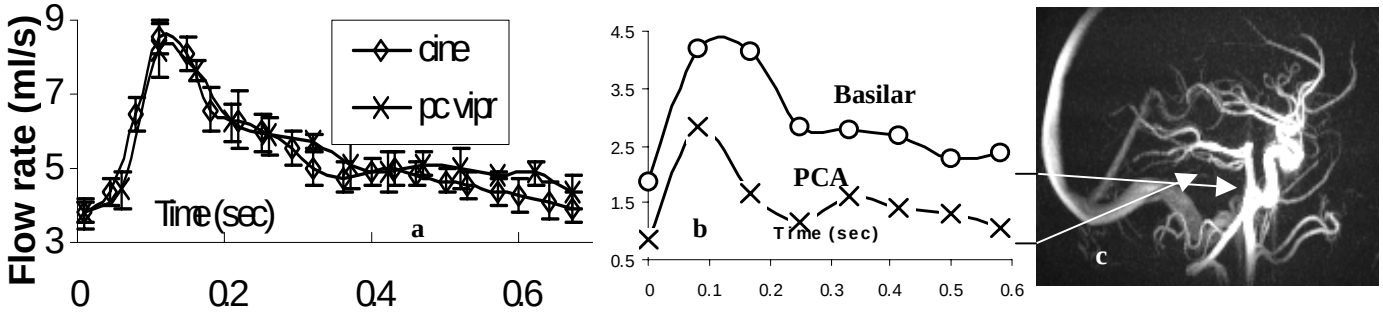

Figure 1. (a) The ICA waveform measured using 2D cine PC and time-resolved PC VIPR. b) The flow waveforms of the basilar and PCA as determined from locations indicated by arrows on the composite image (c).

CONCLUSION: When implemented with retrospective ECG gating, time-resolved PC VIPR can provide flow waveforms of any vessel in a large FOV in a single easily prescribed scan.

ACKNOWLEDGEMENT: This work was supported by NIH grant 1RO1-HL62425 and GE Medical Systems.

References : 1. Markl M et al JMRI 17: 499-506 (2003); 2.Gu T, et al., MR Angio Club, Dublin Ireland (2003).