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Meeting abstract

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2095 Higher order corrections for background phase in flow imaging

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Introduction

Phase contrast (PC) is an invaluable tool for the measurement of blood flow. Unfortunately gradients and eddy currents introduce background phase offsets that can lead to significant errors. It is generally advised that background phase correction should be made by subtracting the phase of stationary tissue adjacent to the vessel of interest; however background phase varies across the image and choosing stationary tissue distant from the vessel may actually worsen the result.

Purpose

To investigate (i) the effect of image orientation, VENC and gradient strength on the spatial variation of the background phase and (ii) the use of higher order surface fits to model and then correct the background phase.

Methods

PC images of a stationary phantom were acquired on a Siemens 1.5 T Avanto using a retrospectively gated velocity encoding technique triggered by an artificial ECG trace. Images were acquired using through-plane velocity encoding at different orientations: axial, coronal, axial-coronal oblique slices and double-oblique slices. The technique was modified to use the maximum available gradient strength of 28/22/22 mT/m (read/phase/slice). Table 1.

Flow was examined in six circular regions of interests (ROI diameter 25 mm) to simulate an aorta centred at 0 cm, 5 cm, 10 cm(×2) and 13 cm(×2) from isocentre. The background phase was modelled using all of the image by a finite element linear/quadratic/cubic order planes and subtracted from phase in the ROI's. As the phantom was stationary, if the phase correction was correct, each ROI should show zero flow.

Results

The background phase error was worst with maximum gradients and in the double-oblique slices. A higher VENC caused larger errors in the modified technique. The standard technique had an average error range of 0.14–0.58% (2.6–12.0 mL/s) and maximum gradient technique 0.15–10.96% (3.2–282 mL/s). At the isocentre where background phase contrast error should be minimised, the error ranged from 0.05–0.34% (1.0–8.2 mL/s, standard) and 0.05–0.58% (0.9–16.7 mL/s, maximum gradient).

Table 1: Image parameters.

	Standard	Maximum gradient
TE (ms)/TR (ms)	2.79/50.85	1.5/46.75
Matrix size	176 × 256	132 × 192
FOV (mm)	300 – 400	300 – 400
Slice Thickness (mm)	6	5.5
Venc (cm/s)	200/500/800	200/500/800

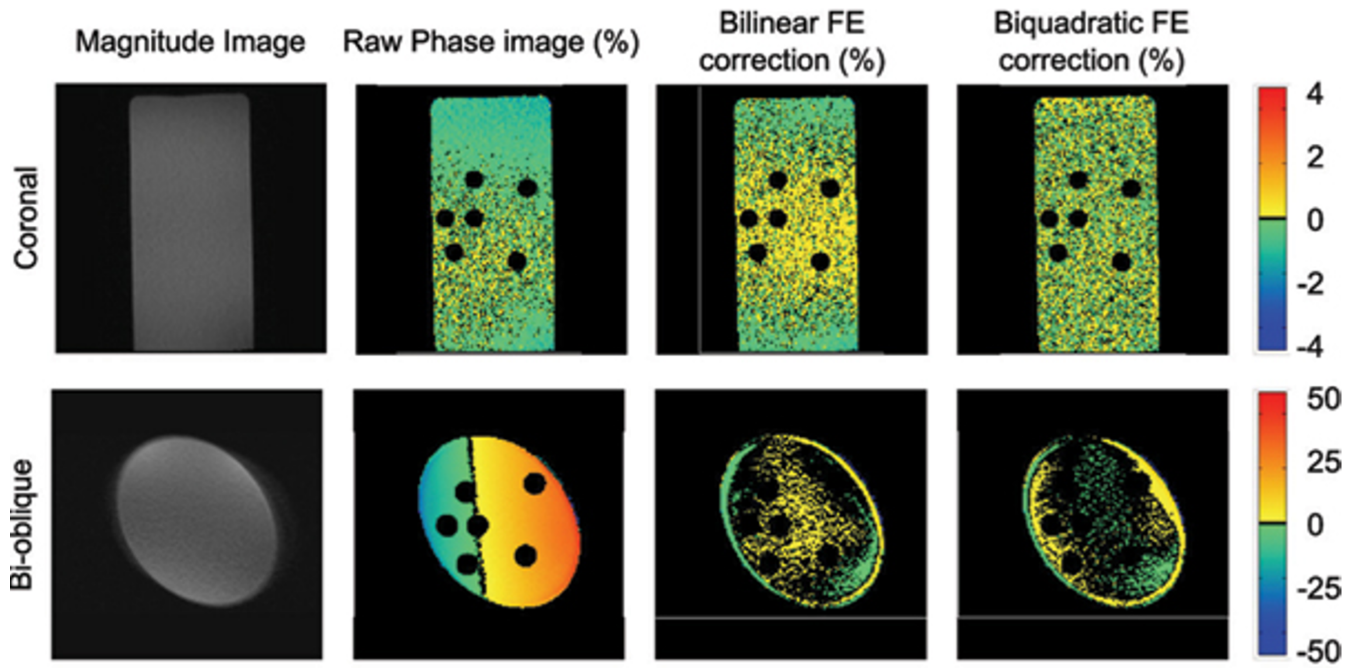

Figure 1
Shows the two examples where a bi-linear FE fit did not perform as well as a higher-order fit (Biquadratic FE).

After background phase correction the average error in ROI's was reduced regardless of the order or type of fitted surface (0.02–0.08%/0.0–3.0 mL/s (standard) and 0.02–1.23%/0.1–57.8 mL/s (maximum gradient)); however the maximum gradient had cases where a bilinear finite-element surface worsened the error. This occurred with a coronal image plane (0.15% to 0.24% 3.6 mL/s to 5.6 mL/s)) and double-oblique images at the isocentre which worsened from 0.39% to 0.99% (6.2 to 24.5 mL/s). Figure 1.

Conclusion

The phantom experiments show as hypothesised that the use of larger gradients available on new scanners increases the background phase offset and it is worse with bi-oblique image orientations required for patient scanning. Though the application of any order or type of fitted surface is usually able to reduce the residual background phase, in bi-oblique images the application of a low order fit can worsen the result.