Comparison of TRUST, projection-based T2 imaging with susceptometry-based oximetry for the quantification of venous oxygen saturation
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Introduction: Venous oxygen saturation (SvO2) is an important physiological parameter, e.g. quantification of SvO2 in the superior sagittal sinus (SSS) or jugular veins allows quantification of global CMRO2. So far, two approaches have been practiced: In T2-based approaches the blood signal is isolated using subtraction techniques analogous to arterial spin labeling (ASL)1 or phase-contrast MRA2,3, following a T2-preparation CPMG train. In susceptometry, estimation of SvO2 relies on phase mapping. The purpose of this work was to compare three different techniques (two T2-based3,4 and one susceptometry-based5) for quantifying SvO2 in the human brain at the level of the SSS.

Methods: T2-based methods: The TRUST blood signal was isolated in the usual manner4 and mapped as a function of eTE determined by the duration of the T2-preparation CPMG train (0, 36.6, 73.2, 146.5 ms). In the projection-based T2 (PT2)3 measurement the blood signal was isolated by taking the complex difference between velocity-encoded projections as a function of eTE (18.3, 36.6, 73.2, and 146.5 ms). Susceptometry: SvO2 was quantified as described in ref [6] based on a field map to estimate the susceptibility difference between the intravascular blood and surrounding tissue. The pulse sequence5 is designed to quantify SSS SvO2 and cerebral blood flow (CBF) in the major vessels feeding the brain simultaneously by means of two interleaved phase difference images yielding SvO2 and CBF maps. Pulse-sequence parameters:TRUST: Thickness of imaging slice= 5 mm, thickness of labeling slab= 50 mm, and gap between imaging slice and labeling slab is 25 mm. Field of View (FOV) =230 x 230 mm², matrix size= 64 x 64 with partial Fourier acquisition, repetition time (TR) = 3000 ms, EPI echo time = 7.47 ms, and inversion time (TI) for the blood to flow from the labeling slab to the imaging slice = 1200 ms. PT2: FOV= 176 x 176 mm², matrix size=176x176, TR=1875 ms, TE=10.2 ms, and VENC=20 cm/s which is close to the average blood flow velocity in the SSS to minimize sensitivity of T2 to the SSS pulsatility. Susceptometry-based oximetry (SBO): FOV=208 x 208 mm², matrix size=208x208, TR=35 ms, VENC=60 cm/s, and the echo spacing between the same-polarity echoes (ΔTE=7.04 ms).

In-vivo studies: SSS SvO2 was measured at resting state in eight healthy subjects (mean age 32±6 years) at 3T (Siemens TIM Trio) using the three techniques in the same session with 10 successive measurements being made for each method.

Results: Figure 1a shows cropped TRUST difference images as a function of eTE. Localizer and projection images versus eTE are given in Figure 1b. An example of a magnitude and phase image obtained by SBO is presented in Figure 2. The bar graph in Figure 3 compares SvO2 derived with the three methods. Mean SvO2 for the three methods was 65±4% (SBO), 67±3% (PT2), and 61±4% (TRUST). ANOVA indicated PT2 and SBO results not to be different (p>0.05) but TRUST yielded mean values that were slightly lower than those obtained by PT2 (p=0.01).

Conclusions: There was good agreement among the three methods based on measurement of venous blood T2 (TRUST and projection T2) and susceptometry. The reasons for the slightly lower values for TRUST need further scrutiny. The main advantage of the susceptometric technique is that it is simultaneously measures CBF and SvO2, therefore generally providing superior temporal resolution. On the other hand, T2-based methods are vessel geometry independent.


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