Experimental investigation of transverse flow estimation using transverse oscillation

Conventional ultrasound scanners can only display the blood velocity component parallel to the ultrasound beam. Introducing a laterally oscillating field gives signals from which the transverse velocity component can be estimated using 2:1 parallel receive beamformers. To yield the performance of the approach, this paper presents simulated and experimental results, obtained at a blood velocity angle transverse to the ultrasound beam. The Field II program is used to simulate a setup with a 128 element linear array transducer. At a depth 27 mm a virtual blood vessel of radius 2.4 mm is situated perpendicular to the ultrasound beam. The velocity profile of the blood is parabolic, and the speed of the blood in the center of the vessel is 1.1 m/s. An extended autocorrelation algorithm is used for velocity estimation for 310 trials, each containing 32 beamformed signals. The velocity can be estimated with a mean relative bias of 6.3% and a mean relative standard deviation of 5.4% over the entire vessel length. With the experimental ultrasound scanner RASMUS the simulations are reproduced in an experimental flow phantom using a linear array transducer and vessel characteristics as in the simulations. The flow is generated with the Compuflow 1000 programmable flow pump giving a parabolic velocity profile of the blood mimicking fluid in the flow phantom. The profiles are estimated for 310 trials each containing of 32 data vectors. The relative mean bias over entire blood vessel is found to be 10.0% and the relative mean standard deviation is found to be 9.8%. With the Compuflow 1000 programmable flow pump a color flow mode image is produced of the experimental setup for a parabolic flow. Also the flow of the human femoralis is reproduced and it is found that the characteristics of the flow can be estimated.

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