Volume 6 Supplement 1 December 2005 ISSN 1525-2167

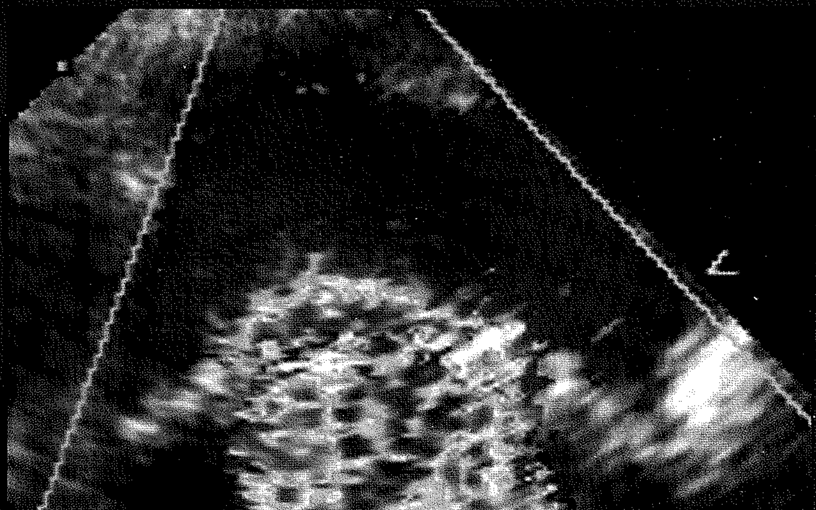
EUROPEAN
SOCIETY OF
CARDIOLOGY®

EUROPEAN
ASSOCIATION OF
Echocardiography
A Registered Branch of the ESC

European Journal of Echocardiography Supplements

The Journal of the European Association of
Echocardiography of the European Society of Cardiology

Abstracts of EUROECHO, the Ninth
Annual Meeting of the European
Association of Echocardiography,
a registered branch of the ESC
Florence, Italy
7–10 December 2005



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Semi-automatic epicardial border tracking

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Introduction: Endocardial semi-automatic tracking has been developed recently. As assessment of left ventricular function is dependent on wall thickening rather than endocardial excursion this has limititations. We assessed a software application (Quamus) for semi-automatic epicardial tracking.

Methods: Four dobutamine contrast stress echocardiograms of apical 4,3,2-chamber and short axis views at rest, intermediate and peak stress were obtained. Epicardial borders were hand-drawn by two experienced stress echocardiographers and also using Quamus in 525 frames for rest, intermediate and peak stress. Frame by frame a total of 3150 regions were assessed. 100 corresponding points were found for each pair of contours using symmetric nearest neighbours and arc length linear interpolation. The mean (dmean) and maximum (dmax) distances between correspondents were used as a measure of agreement between contours.The parameters of the lognormal (ln) distribution mu and sigma, i.e. the mean and standard deviation of the normal distribution of ln(dmean) and ln(dmax) were calculated.

Results: The distribution of dmean and max are lognormal. Mu and sigma are shown in the table below. Distributions of dmean and dmax were very similiar, as can be seen in the table. A Kolmonogorov-Smirnov test showed the distance distribution between Quamus and one expert to be the same as between both experts in all stages of stress

Mu and sigma for dmax and dmean

	Stage	dmean (mm)		dmax (mm)	
		mu	sigma	mu	Sigma
Obs 1 v Quamus	Rest	0.469	0.443	1.435	0.392
	Int	0.537	0.421	1.497	0.401
	Peak	0.628	0.460	1.562	0.434
Obs 2 v Quamus	Rest	0.663	0.420	1.627	0.398
	Int	0.862	0.420	1.805	0.389
	Peak	0.786	0.459	1.711	0.438
Obs1 v Obs 2	Rest	0.477	0.487	1.464	0.497
	Int	0.611	0.415	1.559	0.385
	Peak	0.548	0.441	1.528	0.424

Conclusion: Computerised epicardial tracking is feasible and has the potential to allow quantification of left ventricular function

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Estimating volumetric flow by exploiting the dependency of the Doppler spectrum on the position and insonation direction of an intra-vascular Doppler wire. An in-vitro study

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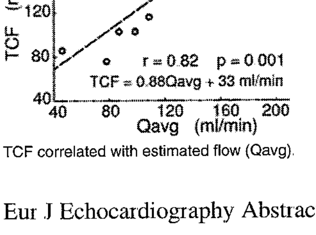
Introduction: Commercial intra-vascular Doppler wire (IVDW) systems only estimate flow velocities and are highly dependent on wire position. Measurement of true volumetric coronary flow (Q) requires the flow velocity distribution (VD) over the cross-sectional area (CA) of the vessel. We modeled the dependency of the power density spectrum (PDS) at different range gate (RG) on the position of the wire in a cylindrical tube. Q was estimated by fitting the modeled to the measured PDS. This methodology was tested in-vitro.

Methods: Setup: Pulsatile flow was generated in silicon tubes (diameters: 3 and 4mm) and time collected flow (TCF) was recorded. We used a FloMap system (Volcano Therapeutics, USA) equipped with a .014″ IVDW (12Mhz). From the Doppler signals at different RG (4-10mm) the normalised PDS at peak flow was estimated as a function of frequency and RG.

Spectral model: The model contained 4 free parameters: vessel diameter (D), VD (parabolic (po=2) to blunted (po=INF)), wire position (offset from vessel centre) and insonation direction. The maximal flow velocity was calculated from the wire position, insonation direction, VD, and the measured peak velocity (MPV). From the resulting VD in the RG of the beam the normalised PDS was calculated.

Flow estimation: By fitting the model to the measured normalised PDS, the free parameters were estimated. Q was estimated at each point in the cycle from the MPV, D and VD. The temporal average of Q (Qavg) was compared to TCF.



TCF correlated with estimated flow (Qavg).

Results: There was a reasonable correlation between TCF and Qavg (see figure) In the 3mm tube the estimated D was 3.22±0.78mm and in the 4mm tube D was 4.26±0.34mm. VD was estimated as po=2.3± 0.3.

Conclusion: Q can be estimated using a IVDW in combination with a spectral model.

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Impact of Doppler wire position on the velocity field and power density spectrum in a middle-sized artery

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Background: Using the range-gate dependency of the Doppler power density spectrum (PDS) measured by ultra-thin (0.35 mm) Doppler wires (DW), volumetric flow (Q) can be assessed through signal processing. The accuracy of these algorithms, however, highly depends on (knowledge of) the position of the DW, and on the potential disturbing effect of the DW on the flow velocity profile (VP) itself. The aim of this numerical study was to assess the effect of a perfectly centered (DWc) and an off-centre DW (DWoc; 0.5 mm from the vessel wall) on VP and PDS.

Materials and Methods: DWc and DWoc were simulated in arteries with diameters of 3 (AD3) and 4 mm (AD4), respectively. In all cases, a constant Q of 215 ml/min was imposed, yielding mean inlet velocities of 0.5 m/s and 0.28 m/s, respectively. Newtonian fluid properties of blood were assumed (density: 1060 kg/m^3, viscosity: 4 mPas), yielding Reynolds numbers of 404 and 303, suggesting parabolic flow profiles in fully developed flow conditions. Zero flow velocity was imposed on the walls of the vessel and the DW ('no-slip' condition). Cross-sections were defined every 0.13 mm (range gate step) perpendicular to and starting from the tip of the DW until 2 cm distal from the tip. Simulations were performed with the CFD (computational fluid dynamics) solver Fluent 6.1. Velocity data were extracted and subsequently used for further post-processing. With the opening angle of the ultrasound beam known (13°), the area sampled by the DW was determined for each range gate and velocity data were converted into PDS.

Results: For DWc, VP immediately distal to the tip has a "doughnut" shape, with zero centerline flow velocity. The parabolic VP gradually restores, but it takes 13.4 mm for the velocity to reach 95% of the maximal noticed value (AD3 and AD4), while full insonation of the vessel is already reached after 6.49 mm (AD3) and 8.66 mm (AD4). In terms of PDS, the highest appearing frequency monotonically increases with increasing range gate and has not reached the theoretical maximum velocity after 20 mm. With DWoc, restoration of VP - a lowering of centerline velocity - takes >20 mm (AD3) and 15 mm (AD4). This effect, together with the asymmetrical vessel insonation leads to an overshoot of maximal frequency in PDS, followed by progressive decline towards the theoretical maximal value.

Conclusions: The presence of the DW has a significant impact on the VP and the derived PDS, and is likely to affect the accuracy of flow-estimation methods based on PDS analysis.

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Identification of nonparallel helical myofiber geometry of the left ventricular wall by high resolution B-mode ultrasound

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Background: Muscle fibers in the left ventricle (LV) have a non-parallel three-dimensional helical distribution that forms a right handed helix in the subendocardium and a left handed helix in the subepicardium.We hypothesized that variations in intensity of transmural ultrasound backscatter in excised and beating hearts using high resolution epicardial ultrasound will correlate with the transmural variations in myocardial fiber orientation.

Methods: The transmural ultrasound backscatter intensity and LV fiber orientation were compared in 14 porcine hearts (8 explanted and 6 beating hearts in situ) using 10 and 14 MHz linear array transducers.

Results: Panning cross-sectional view of LV in its short axis from apex towards base demonstrated a counter-directional arrangement of the inner and outer layers, that correlated with an inverse helical arrangement of the epicardial and subendocardial regions. Reflections at the cardiac apex formed transmural arcs (Fig. A) which corresponded with its spiral muscle fiber geometry. The mean difference in the end-diastolic acoustic intensity of subepicardial and subendocardial

High resolution ultrasound Imaging