myocardium may be different from the infarcted myocardium; however, clinical studies are still rare. In order to investigate the relationship of texture properties of the infarcted myocardium and patency of infarct-related artery (IRA), we have developed the computer program for tissue characterisation of echocardiographic images.

The program uses spatial gray level cooccurrence method for texture characterization to compare tissue samples taken from normal and infarcted areas of myocardium. The program is menu driven and has two main operating modes: auto-diagnose mode and user-diagnose mode. In the auto-diagnose mode, after the decision making procedure that incorporates human experience and knowledge, the program gives the prediction of future recovery. In the user-diagnose mode, the program provides numerical and graphical presentation of obtained results, and may be used as an analysis tool during echocardiographic examinations.

The program runs under MS-DOS or Microsoft Windows on IBM 386/486 compatibles. It accepts ultrasound images stored on disk by commercial frame grabbers. As an input to the algorithm, the user selects two areas to be analyzed: a normal one and an infarcted one. Output data can be transferred to Windows based spreadsheet or database programs using Clipboard feature.

The validation study compared two groups of pts after acute myocardial infarction examined before hospital discharge: the group with occluded and the group with patent IRA. It demonstrated myocardial texture changes in the infarct zone in pts with occluded IRA, whereas no difference between infarcted and normal tissue was detected in pts with successful reperfusion. These data indicate that the program may help in prediction of successful reperfusion in the early post-infarction period.

950-93 Automatic Identification of Calcified Regions on Intravascular Ultrasound Images of Human Coronary Arteries Using Texture Analysis

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The potential for intravascular ultrasound (IVUS) to evaluate arterial pathologies and to suggest invasive techniques thus far has been limited by its qualitative and subjective evaluation. The purpose of this study is to develop tools to automatically identify and objectively quantify the calcifications present in IVUS images of human coronaries.

Human coronary arteries were dissected from explanted hearts within one hour of transplantation and perfused with saline at physiological pressure. IVUS images were acquired using an HP Sonos 100 system and a 3.5 F monorail 30 MHZ catheter. A controlled pullback was recorded on SVHS videotape and images digitized every 250 μm. Texture analysis, consisting of the convolution with several different Laws' matrices followed by texture "energy" extraction and nearest neighbor classification, was used to segment each image into high- and low-information regions. The regions of low-information content corresponded to shadows behind echo-dense features such as calcium. Calcifications were identified as sectors of radially thin texture regions that correlate with bright areas in the intensity image function. Angular percentage of vessel cross section with calcifications and angular localization of calcifications were compared with manual tracing in a set of 230 images from patients with different pathologies. The comparison showed a good correlation: Percentage correct: 86%, Sensitivity: 79%, Specificity: 89%. No preferential angular calcification localization were observed.

Conclusion: The results show that this is an objective method to clearly detect and quantify calcifications in IVUS images.

950-94 Real-time Three-dimensional Intracoronary Ultrasonography: High Resolution Dynamic Images of Coronary Artery Lesions

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Intravascular ultrasound displays coronary arteries in independent cross-sectional images with no axial information. Three-dimensional reconstruction is mandatory, but cardiac cycle linked vessel motions and torsions of the arteries do not allow to apply simple devices that are used for peripheral vessels.

Methods and results: We used a 2.9 F 30 MHz intravascular imaging system in combination with a motorized catheter pullback device. ECG and respiration triggering was performed and cubic datasets were acquired with a time resolution of 25 frames/s. Axial increments were set at 0.1 mm over a distance along the vessels of 25 to 35 mm. After processing the original registrations, three-dimensional real-time images could be created in any plane through the dataset. 25 patients with coronary artery disease were investigated before and after therapeutic interventions including Palmaz-Schatz stents (n = 6), laser angioplasty (n = 5), directional atherectomy (n = 4), and balloon angioplasty (n = 21). The system provided excellent images in all patients. Since the spatial geometry of the stents was known the reliability of the three-dimensional images could easily be proven. Dissection membranes, plaques and vessel takeoffs were clearly visualized in their spatial orientation, and the effect of interventions could be demonstrated in all cases. Major problems arise from tortuous vessels with regionally reduced original image quality and from surface definitions by user dependent settings of the noise/threshold level.

Conclusion: Real-time three-dimensional reconstruction of the coronary arteries is possible and extends future application of intravascular sonography.

950-95 Enhanced Detection of Endocardial Motion by Spatiotemporal Fourier Filtration of 2-D Echocardiographic Acoustic Quantification Images

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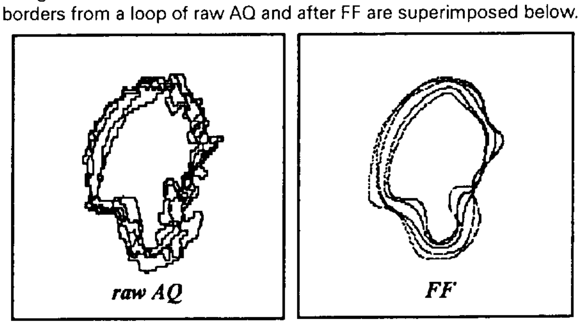
Automated detection of endocardial borders by 2-D echocardiography can be useful for the assessment of regional wall motion. Although Acoustic Quantification (AQ) currently provides on-line endocardial edge detection, the presence of high frequency noise in AQ images limits its utility for this purpose. We propose that spatiotemporal Fourier filtration (FF) of AQ images may improve signal-to-noise ratio and enhance accuracy of analysis of endocardial motion. *Methods:* We stored digitally the 2-D AQ echocardiographic images obtained from the parasternal short axis view in 10 study subjects. These were processed using a stepwise computer algorithm that included smoothing using FF with spatial and temporal cutoff of 10 and 5 harmonics, respectively. We tested the accuracy of the FF against the raw AQ images by 1) comparing the vertical axis diameters of the raw AQ and FF images with the measurements obtained from digitized M-Mode tracings, and 2) counting the number of LV internal diameter reversals during each cardiac cycle along the vertical and horizontal axis. Five successive frames of endocardial borders from a loop of raw AQ and after FF are superimposed below.



Results: 1) The correlation between M-mode and raw AQ was 0.86, vs. 0.95 between M-mode and FF ($p < 0.001$). 2) The number of reversals per cycle was 13 ± 3.5 for AQ vs. 3.1 ± 3 for FF ($p < 0.001$).

Conclusion: By eliminating high frequency noise from the echocardiographic AQ images, spatiotemporal Fourier filtration provides a more accurate representation of the endocardial edge motion.

950-96 Quantification of Left Ventricular Function by Applying Signal Averaging to Echocardiographic Automated Border Detection

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The acoustic quantification technique for automated detection of endocardial boundaries currently provides continuous left ventricular (LV) area or volume signals and beat-to-beat ejection fraction. However, due to displacement of the heart relative to the predefined region of interest, gain settings may become inappropriate, resulting in a distortion of individual waveforms and a wide beat-to-beat variability. To circumvent these limitations, we developed an algorithm for the evaluation of LV function using signal averaging, based on the stochastic sign change as a criterion for temporal beat alignment and rejection of artifacts. Left ventricular area signals obtained from the short axis view at the mid papillary muscle level in 8 normal subjects were digitized over a period of 100 sec and subjected to signal processing. End-diastolic and end-systolic area, stroke area and fractional area change were measured directly from the average waveform. Peak ejection and peak filling rates, and time to peak filling rate were obtained from the time derivative of the average waveform. The proposed algorithm was initially evaluated by studying the variability in the above parameters caused by different template waveform selections and different averaging threshold settings, which