Value of new diagnostic criteria in pacemaker lead endocarditis

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Background. Duke criteria (DC), including echocardiographic criteria, have been shown to be sensitive in diagnosing native valve infective endocarditis (IE), but to have reduced accuracy in pts with IE affecting pacemaker leads (PML). We recently proposed modified Duke criteria (MDC) in which IE was considered as "definite" even when only 1 major and 2 minor criteria were present in pts with negative blood cultures by prior antibiotic therapy and typical echocardiographic findings. Local symptoms of infection and pulmonary symptoms have also been proposed as major criteria for the diagnosis of pacemaker lead IE.

Objectives: To assess the value of DC and MDC in pts with PML IE.

Methods. DC and MDC were applied in 89 consecutive pts with native IE (group 1) and 13 pts with PML IE (group 2). Pathological confirmation was obtained in all cases. Blood cultures (BC) and transthoracic and transoesophageal echocardiography (TOE) were performed in all.

Results. Echocardiography was positive for IE in 12/13 group 2 patients, showing vegetation on the PML or on the tricuspid valve in 11 pts and a sleevelike appearance of the PML in one. Using DC, the sensitivity for diagnosis of IE was lower in group 2 than in group 1 (46 vs 84%, p < 0.01), 7 (54%) of 13 pts with proved PML IE being misclassified as "possible IE" using DC. The causes for misclassification were negative BC in 8 pts (resulting from prior antibiotic therapy in 5), and a negative TOE in 2 pts. Application of MDC resulted in a better diagnosis of PVE, with sensitivities of 92 and 77% in groups 1 and 2, respectively.

Conclusions.

1- Diagnosis of IE is more difficult in pts with IE affecting PML than in pts with native IE.
2- Strict application of Duke criteria confers a low diagnostic sensitivity in these pts.
3- Echocardiography plays a low diagnostic sensitivity in these pts.
4- Use of MDC allows improvement in the clinical diagnosis of pacemaker lead IE.

Pulse inversion imaging - a new technology for improving endocardial definition

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Pulse Inversion imaging (PI) is a new echo technology designed to provide increased sensitivity for detection of ultrasound contrast agents. Two sequential ultrasound pulses, 180 degrees out of phase with each other, are transmitted down each scan line and the received echoes are added together and should cancel each other out. The non-linear response of contrast microspheres provides incomplete cancellation and the harmonic signal is extracted, without the need for narrow-band filtering. We hypothesized that this form of imaging should also be sensitive to tissue harmonics, especially moving tissue targets and offer improved resolution over conventional 2nd harmonic imaging (2HI) because it does not utilise narrow-band filtering. Nineteen unselected patients (11 female; age range 9-70 years) referred for echo evaluation of left ventricular function were studied using an ATL HDI 5000 system in Fundamental (Fun), 2HI and PI modes. All conventional imaging planes were recorded using separate SVHS tapes for each modality. Using a standard 16 segment model, 410 myocardial segments were analysed in each modality by three independent observers. A scoring system of 0= endocardium not visualized, 1= endocardium barely visible but sufficient, 2= good endocardial definition, was used. Comparing the three modalities, there was better endocardial definition with PI (1.676 per segment) than either Fun (1.431, p<0.0001) or 2HI (1.656, p<0.01). PI resulted in an increased number of interpretable segments (92.7%) compared with Fun (65.4%, p<0.0001) or 2HI (90.2%, p<0.01). In conclusion, PI appears to provide superior endocardial definition to either conventional 2HI or Fun imaging modes. This technology may supersede 2HI as the optimum imaging modality in patients with suboptimal echo images, particularly during stress echo.
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**Left ventricular wall thickness assessment with tissue harmonic imaging**

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Tissue harmonic imaging (THI) significantly improves endocardial visualisation. Many echocardiography departments use THI as the default setting for their cardiac ultrasound machines. We have become aware that THI can cause cardiac structures to appear thicker during harmonic imaging than during fundamental imaging. We therefore performed a systematic study to assess the effect of THI on echocardiographic measurements of left ventricular wall thickness. Twenty one consecutive patients, who were referred for transthoracic echocardiography, were studied. All patients were imaged using standard ATL HDI 5000 or HDI 3500 cardiac ultrasound systems. M-mode measurements of interventricular and posterior left ventricular wall thickness were made at end diastole during both fundamental and tissue harmonic imaging. The mean thickness of the interventricular septum was 1.09cm when measured during fundamental imaging. This increased to 1.25cm with THI. This 14.7% increase is statistically significant (p less than 0.0001, paired t-test). There was a similar increase in measurements of posterior left ventricular wall thickness from a mean of 1.02cm in fundamental mode to 1.19cm in THI mode. This 16.7% increase was also statistically significant (p less than 0.0005, paired t-test). THI significantly increases the apparent thickness of both interventricular and posterior left ventricular walls. These results have important implications for echocardiographic assessment of the left ventricle. This study suggests that THI should not be used when measuring ventricular wall thickness.

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**Open scalable architecture for telemedecine in echocardiography**

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OFFIS, Oldenburg University, Oldenburg, Germany; 2ETIAM, Rennes, France; 3CorPusNet, Budapest, Hungary

Telemedecine systems and applications being developed today, range from signal transmission over modems to ATM-based leading-edge tele-radiology. Typically, these developments are limited in two dimensions:

- They are based on one platform (e.g. the昂贵 hardware-dependent and non-standard transmission protocol) and do not allow easy migration to other platforms (operating system, hardware).
- Their functionality is designed with the limitations of the underlying base technology "in mind"; e.g., an application for mobile usage will not support on-line transmission of images, and an application for high-speed networks will often not allow to "scale down".

This means that a change of network technology today usually requires the user to learn a new user interface with totally different functionality, although the basic functions from the users' point of view hardly change. So, it should be feasible to design an architecture for teledmedecine applications which:

- works in a satisfactory way on "modern" basis with inexpensive PCs, but can migrate to fast networks with the upcoming new and intelligent peripherals;
- exploits the additional functionality of these networks and systems by providing the user with additional functionality and comfort (e.g. visual telephony).

At the same time the system should basically use the same "man-machine interface", offering a familiar environment to the user. This will result in a flatter learning curve, less user errors and an increased acceptance of the new technology.

SAMTA (open Scalable Architectoro for Multisite Telemedecine Applications) is the INCO-COPERNICUS project which main objectives are mentioned above.

The architecture has been developed according the HISA model (Healthcare Information System Architecture - Healthcare Middleware layer). The basic idea was to differentiate 3 main levels of abstraction: reference model, architecture and implementation. Three levels of complexity were introduced to classify the services and to hide the technical details where they were unnecessary: Medical functional services, Technical services, Physical services.

The developed architecture has been implemented in cardiac imaging domain. The main functions are:

- image import from DICOM and other formats,
- MJPEG movie capture;
- frame selector for movies;
- general image analysis tools and special ones for cardiac imaging (e.g. mitral annulus);
- structured reporting facilities according to DICOM supplement 23;
- database of examinations and findings plus archive of multimedia data;
- DICOM data exchange over TCP/IP network with data encryption tools.

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The flow convergence region (PISA) method is not a good estimate of mitral valve area before and after percutaneous mitral commissurotomy

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To assess the value of the flow convergence region (PISA) method, mitral valve area (MVA) was determined by 4 methods: planimetry (plan), pressure half-time (PHT), continuity equation (CE), and PISA method within 1 hour before, and by 3 methods (except PHT) immediately after percutaneous mitral commissurotomy (PMC) in 27 consecutive patients (pts) with mitral stenosis (MS). PISA was measured at different aliasing velocities (AV): 20 to 30 (1) and 30 to 40 cm/sec (2), and MVA was calculated using the equation: MVA = [4πR²AV/(160)]V, where R-radius of the flow convergence region, ( = angle between mitral leaflets, V=peak transmural velocity. Results were compared to MVA measured by the Gorlin formula before and immediately after PMC, using direct measurement of left atrium to left ventricle gradients. Agreement between methods was established by the Bland and Altman method.

Results: MVA was on average 1.44 cm² by plan, 1.01 by EC, 1.11 by PHT, 1.44 by Gorlin, 1.56 by PISA 1 and 1.36 by PISA 2. Agreement between methods was as follows:

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MD: mean difference; SD: standard deviation; CI: confidence interval. Plan had the best agreement with Gorlin, EC underestimated MVA. Large discrepancies existed between PISA, Gorlin and other echo-graphic methods.

Conclusion: The PISA method is not reliable in determination of MVA in MS.

Prevention of thromboembolic complication by transesophageal echocardiography guided conversion of atrial fibrillation

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Cardioversion in patients with atrial fibrillation is associated with an increased risk of embolic stroke. Screening for atrial thrombi with transesophageal echocardiography (TEE) before cardioversion should, in many patients, permit safe cardioversion to be done earlier than it would be possible with a prolonged conventional anticoagulation therapy. To compare the feasibility and safety of transesophageal echocardiography-guided early cardioversion with those of conventional management of cardioversion inpatients with atrial fibrillation. The study involved 95 patients with persistent atrial fibrillation lasting longer than two days and having cardioversion. 40 patients (53.1±4.2 of age) underwent transesophageal echocardiography before cardioversion, with a short-term anticoagulation therapy. Cardioversion was conventionally guided in 55 patients (62.1±6.8 of age, long-term anticoagulation therapy and only transthoracal echocardiography). Atrial thrombi were detected in 20% of TEE group patients and led to the postponement of cardioversion. No embolization was recorded with this strategy. Embolization occurred in 9% in the group receiving the conventional therapy. The cardioversion treatment was shorter in the TEE group (p<0.001). Cardioversion was successful in 92% patients of the TEE group, and 78% patients of the conventional group. These results suggest that TEE-guided cardioversion is feasible and safe. The use of TEE may allow cardioversion to be done earlier, may decrease the risk of embolism associated with cardioversion.

Is it possible to predict conversion to sinus rhythm using transesophageal echocardiography?

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Due to its ability to safely exclude thrombus, transesophageal echocardiography (TEE) is now routinely performed to patients proposed to electrical cardioversion. However, what's the value of TEE in predicting conversion to sinus rhythm in patients with atrial fibrillation (AF)?

Methods: To answer this question, TEE was performed to 28 patients with chronic AF before elective cardioversion. Based on the outcome of cardioversion, patients were divided in two groups: Group A - Restoration of sinus rhythm achieved (20 patients; 63.2±10.4 years); Group B - Remained in atrial fibrillation (8 patients; 64.6±10.7 years). The following echocardiographic variables were used to compare both groups: 1 - Left Atrial (LA) size (parasternal longitudinal view); 2 - Left Atrial Appendage (LAA) systolic and diastolic dimensions (short and long axis, longitudinal view); 3 - LA emptying fraction (EF); 4 - LAA filling (FV) Doppler velocities; 5 - LAA emptying fraction (EF); 6 - Presence of LAA spontaneous contrast (SC). The clinical variable evaluated was 6 - therapy with oral amiodarone for more than 2 weeks (> 200mg/day).

Results: The results, presented as Group A versus Group B were as follows: 1 - LA size Parasternal long axis:33,3±7,8 vs 45,8±8,6mm (p<0,01); Apical 4 chambers:56,3±5,4 vs 61,6±7,1mm (p=NS); 2 - LAA Appendage (LAA) systolic: 4,5±2,4 vs 3,9±1,1 cm (p=NS); Diastolic: 4,0±1,2 vs 3,7±1,5 cm (p=NS). Short axis - LAA Appendage: 2,3±0,7 vs 2,3±0,7 cm (p=NS); Diastolic: 2,0±0,4 vs 1,9±0,3 cm (p=NS); 3 - LAA EF: 0,37±0,2 vs 0,18±0,14 m/s (p=0,04); 4 - LAA FV peak: 0,42±0,2 vs 0,21±0,19 m/s (p=NS); 4 - LAA EF: 20,5±9,3 vs 12,8±9,25% (p=NS); 5 - LAA SC: 6 patients (28.5%) vs 4 patients (57.1%) (p=NS) 6 - Oral amiodarone: 18 patients (85,7%) vs 4 patients (57.1%) (p=NS).

Conclusions: The only ETE variable that showed a marginal statistical significance was LAA emptying velocity. In concordance to these and others previous works it's not possible, at present, to predict conversion to sinus rhythm.
463 Visualization of pulmonary arteries during transesophageal echocardiography
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There is an increasing evidence that transesophageal echocardiography by the detection of thromboemboli in the proximal parts of pulmonary arteries is of high clinical value in the diagnosis of hemodynamically significant pulmonary embolism. However, there are limited data on the visualization of pulmonary arteries. We assessed the extension of proximal central pulmonary arteries possible for precise visualization during bi-plane transesophageal echocardiography in consecutive 51 pts (23F, 28M, aged 56±12.5 yr) without pulmonary embolism or pulmonary hypertension. Main pulmonary artery (MPA) and artery right pulmonary artery (RPA) were detected in the majority of patients (56,1% and 94,1%, respectively). It is worth to mention, that a perimural, immobile artifact present in the RPA was detected in the 57% of cases. Although proximal part of the left pulmonary artery (LPA), which is probably shielded by the left main bronchus, was found inside in the minority of patients (47,0%), the region of it branching was visualized in 92,1%. Moreover, during TEE proximal parts of lobar arteries at both sides: intermediate trunk, upper lobe artery and left upper lobe artery could be precisely assessed in 86,2% of patients.

Conclusion: Central pulmonary arteries including the proximal parts of lobar branches at both sides can be precisely visualized by bi-plane transesophageal echocardiography in the majority of patients. Only proximal part of the left pulmonary artery shielded by the left main bronchus is difficult to be assessed.

464 Impaired coronary flow reserve in patients with diabetes mellitus and coronary artery disease
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Coronary flow reserve (CFR) is a good marker of coronary distensibility. International trials have demonstrated the decrease of CFR in patients with diabetes mellitus. The aim of the study was to measure the CFR in patients with or without diabetes mellitus after coronary angiography. CFR was measured in 60 patients (60 men, 22 women, mean age: 57.3 years). There were 22 diabetics and 56 non-diabetics. The value of CFR was evaluated in patients undergoing coronary angiography. CFR was determined as the ratio of peak and baseline coronary flow velocities after dipyridamole administration (0.56mg/kg over 4 minutes). For statistical analysis Student’s t-test was applied. In the diabetic patients without significant coronary artery disease CFR was significantly reduced as compared to normals (1.92±0.21 vs. 2.61±0.24, p=0.05). In case of single-vessel disease patients, there was no significant difference between the diabetic and the non-diabetic group. In significant LAD stenosis, CFR was 1.64±0.09 in the non-diabetics and 1.56±0.12 in the diabetics. Patients with LAD stenosis had significantly lower CFR than subjects with other single-vessel disease in both the diabetic (1.56±0.12 vs. 2.23±0.32) and the non-diabetic (1.64±0.09 vs. 2.49±0.30) group. In patients with multi-vessel disease CFR of diabetics and non-diabetics was not statistically different (1.75±0.17 vs. 2.06±0.16).

Conclusion: coronary flow reserve during maximal pharmacologic vasodilatation was depressed in diabetic patients compared with non-diabetic patients without significant coronary artery disease. In patients with significant LAD disease the CFR was lower, than other single-vessel-disease in both diabetic and non-diabetic patients was observed in diabetic and non-diabetic patients with single- and/or 2-vessel-disease.

465 Transesophageal echocardiographic detection of thoracic aortic plaque could noninvasively predict significant obstructive coronary artery disease
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Objective: Previous pathologic and roentgenographic studies have suggested a relation between aortic plaque and coronary artery disease but have lacked clinical utility. The study was undertaken to elucidate whether atherosclerotic aortic plaque detected by transesophageal echocardiography can be a clinically useful marker for significant obstructive coronary artery disease.

Methods: Clinical and angiographic features and intraoperative transesophageal echocardiographic findings were prospectively analyzed in 131 consecutive patients(68 women and 73 men, aged 17 to 75 years) undergoing open heart surgery. Significant obstructive coronary artery disease was defined as > or = 50% stenosis of > of 1 major branch.

Results: Seventy-six(59%) of 131 patients were found to have obstructive coronary artery disease. In 76 patients with significant coronary artery disease, 71 had thoracic aortic plaque. In contrast, aortic plaque existed in only 10 of the remaining 55 patients with normal or mildly abnormal coronary arteries. The presence of aortic plaque on transesophageal echocardiography studies had a sensitivity of 93%, a specificity of 52%, and positive and negative predictive values of 68% and 90%, respectively, for significant coronary artery disease. There was a significant relationship between the degree of aortic intimal changes and the severity of coronary artery disease (r=0.74, P<0.0001). Multivariated logistic regression analysis of patient age, sex, risk factors of cardiovascular disease, and transesophageal echocardiographic findings revealed that atherosclerotic aortic plaque was the most significant independent predictor of coronary artery disease.

Conclusion: This study indicates that transesophageal echocardiographic detection of atherosclerotic plaque in the thoracic aorta is useful in the noninvasive prediction of the presence and severity of coronary artery disease.
Transcatheter and transesophageal echocardiography with second harmonic imaging in the assessment of the atrial right-to-left shunt

Cardiac Dept., "La Sapienza" University, Rome, Italy, and Cardiac Dept., University of Texas, Galveston, U.S.A.

Second harmonic imaging (SHI) is a new echocardiographic technique which can improve image quality and enhance the definition of contrast microbubbles. The purpose of this study was to evaluate SHI accuracy compared to fundamental imaging (FND) for the detection of interatrial communications using saline contrast echocardiography. 41 patients (pts) with potential cardiac source of embolus or suspected atrial septal defect underwent transesophageal (TEE) and transesophageal (TTE) echocardiography with commercially available systems. Studies were considered positive if more than 3 microbubbles were detected in left atrium within 3 cardiac cycles of contrast enhancement of the right heart. Cough and Valsalva maneuver were routinely used to raise right atrial pressure. A right-to-left shunt was detected in 10/41 pts using FND and TEE, in 19/41 pts using SHI and TTE (p<0.05 vs FND-TEE), in 18/41 pts using FND and TEE and 26/41 pts using SHI and TEE (p<0.05 vs FND-TEE). All positive studies were defined as true positive (n=29) a greater accuracy was found for SHI-TTE and SHI-TTE (72% and 61% respectively). Thus. SHI greatly increases the sensitivity and accuracy of TEE and TTE for the detection of interatrial shunts.

Spontaneous echo contrast in the descending aorta in patients without aortic dissection: associated clinical and echocardiographic characteristics

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Spontaneous echo contrast (SEC) has been found in the descending aorta (DA) in association with dissection. The purposes of this study are to evaluate both the frequency and clinical significance of SEC in the DA in the absence of dissection, and to investigate the hemodynamic correlates of SEC in the DA. Study group comprised 1199 consecutive pts (M 321, F 878, mean age 47.2+15.5) who underwent transesophageal echocardiography (TEE). Cardiac rhythm was atrial fibrillation in 459(41.3 %) of pts. Peak flow velocities (pFV, cm/sec) in the DA were measured and maximal shear rate (SHR, s -1) in the DA was calculated. Spontaneous echo contrast in the DA was detected in 84 (4.5 %) pts. Between subgroups with and without SEC in the DA, age (60.6+8 vs 40.6+14, p=0.0001), male gender (65.7 % vs 43.9 %, p=0.001) patients undergoing TEE have not been well described.

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Sesophageal echocardiography-detected atraial and thoracic aorta abnormalities in patients with atrial tachycardia as compared to atraial fibrillation: a prospective study before cardioversion

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The embolic risk of atrial tachycardia (AT) is currently unknown, although atrial flutter seems to carry a lower risk compared to atraial fibrillation (AF). We aimed to prospectively compare the frequency of TEE-detected markers of embolic risk in patients with AT and AF. Methods: AT patients (n=18) and AF patients (n=107) and no recent embolic event, were studied using transthoracic and TEE before cardioversion. The following parameters were evaluated: atrial size (LA, RA), spontaneous echo contrast, (SEC), thrombus, low left atrial appendage emptying velocity, (LAA vel) and atherosclerotic plaques. Results: There was no difference in Pts with AT and AF regarding age (60 ± 15 and 70 ± 13 NS), fractional shortening (29 ± 11 and 32 ± 10 NS), previous embolism (17% and 18%, NS) respectively.

Conclusion: LA anomolies and PAP are equally frequent in patients with AT and AF. Anticoagulant strategy in patients with AT and AF should thus be similar.

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Degenerative aortic valve disease in the elderly

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The epidemiology of aortic valve disease (AVD) in the industrialized world has changed during the past decades mainly due to the decrease of the incidence of rheumatic heart disease, the increased prevalence of elderly in the population and the extent use of echocardiography in everyday clinical practice. The aim of this study was to examine the prevalence of degenerative AVD in the elderly patients.

Methods: We included in the study population all the patients (pts) over 70 years old who underwent a transthoracic echocardiography in our laboratory with the exception of pts with prosthetic valves, history of rheumatic fever or rheumatic heart disease and obstructive hypertrophic cardiomyopathy. A total of 960 consecutive pts with a mean age of 77.3±6.4 (range 70 to 102 years) were finally included. The severity of aortic valve stenosis (AVS) was estimated by measurement of the mean blood velocity (Vm) through the aortic valve and/or by calculation of aortic valve area (AVA) using the continuity equation. The aortic valve regurgitation (AVR) was assessed semi quantitatively.

Results: A total of 758 pts (79%) were found to have AVD of variable severity. In 413 (43%) of the studied pts the aortic valve was calcified but without limitation of cusps excursion, while in 117 (12%) pts presented calcified valve with limitation of cusps excursion. Out of these 117 pts, 50.2% had mild AVS (Vm=28-32mmHg, AVA=1.20±0.07cm2), 33.4% had moderate AVS (Vm=39±3.6mmHg, AVA=0.85±0.58cm2), 34.3% had severe AVS (Vm=63±6.8mmHg, AVA=0.53±0.15cm2) and 50.7% had associated AVR. After detailed history four of the pts with severe AVS were considered entirely asymptomatic. AVR was detected in 295 pts (30.7%). The majority of them (533, 63.3% presented mild regurgitation (4/4a). Moderate AVR (2 or 4/4) was found in 36 pts (12.5%) and severe (4/4+) in 6 pts (2.03%).

Conclusion: The majority of the elderly pts present some kind of degenerative AVD. Therefore, 20% of the present AVR and 12% of AVS are of variable severity. However severe AVS is more common than severe AVR. Interestingly, four pts with severe AVS had not been previously diagnosed due to lack of symptoms. Although further investigation is needed, transthoracic echocardiography seems to be a valuable diagnostic tool, in order to achieve early diagnosis and appropriate management of AVD in the elderly patients.

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Assessment of left ventricular filling pressures by transesophageal Doppler echocardiography in women with severe aortic stenosis

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When assessing LV filling pressures by Doppler echocardiography, best known predictors are pulmonary vein systolic fraction and the difference in duration between forward mitral inflow and pulmonary flow reversal during atrial systole. Aortic stenosis (AS) in women commonly demonstrates symptoms of diastolic failure while in men systolic dysfunction predominates. Diastolic function is studied in detail by mitral valve and pulmonary veins flow analysis. To study diastolic function we have performed TEE in women with severe AS preoperatively, and compared data to those from cardiac catheterization. Methods. 22 women aged 65.9 years (range 43 to 80 ) with isolated severe AS, stable sinus rhythm and normal coronary tree, underwent TEE and catheterization prior to surgery. Data are shown in Table.


TEE
| Heart rate | 91.2±14.9 | 90.7±12.3 |
| Ejection fraction | 72.2±12.2 | 72.4±11.1 |
| LV mass index | 164.9±52.4 | 164.5±19.9 |
| PV systolic velocity | 56.6±21.9 | 64.9±17.5 |
| PV diastolic velocity | 45.7±16.3 | 50.1±14.5 |
| PV A velocity | 22.6±6.1 | 22.9±6.2 |
| PV A integral | 1.2±0.6 | 1.2±0.6 |
| PV systolic fraction | 63±13 | 64±13 |
| E/A relation | 0.87±0.2 | 0.87±0.2 |
| IVRT | 0.10±0.2 | 0.10±0.2 |
| Deceleration time | 164.1±40.9 | 164.8±40.1 |
| Diff. dur. Am-Apv | 25.3±33 | 25.3±33 |

There was only statistically significant correlation between PV systolic fraction and PCWP (r=0.48), but not with LVEDP. Difference in duration between mitral A and PV arial kick did not show statistical relationship with neither PCWP or LVEDP. In conclusion, PV systolic fraction is the only parameter related to LV filling pressures in women with severe AS.

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Echocardiographic evaluation of aortic stenosis in patients with low left ventricle ejection fraction: preliminary results

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Non-invasive estimation of the aortic valve area (AVA) is performed by means of Doppler echocardiography in clinical routine in order to evaluate the severity of the aortic stenosis (AS). The aims of this study are to determine the value of Doppler parameters-maximal aortic velocity (Vmax) and mean pressure gradient (P mean), Doppler velocity index (DVI), defined as the ratio between the maximal left ventricular outflow tract systolic velocity to the maximal aortic jet systolic velocity), fractional shortening velocity ratio (FSVR, obtained by dividing the percent fractional anteroposterior shortening at the midventricular level by peak gradient) and ejection fraction velocity ratio (EFVR, obtained by dividing the ejection fraction by peak gradient) for the assessment of AS in the patients with low left ventricular ejection fraction (LVEF). Twenty-two patients (7 women, mean age 61 ±11) with low LVEF (≤40%), hospitalized for AS suspicion were included. The values of above mentioned parameters were evaluated with AVA obtained by cardiac catheterization using Gorlin formula: AVA≤0.53 cm2/m² was considered "significant" for calculating the sensitivity and specificity.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>V max</th>
<th>P mean</th>
<th>DVI</th>
<th>FSVR</th>
<th>EFVR</th>
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<tr>
<td>Sensitivity (%)</td>
<td>93</td>
<td>75</td>
<td>93</td>
<td>88</td>
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<tr>
<td>Specificity (%)</td>
<td>93</td>
<td>75</td>
<td>93</td>
<td>88</td>
<td>93</td>
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</tbody>
</table>

This study demonstrated that the Doppler velocity index has the best correlation with actual present AV and the highest sensitivity and specificity to identify significant aortic stenosis.
Tissue characterization in aortic stenosis: segmentary variation in backscatter signal
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Pathological myocardial hypertrophy can be characterized by analysis of the integrated backscatter signal. This study aimed to assess the segmentary variation of this signal in aortic stenosis after adjustment by time gain compensation (TGC).

13 patients with aortic stenosis (AS) and 13 healthy subjects (C) were studied. Backscatter images form three echocardiographic views were acquired: septum and posterior walls in the parasternal long axis view; anterior, lateral and inferior walls in the parasternal short axis view, and apex in the four chamber view. In each segment maximum signal intensity (M), range (R) and deviation (D), all in decibels (db), as well as TGC were measured. All data were adjusted for TGC before statistical analysis.

In group AS, R and D did not show any difference among the segments. M was highest in apex and higher in apex and septum than in the posterior and lateral walls (P<0.05), the lateral wall show the smallest value (P<0.05). In group C, M was higher in septum and apex but we found less signal heterogeneity than in group AS.

Conclusion: Acoustic densitometry after adjustment by the segmentary TGC shows signal heterogeneity in aortic stenosis, higher than in healthy subjects. This can be of importance in understanding symptoms, complications and prognosis of these patients.

The ultrasonographic study of mitral regurgitation in surgical aortic stenosis
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Purpose: 1. Determination of the frequency and mechanisms implicated in the etiology of mitral regurgitation in patients with surgical aortic stenosis of different etiologies. 2. Establishment of the relationship between the degree of mitral regurgitation and aortic valvular dysfunction. 3. Assessment of the consequences of mitral regurgitation on postoperative mortality and morbidity.

Materials and methods: We studied 209 patients (30% female, 70% male), aged between 6 and 75 years (mean age 43.3 years) operated on for surgical aortic stenosis in the clinic for cardiovascular surgery of the "Prof. Dr. C. C. Iliescu" Cardiology Institute between January 1st 1996 and December 31st 1998 by means of ultrasonography and cardiac catheterisation. We also included in our study the patients with associated mitral and/or coronary lesions.

Results: 1. The incidence of mitral regurgitation in patients with surgical aortic stenosis ≤36% (p=0.0000001).
2. The degree of mitral regurgitation was correlated with age (r=0.9), LV remodelling parameters (LVH degree: IGV r=-0.56; LV lateral wall r=-0.63; LV mass r=0.68). LV performance parameters (EF and SF: r=0.81 and 0.72 respectively) and LV end-systolic diameter (r=0.76), and does not correlate with aortic valve lesion severity parameters (LV/aorta gradient, aortic regurgitation degree), mitral valve area and LVend-diastolic diameter. 3. Simple linear and multivariate regression analysis shows a relationship between the degree of mitral valve regurgitation, LV wall thickness and LV mass as follows: Y=0.08*(IVS thickness)Lateral wall thickness) +0.35*LV mass-67 (r=0.64, p<0.00001). 4. Mitral regurgitation of the second degree in severity is predictable for perioperative mortality and morbidity. It increases two-fold: the risk of death and prolongs the duration of stay in the intensive care unit three-fold compared with less severe mitral regurgitation.

Conclusions: 1. Approximately one third of the patients with surgical aortic stenosis have mitral insufficiency, mitral annular calcification being the main mechanism implicated in its etiology. 2. The degree of mitral regurgitation in surgical aortic stenosis is influenced by patient age, LV remodelling parameters and LV performance parameters and is not influenced by the lesion severity. 3. Hemodynamically significant mitral regurgitation in patients with surgical aortic stenosis is an important parameter for preoperative assessment by its implications on perioperative mortality and morbidity.

Quantification of aortic regurgitation using color and continuous wave Doppler: an echo-Doppler and aortic stenography
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Background: Effective regurgitant orifice area (EROA) has been proposed as a marker of lesion severity in valvular regurgitation. It can be closely approximated by measurement of the vena contracta (VC), the narrowest cross sectional area of the jet.

Aim: is to use VC X velocity time integral (VTI) as a determinant of regurgitant volume/beat (RV/IV) in assessing aortic regurgite (AR) severity in patients with rheumatic AR in comparison with the gold standard aortography.

Patients and methods: the study included 34 patients with rheumatic AR (26 with pure AR and 8 with double aortic lesions). The mitral valve was affected in all patients (15 with pure mitral stenosis, 8 with mild to moderate mitral regurgite and 11 with double mitral lesion). Echo-Doppler study was done for all patients in the same day of aortography to measure VC width by color Doppler and calculate VC2/VTI. RV/IV of the regurgitant wave using planimetric tracing. Outflow tract diameter was measured and VC X VTI was calculated. Jet width/outflow width (JW/Outflow W). We used cutoff values of RV/IV<0.60 ml/beat group I, 0.60<IV<1.0 group II, 1.0<IV<1.5 group III and IV>1.5 group IV.

Results: Using cutoff values of RV/IV derived from VC X VTI, correctly classified 93.3% of patients of group I into aortic grade I, 87.5% of patients of group II into aortic grade II, 63.3% of patients of group III into aortic grade III, and 60% of patients of group IV into aortic grade IV (p<0.0001). Values <80 ml/beat correctly classified 95.7% of group I and 110 ml/beat correctly classified 100% of group III and IV into aortic grade III and IV (p<0.001) with minimal overlap between those cutoff values. Comparing cutoff values derived from JW/Outflow W, we found that RV/IV cutoff values had a higher accuracy in classifying patients into aortic grades.

Conclusion: Doppler derived RV/IV can assess the severity of AR with higher accuracy, with better separation and lesser overlap between the 4 aortic grades. It is superior to other jet parameters in that it reflected the EROA and the duration of diastole (VTI). It is an easy, bedside noninvasive technique to assess the severity of AR.
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Reproducibility of estimation of mitral valve area in patients with mitral stenosis by the flow convergence region method
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There is no gold standard for estimating mitral valve area (MVA) in patients with mitral stenosis. Reliability of the pressure half time method is diminished under conditions that affect LV outflow resistance, and accuracy of the planimetry method is impaired by poor sternal window or severe calcified valve. The flow convergence region (FCR) method has been proposed as an alternative method for noninvasive quantification of MVA that can be used either in transthoracic echocardiography (TTE) or in transesophageal echocardiography (TOE). However, reproducibility of this method has not yet been reported in detail.

Method. Reproducibility of both acquiring and measuring MVA by the FCR method was assessed in TTE and TOE (biaxial probe) for a Nyquist limit of 24 cm/s. MVA was calculated according to the following formula: MVA (cm²) = 2 x (p/d)² x a x 1.045 x V (cm/s) x a x 1.045 x V (cm/s), where p = maximal radius of the FCR, a = annular angle formed by mitral leaflets that contains the FCR, V = aliasing velocity (24 cm/s), and VCW = peak transmitral velocity recorded by CW Doppler. Intraclass correlation coefficient (ICC) was calculated.

Results. 95% confidence limits of a single estimate of the MVA measurements were calculated as 2xSD/1.4142 of the mean difference, and reported as % from the mean value (see table "Reproducibility limits.")

Reproducibility results

Table 1: TD and AQ measurements before and after MVA

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Tissue Doppler and acoustic quantification measurements before and after successful percutaneous mitral balloon valvuloplasty
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We evaluated the left ventricular filling patterns and volumes before and after percutaneous mitral balloon valvuloplasty (PMBV) by using the relatively new techniques, namely tissue Doppler echocardiography and acoustic quantification.

Methods. 11 patients (9 female; 81.8% and 2 male; 18.2%, mean age 38.8±12.7) with severe mitral stenosis who were in sinus rhythm were enrolled. After standard measurements, tissue Doppler (TD) and acoustic quantification (AQ) studies were performed in apical four chamber view before and 1 day after PMBV. TD measurements were obtained from the septal part of mitral valve annulus. By TD; E, A, E/A and S waves and by AQ; end diastolic volume (EDV), end systolic volume (ESV), ejection fraction (EF), peak filling slope (EFS), peak emptying slope (EFS) and time to peak filling rate (TRFR) were measured.

Results. Mean mitral valve gradient decreased from 14.1±3.7 to 4.2±1.2 mm Hg (p<0.001) and mitral valve area increased from 1.4±0.2 to 2.0±1.2 cm² (p<0.001). TD and AQ measurements before and after PMBV are shown in Table 1.

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Mitral regurgitation in apparently healthy adults
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It is known that a retrograde flow (RF) indicative of mitral regurgitation (MR) can be depicted by Doppler echocardiography in a percentage of apparently healthy subjects. The aim of this study was to examine the prevalence and the possible importance of this finding in young healthy adults.

Methods. In the study population we included 526 consecutive adults (mean age 29.4±7.8 years, range 18 to 45 years) who underwent a transthoracic echocardiogram. All subjects included in the study population had no detectable organic heart disease by means of physical examination, chest x-ray and electrocardiogram. Patients with structural abnormalities of mitral valve were excluded. The assessment of the MR severity was made by the measurement of the absolute value of the surface of the retrograd flow in cm² with color Doppler from the four-chamber view during systole. If the retrograde flow had a velocity < 1 m/sec during a duration ≤ 200 msec it was not considered as indicative of MR. The ejection fraction of the left ventricle (LVEF) and the E to A wave ratio from transmitral flow were also calculated.

Results. A retrograde transmural flow was found in 89 (16.9%) subjects. Fifty-one of them (8.7% of the study population) fulfilled the aforementioned criteria of MR while the remaining 38 did not. None of these 38 adults had a systolic murmur indicative of MR during physical examination while 35 of the 51 subjects with established MR (68.6%) did have a systolic murmur indicative of MR. The mean surface of the detected RF was 1.56±0.35 cm². The subjects with established MR compared to the 475 adults without RF with normal echocardiography showed no differences regarding LVEF (62.4±4.5% vs 67.3±4.99%, P=NS) and E/A ratio (1.47±0.9 vs 1.52±0.2, P=NS).

Conclusion. Doppler echocardiography may depict a transmural RF in a relatively high proportion of apparently healthy adults undergoing transthoracic echocardiographic examinations. Interestingly, one out of ten healthy controls without organic heart disease present MR during echocardiography and the majority of them presented a systolic murmur indicative of MR during cardiac auscultation. Conversely, none of the study participants that had an RF but did not fulfill echocardiographic criteria of MR had an audible systolic murmur during physical examination. A specifically designed prospective study is needed to clarify the potential prognostic clinical value of this observation.

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Mitral valve aneurysms recognised by transoesophageal echocardiography. Clinical and echocardiographic aspects
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Cardiology Dept., Liparit Hospital, Lisbon, Portugal
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Mitral valve aneurysms (MVA) are rare. After their initial description in 1729 by Morand, only sporadic report cases appeared in the literature. Between 1994 and 1999, 7 cases of MVA were diagnosed at our Centre. The purpose of this study was to analyze their clinical and echocardiographic characteristics. We retrospectively studied 7 patients (pts), 4 males, mean age 67±10 years. Four had a history of endocarditis and one had a recurrent cerebral transitory ischaemic attack (TIA). All were in heart failure (NYHA class III-IV). Transthoracic (TTE) and transoesophageal echocardiography (TEE) were performed in all.

In 3 pts TTE identified an echogenic mass in the anterior leaflet of the mitral valve, bulging to the left atrium and in 2 the leaflet had a thickened appearance. All had important mitral reguration and 2 had significant pulmonary hypertension. In 3 pts there was also the suspicion of rupture chordae tendineae. TEE examination in 1 of a sacular lesion situated in the base of the anterior mitral leaflet, protruding into the left atrium, which demonstrated systolic expansion and diastolic collapse. All aneurysms were perforated and a turbulent flow could be seen inside the aneurysm with color Doppler, causing severe mitral regurgitation through the perforation. The rupture of chordae tendineae was confirmed in 3 pts. Five pts underwent urgent mitral valve replacement. One of the other two, who refused surgery initially, was operated one year later, because of clinical worsening. The other one had one more TIA. Conclusions: 1) TEE is an important tool for the diagnosis of this rare entity; 2) in our small series all the aneurysms were perforated and there was severe mitral regurgitation.
Isometric exercise as a provocative test for mitral regurgitation in patients with mitral valve prolapse

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The purpose of this study was to assess the effectiveness of isometric exercise (IE) in provoking mitral valve regurgitation (MR) in patients with mitral valve prolapse (MVP) without any regurgitation at rest, and to identify the parameters which determine this reaction. Methods. We studied 46 patients (31 women, 15 men, aged 35 ± 13 years) with an echocardiographic diagnosis of MVP. All pts underwent a full echo examination at rest, which was repeated at the maximum recommended level of IE - hand-grip at 30% of maximum effort for 4 minutes. Any changes in mitral valve leaflet thickness (MVT) or the diameter of the mitral valve annulus (MVA) were recorded during simultaneous monitoring of blood pressure (BP) and heart rate (HR). The Student t-test was used for statistic analysis.

Results. 25 patients showed MR during the resting examination. Of the remaining patients, IE caused MR > 1+ in one group (A) of 9 patients (42.8%), but in not another group (B) of 12 patients (57.2%). The results are given in the table below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Ga</th>
<th>SPVFR</th>
<th>E velocity</th>
<th>VC</th>
<th>ROA</th>
<th>JA/LAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>38±11</td>
<td>37±9</td>
<td>37±10</td>
<td>0.6±0.8</td>
<td>1.2±1.0</td>
<td>6±10</td>
<td>0.6±0.8</td>
</tr>
<tr>
<td>B</td>
<td>38±11</td>
<td>37±9</td>
<td>37±10</td>
<td>0.6±0.8</td>
<td>1.2±1.0</td>
<td>6±10</td>
<td>0.6±0.8</td>
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</tbody>
</table>
Assessment of severity and dynamics of ischaemic mitral regurgitation - Doppler quantitative and semi-quantitative methods

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The subject of our study was the semi-quantitative and quantitative Doppler evaluation of mitral regurgitation (MR) after acute myocardial infarction (MI) (the first measuring being done from 1st - 3rd day, second from 10th -14th day, third from 4th - 5th month after MI) and the evaluation of the regurgitation mechanisms.

Methods: 50 patients (average age 56±5) were being controlled after the operation. MR was registered in 24 cases (48%). The semi-quantitative method was used on the basis of ratio of regurgitant jet area and left atrial area (R/A/LAA). Quantitative evaluation of MR fraction from Doppler echocardiography (FMF) and corrected regurgitation stroke volume (RS-Vo) using the PISA method. In order to evaluate the mechanisms of appearance and dynamics of MR we measured D distance (perpendicular distance between the point of coaptation of the mitral leaflets and the mitral annular plane at end-systole), mitral annular diameter (DIA), indexes of LV chamber, namely end-systolic major-to-minor axis ratio and end-diastolic/LV major-to-minor axis ratios, LV telediastolic volume, biplane area length ejection fraction (EF), total wall motion score (TWMS).

Results: In patients with MR significantly worse TWMS was shown (each measuring p < 0.0001), as well lower EF (1st measuring p < 0.05, 2nd measuring p < 0.001, 3rd measuring p < 0.0001), when compared to that in patients without MR. In patients with MR there was the progressive decrease of systolic and diastolic chamber indexes which were significantly lower (systolic 3rd measuring p < 0.001, diastolic 1st measuring p < 0.05, 2nd p < 0.01, 3rd p < 0.001), unlike in patients without MR. In patients with MR D distance was significantly increased from 1st - 3rd measuring, p < 0.05, and it was significantly higher when compared to that in patients without MR (p < 0.001). In patients with MR there was significantly longer DIA during 3rd measuring, when compared to that in patients without MR (p < 0.001). In patients with MR the increase of diastolic diameter/LV appearance was significantly longer during 2nd (p < 0.05) and 3rd measuring (p < 0.001), unlike in patients without MR.

In patients with MR the severity of MR wasn't significantly changed during 2nd and 3rd in respect to 1st measuring, but it was in correlation with D distance (r = 0.79, p < 0.01). Using all three methods for the evaluation of the MR size, we found out the significant increase of D in patients with anterior MI.

Significant increase in D was found in 2nd and 3rd measuring in patients with anterior MI.

Valve repair in ischaemic mitral regurgitation. An echo assessment

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Ischaemic mitral regurgitation (MR) if left uncorrected, may lead to a development of a congestive heart failure.

The aim of the study was to assess the early results of mitral valve repair treatment with transcatheter prosthesis (TTETE) in patients with MI.

Methods: 21 patients were referred for CABG and mitral valve reconstruction. In all patients but one one, annuloplasty with the use of Prolene was performed. In 11 patients with anterior MI. There was a significant increase in mean mitral valve area in patients with anterior MI.

Results: We noted an improvement in MR grade: 11 patients (52%) grade 1, 4 patients (19%) grade 2. There was a significant change in mean mitral valve area (22.0±2.87cm² vs 27.7±2.20 preoperatively (p<0.05). Mean postoperative mitral valve area was calculated to be 2.7±0.28cm². One week after repair there was a significant reduction in mean regurgitant jet area: 6.2±2.10cm² vs 14.9±4.52cm² preoperatively (p<0.05) and in mean left atrial area: 22.2±2.87cm² vs 27.7±2.20 preoperatively (p<0.05).

Conclusion: Simple techniques of mitral valve repair as an adjunct to myocardial revascularisation may lead to successful outcome, avoiding complications related to prosthetic valves. Intercostal TEE is mandatory to perform the procedure safely and reliably.

Echo-Doppler comparative study between normal functioning mono- and bileaflet prosthetic valve in aortic position

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Aim: To evaluate postoperative pressure gradient (PG) across prosthetic valves (PV) in aortic position in relation to the size of the prostheses, cardiac output, body surface area, cardiac index and stroke index by using Doppler echocardiography and to compare the hemodynamic pattern of mono- and bileaflet aortic prostheses.

Methods: The study included 61 patients, in whom 61 PV were implanted in the aortic position. Group I included 30 patients with St. Vincent prosthesis (monoleaflet), group II included 31 patients with Carbomedics prosthesis (bileaflet). The first study was done after a mean of 10 days postoperatively, the day just before discharge, while the second postoperative study was done 6-8 weeks after discharge. All studies included measurement of the following parameters: mean PG, effective orifice area (EOA), and Indexed aortic prosthetic valve area (IA). Comparison between the two groups was done in terms of the valve size 23 and 25 mm which were the commonly used.

Results: For valve size 23, mean postoperative PG was 18.71 mmHg, ± 5.09, and 15.93 mmHg, ± 4.98. Mean EOA was 1.35 cm2 ± 0.17, and 1.57 cm2 ± 0.27, mean IA was 0.77 cm2/m2 ± 0.13, and 0.9 cm2/m2 ± 0.17, in the two groups respectively. There was a statistically significant difference in mean PG between the two groups, while there was a statistical significant increase in EOA and IA in group II than that of group I (p<0.05). For the valve size 25mm, mean postoperative PG was 16.44 mmHg, ± 5.32, and 14.33 mmHg, ± 3.2, mean EOA was 1.6 cm2 ± 0.09 and 1.74 cm2 ± 0.42, mean IA was 0.83 cm2/m2 ± 0.09 and 0.99 cm2/m2 ± 0.28 in the two groups respectively.

Conclusion: It was found that there is a non significant difference between mono and bileaflet prosthetic valves in regard pressure gradient, EOA, and IA. However, the EOA and IA were significantly higher in bileaflet than monoleaflet prostheses in valve size 23 mm. Every patient with a prosthetic aortic valve should undergo Echo-Doppler baseline study, prior to hospital discharge to be used as a reference in case of suspected valve dysfunction at a later stage.
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Left ventricular outflow tract obstruction after mitral valve replacement with preservation of native valve and subvalvular apparatus: relief of gradients over time
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Because of its protective role on left ventricular function, total preservation of the native valve and subvalvular apparatus has been achieved in selected patients (pts) when performing mitral valve replacement, particularly for pts with mitral regurgitation. Systolic anterior motion (SAM) of the anterior leaflet and left ventricular outflow tract (LVOT) obstruction has been reported after these procedures. We describe three consecutive pts who received Carpentier-Edwards bioprosthetic valves for mitral regurgitation with complete retention of all mitral tissue. All were >70 years old hypertensive pts with nondilated, hypertrophic and hypercontractile left ventricles. Mitral regurgitation was due to mycosasym degeneration of the valve with prolapse of both leaflets in all cases. The transthoracic echocardiogram performed early post-operatively disclosed SAM and moderate to severe LVOT obstruction (table). Transeosophageal echo was carried out in two pts to better identity the mechanisms behind the obstruction. During follow-up and after optimised medical management, although SAM remained, the grade of obstruction was significantly reduced (table) and all pts became asymptomatic with no need of surgical intervention.
LVOT Peak Gradients (mmHg)

<table>
<thead>
<tr>
<th>Pt</th>
<th>Post - Operative</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>160</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
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</tr>
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</tbody>
</table>

Conclusion: Total preservation of mitral tissue during valve replacement may produce SAM and significant LVOT obstruction early after surgery. Left ventricular size, parietal thickness, contractile state and other factors (amount of valve tissue, hypoxemia, medical therapy) may contribute/ influence this phenomenon. Significant relief of gradients can occur after a few months.

494
Comparison of vena constricta width and proximal convergence method in quantification of mitral paraprosthesis regurgitation using multiplane transoesophageal echocardiography
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Purpose: The purpose of this study was to compare two recently validated echocardiographic methods in assessment of mitral paraprosthesis regurgitation (MPR).
Methods: The vena constricta width (VCW) is the narrowest portion of the regurgitation jet and reflects the size of the orifice. It has been proposed that VCW is relatively load independent and not affected by jet eccentricity and can be used as a simple marker of MPR severity. Review of literature revealed that sufficient data is lacking on utility of FCR method in evaluation of significance of MPR. According to our knowledge this is the first study for comparative accuracy of these novel methods. The study population consisted of 20 patients with MPR: 12 (43.5%) male, 14 (56.5%) female with a mean age of 44±6 years. Type of the valves were St Jude (n=20, 78.3%) and Sorin bileaflet (n=6, 21.7%). Largest diameter of contracted zone during systole on ventricular side were measured and averaged values were used for VCW. Measurement of flow convergence region were taken in mid systole with Nyquist velocity of 35-40cm/sec and regurgitant volume (Vreg) calculated according to the formula validated earlier. For comparison of FCR VCW and VCW, Spearman correlation analysis was done. Semi-quantitative evaluation of MPR were made visually as mild to severe.
Results: The comparison of FCR and VCW showed excellent correlations (r=0.68 and p<0.001). VCW values could not be obtained in 3 of 8 patients with mild regurgitation. The relation between severity of MPR, by semi-quantitative grading. VCW and VCR according to variance analysis are as follows:

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<tr>
<td>Severe</td>
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</tr>
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Conclusion: VCW may serve as a simple and reliable marker of paraprosthetic regurgitant jets. FCR method gives accurate estimation of regurgitant volume with an accordance of VCW.

495
Microbubbles phenomenon in patients with mechanical mitral prostheses
L. Jovovic, I. Jovanovic1, B. Vujicic Tesic2, M. Zlatanovic, I. Petrovic2, Z. Popovic2, N. Tajic3, M. Bojic3
Cardiac Ultrasound dept, Dedijne Cardiovascular Institute, 1Children’s Hospital, Institute for Cardiovascular Disease, 2Dedijne Cardiovascular Institute, Belgrade, Yugoslavia
Echocardiographic phenomenon of the gas microbubbles (MB), in the left atrium (LA) during systole, has been noticed in patients with mechanical mitral valve prostheses (MMP). Nature of the MB is still controversial. Aim of the study: to evaluate the frequency of MB in pts with MMP and correlation of MB with the function of MMP, LA and left ventricular (LV) size and function. Methods: The study group included 149 pts (77 male and 72 female) average age 54±2.9 yrs with different types of MMP. In all of them transesophageal (TEE) and transeosophageal examination (TEE) were done to assess MMP function. Presence of MB in LA was recognized from TEE. Following measurements were done: size of LA, LV and LV volumes, transmural diastolic peak velocity and mean pressure gradient. Fractional shortening (FS) and ejection fraction (EF) of LV were calculated.
Results: Normal function of MMP was recognized in 71 pts, 40 pts had severe regurgitation of MMP. In 3 pts with severe regurgitation jet and reflects the size of the orifice. It has been proposed that VCW is relatively load independent and not affected by jet eccentricity and can be used as a simple marker of MPR severity. Review of literature revealed that sufficient data is lacking on utility of FCR method in evaluation of significance of MPR. According to our knowledge this is the first study for comparative accuracy of these novel methods. The study population consisted of 20 patients with MPR: 12 (43.5%) male, 14 (56.5%) female with a mean age of 44±6 years. Type of the valves were St Jude (n=20, 78.3%) and Sorin bileaflet (n=6, 21.7%). Largest diameter of contracted zone during systole on ventricular side were measured and averaged values were used for VCW. Measurement of flow convergence region were taken in mid systole with Nyquist velocity of 35-40cm/sec and regurgitant volume (Vreg) calculated according to the formula validated earlier. For comparison of FCR

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Results: Normal function of MMP was recognized in 71 pts, 40 pts had severe regurgitation of MMP. In 3 pts with severe regurgitation
496 Morphologic characteristics of thrombus in patients with mechanical valve associated with embolic events
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This study aims to assess the relationship between morphologic characteristics (MC) of prosthetic valve thrombus (PVT) and recent embolic events (EE). Study group comprised 67 pts (M 28, F 39, age 39.7±12) with PVT associated with mitral (n=53), aortic (n=10), both mitral and aortic valves (n=3) and tricuspid valve (n=1) detected by both transesophageal (TEE) and transthoracic echocardiography (TEE). Thrombus was classified as its MC (mobility, valve obstruction) determined by both TEE and TEE. Obstruction was defined as significant occlusive restriction and narrowing of valve area. Mitral valve area <1.5 cm², mitral mean gradient >10 mmHg, aortic mean gradient >40 mmHg). Mobility was defined as the presence of mobile portion and was scored (MS) from 0 to 3. According to these criteria four types of PVT were diagnosed: (1) mobile-nonobstructive (MNO) (n=15), (2) immobile-embolic (IOM) (n=32), (3) immobile-nonobstructive (IMNO) (n=12), and (4) mobile-embolic (MO) (n=4) PVT. Recent EE was defined as documented cerebral, peripheral or pulmonary embolism in the last 15 days prior to TEE study. Incidence of EE was 64.7 % (11/17), 25 % (6/24), 54.5 % (6/11) and 50 % (2/4) in pts with MNO, IMNO, IMO and MO type mitral PVT, respectively. In pts with aortic PVT, EE was documented in 1 out of 2 pts with MNO, and 1 out of 7 (14 %) pts with IMO PVT. In comparison to group without EE, MVA(cm²) was larger (2.7±0.7 vs 1.5±0.8, p=0.001), mitral mean gradient (mm Hg) was lower (5.4±3.7 vs 12±8.5, p<0.0005), diameter of PVT base was smaller (11.4±5.4 vs 17.3±6.8, p=0.005), and MS was higher (0.96±0.9 vs 0.45±0.45, p<0.05) in pts with EE. Age, gender, rhythm, duration from valve replacement to diagnosis, and type of mechanical valve were not different between groups with and without EE (p>0.05). In multivariate analysis, MS and diameter of PVT base portion were found to be two independent variables associated with recent EE.
Conclusion: Mobile PVT is more likely associated with EE. Patients with MNO type and smaller PVT may prone to higher risk for EE than in pts with immobile obstructive PVT.

498 Real-time three-dimensional assessment of total cardiac volume and the ratio of chamber specific volumes
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Department of Cardiology, The Cleveland Clinic Foundation, Cleveland OH, United States of America
Advances in real-time 3D echocardiography now allows for the simultaneous volumetric assessment of all 4 cardiac chambers. In order to apply chamber specific volumes to volumes in the understanding of pathology, the normal ratios of each chamber's volume to total cardiac volume needs to be better quantified.
METHODS: Real-time 3D echo was performed in 7 healthy volunteers undergoing preload altering maneuvers using a tilt table (90° and 45° upright, -6° and -30° head-down). 28 total conditions were measured. From a single cardiac cycle, end-diastolic (EDV) and end-systolic (ESV) volumes for each chamber and the percentage of the total cardiac volume was determined for each condition. Least-squares linear regression and Pearson's coefficients were determined for each chamber versus the total cardiac volume.
RESULTS: Total EDV and ESV cardiac volumes ranged from 155 to 331 ml (247.4±50.7 ml) and 67 to 193 ml (124.9±31.7 ml). Slope and r represents the relationship and correlation coefficients were determined for each chamber versus the total cardiac volume. No significant interobserver differences were found with respect to EDV and ESV. A significant interobserver variability was found in 10 patients the volume measurements compared with rest gated SPECT thallium within a 72 h period.

499 Assessment of Ventricular Volumes and Ejection Fraction by Real-Time 3D Echocardiography in Comparison with Gated SPECT Thallium
S. Möller, T. Bartel*, E. Neubauer, M. Katz*, D. Marren*, R. Eibel*, O. Pachinger
Departments of Cardiology, Universities Innsbruck, Austria and Essen, Germany*
Background: The purpose of this study was to evaluate the accuracy and interobserver variability in quantifying left ventricular volumes and ejection fraction (LVEF) using real-time 3D echocardiography (RT3DE).
Methods: In 44 patients with coronary heart disease, RT3DE was employed to measure end-diastolic and end-systolic left ventricular volumes (EDV, ESV). The system uses a matrix phased array transducer (2.5 MHz, 512 elements) and a 16.1 receive/transmit parallel processing scheme to develop a 4096 line scan interrogation of all positions in a 60° pyramidal volume at 18 frames/s. Volume determination was performed by summation of multiple discs obtained by manually tracing the endocardial border in 7 equally spaced and 0.9–1.2 thick short axis images. The interobserver variability was determined and in 10 patients the volume measurements compared with rest gated SPECT thallium within a 72 h period.
Results: No significant interobserver differences were found with respect to EDV and LVEF. A significant interobserver variability was shown in the determination of ESV. RT3DE and gated SPECT were found to be in good agreement.
Parameter & Difference between both observers
Mean+/-SD (%) & Mean+/-SD (%) & P
EDV 0.74+/-0.1 & 0.73+/-0.1 & 0.95
ESV 2.64+/-0.3 & 2.64+/-0.3 & 0.99
LVEF 0.01 & 0.01 & 0.99

Conclusions: RT3DE volumetry was found to be closely related to gated SPECT thallium measurements of EDV and ESV. RT3DE is time saving and therefore can be employed alternatively in an intermediate care unit where hemodynamic monitoring is not available.

500 An in vitro steady flow model of mitral regurgitation by three-dimensional Doppler
R. De Simone, G. Glombtza*, CHF. Vahl, HP. Meinerz*, S. Hagl
Cardiac Surgery Dept., University of Heidelberg, Heidelberg, Germany*
German Cancer Research Center, Heidelberg, Germany
Objective: The recent clinical application of three-dimensional (3D) color Doppler showed that the jet volumes provided a useful parameter of mitral regurgitation in patients. Aim of this study was to investigate the relationship between jet volumes and the actual flow rates.
Methods: We analyzed 46 examinations accomplished by a steady flow system that pumped a fluid at different flow rates and pressures through different pericardial patches. A set of 7 circular holes and 7 linear slits simulated mitral regurgitant orifices of different sizes (2–8 mm). The flow rate distal to the orifices and the jet volumes obtained by 3D color Doppler were measured. In a series of 17 examinations the jets were deviated along curved surfaces to simulate the atrial wall curvature.
Results: The actual flow through the orifices ranged from 0.18 to 2.5 l/min (mean 0.64±0.61). A significant correlation was found between the flow rates and the jet volumes (r=0.95, p<0.01). No significant difference was found between the volumes of 17 free jets and 17 wall jets measured at identical flow rates. The increase in pressure gradients resulted in a significant, but relatively minor increase in jet volumes, when compared to increasing orifice sizes. Conclusions: The volume of the regurgitant jets is significantly correlated to the flow rate, it is independent of jet geometry, and it remains fairly constant during moderate changes in pressure. The jet volume is a reliable parameter for predicting the orifice size and the actual regurgitant volume.
Real-time 3D volumetric echocardiography allows improved assessment of mitral valve stenosis

I. Rosenhek, T. Binder, G. Farenta, G. Maurer, T. Baumgartner
Dept. of Cardiology, Univ. of Vienna, Austria

Background: Conventional planimetry of the mitral valve area (MVA) by 2D echo (2DE) requires a favorable parasternal acoustic window and depends on operator skill. Real-time 3D echo (3DE) allows the reconstruction of multiple 2D planes in any desired orientation and is not limited to parasternal acquisition.

Methods: To evaluate the feasibility and accuracy of 3DE for the assessment of the MVA, 32 pts with mitral stenosis (FIM 2/75, mean age 58±14 yrs) were studied with both, conventional 2DE and 3DE (Volumeetrics, 2.5 MHz) by two independent operators.

3DE data was acquired from an apical view. Furthermore, the potential measurement errors caused by inappropriate alignment of the imaging plane through the mitral valve were analyzed.

Results: Planimetry was possible in 28 pts (87%) using 2DE but in all pts with 3DE. MVA by 3DE correlated well with MVA by 2DE (r=0.9) and the PHT method (r=0.88). Interobserver variability was significantly lower for 3DE than for 2DE (SD 0.08 cm² vs 0.23 cm², p<0.05). It was shown that even small changes of the optimal imaging plane (due to angulation and/or parallel shift) result in considerable measurement errors.

Conclusion: Real-Time 3D volumetric echocardiography provides accurate and highly reproducible measurements of mitral valve area, less susceptible to measurement errors and can easily be performed from an apical approach.
Comparison of scanning techniques for three-dimensional forward-viewing Intravascular ultrasound imaging

Medical Physics and Medical Engineering, University of Edinburgh, & Department of Cardiology, Royal Infirmary of Edinburgh, Edinburgh, United Kingdom

Purpose: Forward-viewing intravascular ultrasound is a promising tool to overcome the inability of the conventional side-viewing intravascular ultrasound systems to image occluded or severely stenosed vessels. The aim of this study was to investigate forward-viewing scanning patterns for 3D imaging along tubular structures such as coronary arteries.

Methods: The study was carried out with three models of 3D ultrasound machines with different scanning patterns. The models were: 1) the Siemens Sonoline SL-1 scanner, 2) the Siemens Sonoline SL-1 scanner equipped with a standard Bird and a modified Siemens Sonoline SL-1 scanner, and 3) the Siemens Sonoline SL-1 scanner. The scanners were used to image the coronary arteries of a human cadaver. The images were compared using quantitative imaging techniques.

Results and Conclusion: The conical scan suffered from poor image quality at the vessel wall and a reduced field of view. Due to the latter limitation, it proved unsuitable for quantitative applications. The use of the conical scan with the spiral scan seems to be strongly affected by the frame density of the scanned volume. Overall, the spiral and the rotational scans appeared to provide the best image quality for imaging structures of circular symmetry. On the other hand, the conical scan was the least accurate in measuring small dimensions, leading to large underestimations of narrow lumens. The rotational scan proved the most accurate of all for quantitative applications. This feature and the displayed image quality seem to indicate that the rotational scan is the best scanning technique for forward-viewing intravascular ultrasound. This conclusion is supported further by the ability of the rotational scan to provide 2D longitudinal and transverse transducer orientation, something unobtainable with the other scanning patterns.

In conclusion, the rotational scan is the most suitable for real time imaging and guidance of interventional procedures.

Potential errors due to environmental metal when performing quantitative ventriculography by freehand

Three-dimensional echocardiography using an electro-magnetic locator

D. King, L. Coffin, D. King Jr
Medicine and Cardiology Dept., Columbia University, Darien CT, United States of America

Quantitative ventriculography by freehand 3D echo using an acoustic spatial locator (ASL) provides highly accurate, reproducible measurements of LV volume, mass and function. The Bird electro-magnetic locator (EML) is an attractive alternative locator because it is smaller and more portable. However, EML accuracy may be compromised by ferromagnetic metals in the near environment likely to be found in hospital settings. Using tissue equivalent ellipsoid phantoms of known volumes we compared three-dimensional models (ASL) with standard Bird and miniBird systems to our 3D ASL system in 3 experiments: 1) no metal within 75 cm of phantoms/ASL; 2) on a standard metal hospital stretcher <25 cm from phantoms/ASL, echo machine >75 cm from EML; 3) same stretcher <25 cm from ASL/EML, echo machine <25 cm from EML. Results: Exp 1 - No significant volume error (<1%). No significant difference among the three systems (p=0.63). Exp 2 - Significant volume underestimation error by both EML systems (10.5%, p<0.05). Exp 3 - Significant and greater volume underestimation error by both EML systems (-14.7%, p<0.05). Inter-observer variability was 5.1%. Conclusion: For quantitative ventriculography, EML systems should not be used if ferro-magnetic metal is in the near environment. Accuracy quantitative ventriculography may be performed using EML systems in a near environment free of ferro-magnetic metal, e.g., using a wood examination table. Environments containing potentially interfering metal should be tested using tissue-equivalent quantitative phantoms of known volumes prior to performance of quantitative ventriculography examinations by freehand 3D echo.

Normal values for transcranial echocardiography and abdominal sonograms in mice

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Kardiologie und Angiologie Abt., Westfälische Wilhelms-Universität, Münster, Germany

Technical improvements in Doppler-echocardiography and progress in molecular genetics to produce transgenic and knock-out mice give rise to the need for echocardiographic and abdominal ultrasound imaging of wild type mice. CD-1 (Swiss mice) are introduced.

In vivo evaluation in anaesthetized closed chest mice was made on the HP Sonos 5500 ultrasound system equipped with an 8-12 MHz, Fusion-Imaging-transducer.

Data were obtained for a two-dimensional (2D) echocardiography, M-Mode, continuous wave (cw), pulsed wave (pw) and color flow (cfl)-Doppler.

In 35 evaluated mice mean values ± standard deviation were as follows: weight 20,71±1,41g, heart frequency (HF) 348±56bpm, left ventricular enddiastolic diameter (LVEDD) 4,09±0,91mm, left ventricular enddiastolic diameter (LVEDD) 2,49±0,61mm, enddiastolic thickness of intraventricular septum (IVSed) 0,51±0,08mm, posterior wall enddiastolic thickness (PWed) 0,68±0,13mm, Maximum aortic flow velocity 58,5±24,1cm/s, Length of left kidney 10,5±1,7mm, Length of right kidney 10,6±0,3mm.

Results show that dorsal and ventral echocardiography are feasible and abdominal ultrasound imaging using mice is an alternative for cardiovascular research in normal and gene targeted mice.

Future investigations of the present study will provide sex and age related normal values for cardiovascular and abdominal ultrasound in the wild type mouse as we are planning subgroups of 25 animals of young and old, male and female mice. These results are absolutely necessary as baseline data for future cardiovascular phenotyping in gene targeted mice.

Noninvasive cardiovascular phenotyping of PKD2-knock-out mice

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Kardiologie und Angiologie Abt., Westfälische Wilhelms-Universität, Westfälische Wilhelms Universität, Humangenetik, Münster, Germany

The autosomal dominant polycystic kidney disease (ADPKD) is with an incidence of 1:1000 one of the most common genetical diseases. ADPKD is characterized by bilateral kidney cysts leading to terminal insufficiency of the kidneys in older patients. Because there is a great number of extrarenal pathologic changes, ADPKD meanwhile is considered as a systemic disease. Insufficiencies of the aortic and mitral valve and an arterial hypertension are the leading cardiovascular manifestations. Two genes (PKD1 and PKD2) are described to be responsible for 98% of the sick patients with ADPKD. In spring 1999 we could establish a mouse model for the ADPKD type 2. The ADPKD-knock-out mouse (PKD2-knockout) does not show clear phenotypic abnormalities.

We screened 15 female homozygotic and heterozygotic mice aged 9 weeks with the HP Sonos 5500 ultrasound system equipped with an 8-12 MHz-Fusion-Imaging-transducer for cardiovascular findings in the transcranial Doppler-echocardiography (TTE) and abnormalities in the abdominal sonogram. There was no difference in weight and heart rate (HR) for homozygotic and heterozygotic animals. Mean values and standard deviation: 20,77±1,62g and 20,67±1,25g, HF 345±44bpm and 351±73bpm. Homozygotic mice show thicker enddiastolic posterior wall thickness (PWed) 0,14mm versus 0,85±0,10mm, thicker enddiastolic interventricular wall thicknesses 0,90±0,07mm versus 0,85±0,10mm, a higher cardiac output (CO) 12,5±0,10min versus 9,0±0,10min and a higher maximum velocity of the aortic flow (Vmax=40) 27,3±7,7cm/s versus 75,30±7,56cm/s than heterozygotic female mice of the same age.

In theory more definite cardiovascular findings are expected under the stress of pregnancy. The noninvasive cardiovascular phenotyping study of the PKD2-mice by TTE will check cardiovascular abnormalities in homozygotic and from day 11 of the pregnancy of the embryos. Special interest will be considered to cystic abnormalities of the homoyzogotic or heterozygotic embryos, the HR and the size of the embryo-hearts.
The effects of intra-uterine growth retardation on wall stress-induced arrhythmia in the working rat heart
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Dept. of Physiology, University of Bristol, Bristol, United Kingdom

Objectives: There is strong evidence in humans that intrauterine growth retardation (IUGR) is associated with an increased risk of hypertension and coronary heart disease in later life (Barker D.J.P. Arch. Dis. Child. 1995; 80: 002). To assess whether rats subjected to IUGR develop more arrhythmias after 4 months, we have used the isolated working heart model, which allows us to study heart function independent of blood pressure or the effect of extrinsic, venuos or hormonal influences. (Salmon, et al., Cardiovasc Res. 1997; 34: 493).

Methods: Immediately after mating, Wistar dams were fed a protein-free diet throughout pregnancy and pups were cross fostered onto normal dams at birth. At 4 months of age, hearts from both IUGR and control rats were removed and mounted on a working heart apparatus, and subjected to abrupt increases in afterload. Type and frequency of dysrhythmias produced were quantified.

Results: In response to a 20 s increment of afterload by 60 mmHg, control rats (n=11) developed 13.3 ± 4.5 ventricular premature beats (VPBs) and 3.9 ± 1.4 ventricular tachycardias (VT). In contrast, hearts from IUGR rats (n=13) developed 45.7 ± 6.1 VPBs (p<0.006), and 18.4 ± 5.9 VTs (p<0.04). Coronary flow was reduced in the IUGR group 16.5 ± 0.88 (m/m/min ± 1 s.e.m) compared to control group 20.4 ± 0.89 (p<0.007). No changes of left ventricular wall thickness or mass were observed at this age.

Conclusions: This study indicates that IUGR increases the susceptibility of the heart to arrhythmias produced by changes of wall stress, even at this relatively early stage of their life. The mechanism of this effect is unclear, however, it is possible that relative ischemia of the IUGR rats heart may contribute to their arrhythmogenicity. Further investigations on middle and old age rats are underway.

Do high resolution and II harmonic echocardiographic imaging increase feasibility of diagnostic routine imaging?
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Increased costs of new echocardiographic imaging technologies (high resolution >50Hz, HR; II harmonics, SH) and high quality Doppler have not been balanced by demonstration of a significant increase in feasibility of diagnostic routine imaging. We evaluated standard (SR, resolution <50Hz), HR and HR+SH echocardiography in a large (500 routine pts) unselected population studied consecutively by an experienced operator (ASE level 3). We compared % success in obtaining satisfactory standard left ventricular (LV) 2D (diastolic, EDD, and outflow tract, OD, diameters; end-diastolic volume, EDV, and ejection fraction, EF) and pulsed Doppler (peak E/A, mitral flow velocity ratio; pulmonary venous systolic flow integral, PSI) parameters (Table). The 3 imaging groups (SR, HR, HR+SH) were similar for age, sex, BSA, heart rate, distribution of diagnostic groups (normals, hypertensive LV hypertrophy, ischemic heart disease, dilated cardiomyopathy, valve regurgitation or prosthesis) and distribution of EF classes (<35%, 35-45%, >45).

Table

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<tr>
<th></th>
<th>pts</th>
<th>Age</th>
<th>BSA</th>
<th>OD%</th>
<th>EDD%</th>
<th>EDV%</th>
<th>EF%</th>
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<td>3R</td>
<td>38</td>
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<td>38</td>
<td>60±14</td>
<td>1.8±1.9</td>
<td>98.9</td>
<td>93.3</td>
<td>100</td>
<td>94.6</td>
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In conclusion, use of HR+SH imaging and high quality Doppler, when compared to SR, does not increase feasibility of obtaining standard 2D or Doppler indices during routine imaging by an expert operator. In contrast to previous observations, pulmonary venous flow velocities are obtained in >92% of pts even when SR equipment is used. Adequate operator experience probably compensates for older imaging technology.

Tissue harmonic Imaging enhances left atrial appendage visualisation
Dept. of Cardiology, Freeman Hospital, Newcastle upon Tyne, United Kingdom

Left atrial appendage (LAA) thrombus is an important risk factor for embolic stroke. Transoesophageal echocardiography (TOE) is the gold standard for LAA assessment. Tissue harmonic imaging (THI) improves left ventricular endocardial definition during transthoracic echocardiography (TTE). We hypothesised that THI would increase our ability to visualise the LAA using TTE. 50 consecutive patients referred for TTE were scanned using a conventional cardiac ultrasound system. The LAA was examined in both fundamental (FND) and THI modes. Images were reviewed offline by two independent observers. The LAA was divided into four segments and endocardial definition was scored as follows: 0 = not visible, 1 = inadequately seen, 2 = just adequately visualised, 3 = good visualisation, 4 = TOE quality. THI significantly increased the visualisation scores for each of the four segments of the left atrial appendage. The overall mean visualisation score was also significantly increased (see table 1). LAA thrombus was suspected in four (2%) patients and confirmed in two on TOE. Consent for TOE was not obtained in the other 2 patients. These data suggest that tissue harmonic imaging improves LAA visualisation on TTE. It may be that THI will increase the accuracy of TTE for the diagnosis of LAA thrombus. Further studies will be required to answer this question.

Harmonic power Doppler imaging without the use of contrast agents
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Tissue Harmonic Imaging (THI) has been shown to improve the enhancement of endocardial borders. This can be explained by non linear propagation of ultrasound within tissue resulting in the generation of harmonic frequencies. However, the impact of studies without contrast using Harmonic Power Doppler Imaging (HPD) is still unknown. Method: 10 consecutive patients with good acoustic windows were investigated using THI and HPD. Standard parasternal and apical views were obtained with an HDI 5000 ultrasound system (ATL, Bothell, WA) using a broadband transducer. Continuous and transient imaging (1 frame per cardiac cycle) were performed with varying settings of emission power, PRF and wall filter. Recordings were analyzed using a calibrated software allowing quantitative assessment of raw THI and HPD data. Results: In all patients HPD signals were recorded. No HPD signals were found in the myocardium in end-systolic, mid-diastolic and end-diastolic frames. LV cavity signals were observed in all frames of the cardiac cycle. In single frames the low intensity signals did not completely cover the LV cross sectional area. Using an image alignment technique and summing up >16 consecutive frames provided complete opacification and excellent delineation of the LV cavity. LV volumes calculated from HPD data compared well with the results of tracing endocardial borders using tissue harmonic imaging.

Conclusion: Harmonic Power Doppler Imaging can be done without injection of a contrast agent. Postprocessing of LV cavity signals provides excellent opacification and delineation of the whole LV cavity with the potential of assessing LV volumes.
Computer aided analysis of mitral annulus motion
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The analysis of mitral annulus (MA) motion provides useful information on left ventricular (LV) systolic and diastolic function. Two kinds of techniques usually can be applied for MA motion investigation:
1) M-mode images (under control of two dimensional B-mode image);
2) tissue Doppler investigation.

The first technique has an advantage over the second one. M-mode image allows a user (a physician) to assess three main parameters of the MA motion: amplitude, speed, and time.

Manual drawing of boundaries on M-mode echocardiographic images is time consuming, and tiresome for a physician. Thus, automatic boundary detection should simplify such an analysis.

There are two main techniques for the curve detection:
* manual detection (a physician draws the curve with a help of the "mouse" device);
* automatic detection.

Both techniques were implemented in our program.

The main steps of the MA motion curve automatic detection are as follows:
1) definition of a rectangular region of interest (ROI) by a user;
2) application of the Matched Detector technique in the ROI;
3) correction of the detected curve with a help of non-linear operations;
4) application of a low-pass filter for the detected curve.

The program enables:
- image calibration (time and distance axes calibration);
- manual drawing of a curve;
- automatic detection of a curve;
- marking key points (e.g. the main axis, the moment of R wave of the ECG, etc.);
- calculation of the medical parameters (MA motion amplitudes, time intervals, velocity and acceleration curves, etc.);

The developed program was tested by experienced cardiologists. Eighteen cycles of the MA motion curves were analysed. The echocardiograph "Toshiba 380A" was used for acquisition of the M-mode images. The images were recorded on the video tape. Then, they were acquired and stored on the hard disc of a PC.

Three cases of the testing measurements were investigated:
- manual (ordinary), automatic and mixed evaluation. Statistical data of medical validation are presented.

Conclusions:
1. The developed software detects mitral annulus (MA) motion curve on noisy M-mode image, and estimates quantitative parameters of the left ventricular function: amplitudes, speed, acceleration, etc.
2. The automatic evaluation of MA motion curve and the medical parameters speeds up the process of investigation of a patient.
3. The system uses digitised M-mode images, therefore it may be attached to any echocardiograph. Thus, it may be widely used in clinical practice.