### S172  
#### Abstracts

## Poster session 5

**Saturday, 10 December 2005, 8:30-12:30**

**Location:** Poster Area

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### DIASTOLIC FUNCTION

**1066**  
**Assessment of mitral A-wave deceleration time normal variations. The impact of age and gender**

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**Purpose:** Mitral A-wave deceleration time (Adt) is a promising Doppler parameter for evaluation of left ventricular (LV) diastolic dysfunction. Adt has been reported as a useful index for the prediction of elevated left ventricular (LV) filling pressures and detection of the type of LV diastolic dysfunction. The present study aims to evaluate normal values of Adt and determine possible effects by sex and aging.

**Methods:** We studied 82 healthy individuals between 15-76 years old, 35 males (MGroup) and 47 females (FGroup) of matched age. Concerning age, the groups studied were a) 29 individuals of 15-35 years old (Group 15-35), b) 26 individuals of 36-55 years old (Group 36-55) and c) 17 individuals of 56-75 years old (Group 56-75). Gender was comparable among three groups. Adt was calculated in all subjects of study groups at rest. Values between groups were compared with student's t-test and a value p<0.05 was considered significant.

**Results:** Mean Adt value for total population was 95.83±1.64 (range 80-110). The Adt in the subjects of MGroup (96.57±1.55) didn't differ compared to that in subjects of FGroup (94.04±1.41) (p=NS). On the contrary, the Adt in Group 15-35 (90.00±1.27) was significantly smaller than those in Group 36-55 (96.94±1.78) (p=0.006) and in Group 56-75 (100.00±2.94) (p=0.001). The Adt in Group 36-55 didn't differ compared to that in Group 36-75 (p=NS).

**Conclusions:** 1) Mean value of Adt is 95.83±1.64 (2) Adt is sex-independent and does not seems being affected by age in individuals older than 35 years. 3) The influence of age to the Adt concerns younger ages (15-35 years) where the Adt is significantly smaller.

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**1087**  
**Tissue Doppler early diastolic velocity is equally dependent on changes in preload as transmirtal early filling wave**

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**Objectives:** The influence of preload on tissue Doppler imaging (TDI) parameters is still controversial. In the present study we wanted to investigate the effect of preload on two different echocardiographic indices for LV filling pressure. Furthermore, we wanted to explore the influence of preload on the Tei index combining both LV systolic and diastolic function.

**Method:** Eight healthy men, 23±2 years of age, were examined with both standard echocardiography and TDI at rest, and at the level of lower body negative pressure to -40 mmHg, reducing left ventricular stroke volume by 35%. The LV diastolic filling was assessed by transmirtal early E velocity and flow propagation velocity (Vp) by color M-mode Doppler. The Tei index was measured from one pulsed Doppler recording combining transmirtal and aortic flow and calculated as the sum of monodimensional contraction- and relaxationtime divided by the aortic ejection time. In addition early diastolic pulsed Doppler tissue velocity from septal mitral annulus, E', was measured. Both E' and E/Vp were measured as indices of LV filling pressure.

**Results:** See table

<table>
<thead>
<tr>
<th>Baseline</th>
<th>-40 mmHg</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR, beats/min</td>
<td>58±8</td>
<td>69±9</td>
</tr>
<tr>
<td>SV, ml</td>
<td>97±17</td>
<td>57±14</td>
</tr>
<tr>
<td>E-wave, cm/s</td>
<td>75±18</td>
<td>5±10</td>
</tr>
<tr>
<td>Vp, cm/s</td>
<td>50±5</td>
<td>41±6</td>
</tr>
<tr>
<td>E'/E</td>
<td>1.5±0.3</td>
<td>1±0.2</td>
</tr>
<tr>
<td>E'/Vp</td>
<td>11.4±2.3</td>
<td>7.9±1.6</td>
</tr>
<tr>
<td>E'</td>
<td>6.7±1.8</td>
<td>6.6±1.4</td>
</tr>
<tr>
<td>TDI</td>
<td>0.7±0.2</td>
<td>0.9±0.1</td>
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</table>

**Conclusion:** In this model of lower body negative pressure, E' and E were markedly and equally reduced. There was also a decrease in Vp, but to a lesser extent. The echocardiographic indices of LV filling pressure, E'/E and E/Vp were not influenced by the considerable change in preload. However, the Tei index increased, reflecting a dependency of preload.

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**1088**  
**Prevalence and characteristics of diastolic dysfunction in a large patient group referred to routine echocardiography**

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**Diastolic dysfunction (DD) is frequently detected in patients referred to routine echocardiography (Echo) but it rarely gives rise to a therapeutic change. One major concern may be the popular assumption that DD is 'normal' in elderly or otherwise ill patients. The aim of this study was to examine in a large patient group the prevalence and characteristics of DD with regard to age and various echocardiographic findings.**

**Methods:** In 5,145 consecutive patients (51.8% male, 58±15.8 years) referred to routine Echo, DD was assessed semi-quantitatively by pre-Doppler measurement of the flow over the mitral valve and pulmonary veins (1=normal to 5=restrictive flow pattern). Patients with atrial fibrillation or tachycardia >110/min were excluded. Additionally, end-diastolic diameters of the left ventricle (LVED), the posterior (LVPW) and mitral regurgitation (rho=0.309, p<0.001) and septal (IVS) LV wall and left atrium (LA) were determined by m-mode. Mitral and aortic regurgitation were assessed in each patient semi-quantitatively. LV mass was calculated using the formula of Devereux and LV-EF was measured by planimetry in a subset of patients. All data were recorded with the FileMaker® software and the statistics were computed using SPSS 12.0.

**Results:** Only 1366 (26.6%) patients showed a normal diastolic function. The mean LA was 37±16 mm, LVED 51±6 mm, LVPW 10±5 mm, IVS 11±2 mm, LV mass 293±197 g. Surprisingly there was no correlation found either between age and DD (Spearman rho=0.05, p=0.712) or aortic regurgitation and DD (rho=0.062, p=0.888), whilst highly significant correlations emerged between all other parameters and DD. The strongest correlation was found for LV mass (rho=0.432, p<0.001), IVS (rho=0.421, p<0.001), LA (rho=0.363, p<0.001), LVPW (rho=0.379, p<0.001) and mitral regurgitation (rho=0.309, p<0.001). A weak correlation of merely rho=0.161 (p=0.001) was detected for DD and LV fractional shortening.

**Conclusion:** DD does not depend on patient's age but it strongly correlates with findings associated with elevated LV mass.
Is the new cardiac time interval TEm-E really preload independent in healthy subjects?

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Background and the aim of the study: Time interval between the onset of early diastolic mitral annular velocity (Em) and mitral inflow (TEm-E) has been recently proposed as a new index of left ventricular (LV) filling. We sought to assess the influence of changes in loading conditions on this new parameter.

Methods: Sixteen healthy males (27±4 years) were examined at rest, after passive leg lifting and after sublingual administration of nitroglycerin (NTG). Em of the lateral mitral annulus using pulsed wave tissue Doppler imaging and early transmitral flow velocity using spectral Doppler were recorded. TEm-E was subsequently measured.

Results: At rest, E was 0.84±0.14 m/s, Em 0.14±0.02 m/s and TEm-E was 23±26 ms. With leg lifting, E was 0.93±0.18 m/s (p<0.05 vs. normal) and NTG administration 0.52±0.13 m/s (p<0.001 vs. rest values, p=0.001 vs. values after leg lifting). With legs lifting, Em was 0.15±0.01 (p<0.05) and 0.11±0.02 after NTG (p<0.01 vs. rest values, p<0.01 vs. values after leg lifting). TEm-E was 19±20 ms with NTG administration (p<0.05) and 5±27 ms with NTG administration (p<0.05 vs. rest values, p=NS vs. leg lifting).

Conclusions: In comparison to other tested parameter, significant changes of TEm-E occurred only when preload was significantly decreased. Both E and Em were preload dependent as well as TEm-E. We found that the Cardiac Time Interval is less load dependent in healthy subject in comparison to Doppler peak velocities but remains still preload dependent, yet partially.

Does flow propagation velocity reflect left ventricular diastolic dysfunction preload-independently?

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Introduction: Left ventricular (LV) diastolic dysfunction (DD) has been recognized as the leading pathology in developing heart failure in over 30%. For quantification conventional Echocardiographic diastolic parameters have been shown to be preload dependent and thus not reliable for monitoring diastolic function during major load changes caused by medical treatment, during Anesthesia or surgical procedures. Recently flow propagational velocity (Vprop) has been described as a parameter reflecting LV compliance. Early studies suggested Vprop to be preload independent.

Methods: Sixteen healthy volunteers were studied under different levels of LBNP (-20, -40, -80 mbar) in a randomized order. Baseline pressure levels (0 mbar) were applied in the beginning and end and in between of each negative pressure levels. Duration of each level was 10 minutes, duration of one study case 70 minutes. The observer was blinded to the amount of LBNP. Hemodynamic measurements included heart rate (HR) and blood pressure (RR systolic/diastolic/mean). Echocardiographic measurements included mitral flow pattern (E, A, E/A, DT, IVRT, A'd'), Vprop and tissue Doppler measurements (Em, Am, Em'/Am') of the septal wall.

Statistics: Statistical analysis was performed using ANOVA with P<0.05 to be statistically significant.

Results: Whereas overall hemodynamics did not change significantly Vprop decreased significantly with different levels of LBNP compared to baseline (p<0.0001) and from -40 to -80 mbar (p=0.04).

Conclusion: As Vprop changed with different levels of LBNP it is considered to be a load dependent parameter of LV diastolic function.

Influences of aortic stiffness and blood pressure on target organ damage in hypertension

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Objectives: Hypertension could causes target organ damage, including left ventricular hypertrophy and renal function impairment. However, the effects of aortic stiffness and degree of blood pressure and its relationship to target organ damage were not fully elucidated. This study was undertaken to investigate the relationship between aortic stiffness, blood pressure and target organ damage in hypertension patients.

Methods: Ninety-seven patients (mean age 54±14 years) with untreated essential hypertension were included in this study. Left ventricular mass (LVM) and left ventricular mass index (LVMI) were measured by M-mode echocardiography. Indices of aortic stiffness were measured by M-mode echocardiography and were calculated from following formula: Stiffness index (SI) = Systolic blood pressure/diastolic blood pressure (changes in aortic diameter/diastolic diameter); Disstenility (Di) = 0.5 changes in aortic diameter/diastolic diameter (pulse pressure); Systolic pressure (SBP) and diastolic blood pressure (DBP) were measured at the same time. Renal function parameters were checked at the same time, including blood urea nitrogen, serum creatinine and 24 hours creatinine clearance (CCr). Results: Among all patients, LVM was significantly correlated with SBP (r = 0.387, p = 0.006), DBP (r = 0.251, p = 0.014), SI (r = 0.344, p = 0.001) and Di (r = 0.363, p = 0.003). Blood urea nitrogen was significantly correlated with SBP (r = 0.259, p = 0.013) and Di (r = 0.221, p = 0.034), and the CCr was significantly correlated with DBP (r = 0.298, p = 0.003) and Di (r = 0.417, p = 0.000).

Conclusion: Our data indicated that aortic stiffness and degree of blood pressure were correlated with target organ damage. When assessing target organ damage hypertension, not only blood pressure but also aortic stiffness should be taken into account.

The effects of age and hypertension on the protodiastolic left ventricular suction wave measured using wave intensity analysis

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Background: Diastolic filling is initiated by a left ventricular suction wave. When the myocardial systolic contraction velocity falls from its peak value in systole, it falls below that of the blood exiting the heart, resulting in a "suction" wave (protodiastolic of Wiggers) which decelerates aortic flow and may aid aortic valve closure. We assessed, at the carotid artery, the effect of age, hypertension, β-blockers and left ventricular filling (all of which affect ventricular compliance) on protodiastole.

Method and Results: We used wave intensity analysis to quantify the protodiastole wave in the carotid artery of 299 hypertensive patients, and a group of 52 normal subjects with a wide range of ages (mean 44±17). Tissue Doppler and conventional echocardiography were used to measure early ventricular relaxation velocity (E'), early transmural flow (E), and thus E/E' (a marker of left ventricular stiffness and degree of blood pressure and its relationship to target organ damage)

- Protodiastolic wave energy (D/S energy) was found to increase with age (r=0.46, p<0.0001), and was significantly greater in hypertensives than normals (Figure 1). E/E' = 0.24v0.15, p<0.0001.
- Protodiastolic wave occurred earlier in hypertensives than normals (r=0.46, p<0.0001) – amongst hypertensions this effect was diminished in patients taking β-blockers (r=0.38v0.36,p<0.004).
- E/E' was inversely correlated to protodiastolic wave energy, even when corrected for age (r=0.46, p<0.0001).

Conclusion: Advancing age and hypertension result in reduced ventricular compliance with earlier and increased protodiastolic waves. The protodiastolic waves, as measured at the carotid, is related to conventional measures of diastolic function.
The mitral E/Ea ratio is an accurate estimate of left ventricular filling pressure. A drop in this ratio provides prognostic information in end stage renal disease.

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Background: Mitral annular diastolic velocities derived from tissue Doppler imaging (TDI) provide an estimate of left ventricular (LV) filling pressure in selected subsets of patients. The aim of this study was to assess whether the mitral E/Ea ratio can reliably estimate LV filling pressure in renal failure and to determine its prognostic significance in patients with end stage renal disease (ESRD).

Methods: 125 patients (mean age 52±12 years, 79 male) awaiting renal transplantation (mean creatinine 608±279 μmol/l) were prospectively studied over a mean follow-up time of 1.6±0.58 years. On - line pulsed wave TDI velocities during systole (Sm) and diastole (Ea, Am) were derived from the septal mitral annulus. Flow propagation velocity in early diastole (Vp) was calculated from the colour M-Mode in the apical 4 chamber view. LV diastolic dysfunction was defined from the transmittal Doppler filling pattern as slow relaxation (E/A ratio <1, E deceleration time >290 ms), restrictive filling (E/A >2.5, E/A between 1 and 2 with E deceleration time >150 ms), or pseudonormal (E <0.08 m/s, Vp < 0.45 m/s, with a normal transmittal Doppler pattern). Corroary artery stenosis severity and LV end-diastolic pressure (LVEDP) were measured during cardiac catheterisation. End stage renal disease (ESRD) was defined as luminal stenosis >70% by visual estimation at least one coronary artery.

Results: 56 patients (29%) were diastolic, 69 (55%) on diastasis and 36 (29%) had severe CAD. 101 (81%) patients had evidence of diastolic dysfunction (10%) had a restrictive filling pattern, 36 (29%) a pseudonormal filling pattern and 46 (36%) a slower relaxation filling pattern. Mitral E/Ea ratio was significantly related to LVEDP (r = 0.79, p<0.00 1). An E/Ea ratio > 14, seen in 26% patients, identified an LVEDP >15 mm Hg, with a sensitivity of 95% and a specificity of 90%. The proportion of patients on diastasis, with diabetes and without CAD were similar in those patients with and without an E/Ea ratio > 14 respectively. Over the follow - up time period, there were 12 deaths, 7 of which were cardiac. Kaplan – Meier survival analysis identified an E/Ea ratio > 14 (p = 0.05) but not a restrictive filling pattern to be associated with significantly worse survival.

Conclusions: In patients with ESRD, the E/Ea ratio was a reliable estimate of LV filling pressure. An E/Ea ratio > 14, but not a restrictive filling pattern, was associated with significantly worse survival.
Effect of hemodialysis on echocardiographic left ventricular parameters, left atrial volume and myocardial ultrasonic backscatter in patients with end-stage renal disease

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Methods: We examined 25 patients with ESRD undergoing routine HD (age 54±16 years, 9 females) and 19 age-matched healthy volunteers (age 52±5 years, 4 females). Routine echocardiographic parameters, tissue Doppler of mitral annulus, LA volume and CVIBS were measured in healthy volunteers and in patients with ESRD just before and immediately after HD. For CVIBS analysis two regions of interest were chosen in the parasternal LAX view: mid septum and mid posterior wall.

Results: After HD the E wave (85±33 vs 65±38 cm/s, p=0.046) was significantly reduced, and E/Em ratio (10±4.5 vs 8.5±4.4) was significantly reduced, and IVRT (77±21 vs 92±25 ms) was increased. There was no significant differences between study groups with respect to TDI of mitral annulus velocities (Em). HD significantly reduced LVD, LVS diameters and left ventricular mass (599±68 vs 273±107 g) and LA volume (853±33 vs 65±28 cm^3). CVIBS of both interventricular septum and posterior wall were significantly lower after HD than before HD. There was no significant difference of CVIBS between patients with ESRD before HD and healthy volunteers (Table 1).

Conclusions: The present results demonstrate that HD reduced LVM and improved indices of the left ventricular diastolic performance estimated by echocardiographic Doppler parameters. Interstitial edema could be responsible for poor LV function than mitral inflow parameters and LA volume.

End-systolic dimensions and left atrial diameter (LVIDd, 4.8±0.6 vs. 4.6±0.7 cm, p<0.0001, LVIDs, 3.4±0.7 vs. 3.2±0.8 cm, p<0.0001, LA, 4.2±0.7 vs. 3.8±0.8 cm, p<0.0001). Also consistent with a reduction in preload there was a reduction in the peak early transmural flow velocity (85±28 vs 92±25 cm/s, p=0.05). Pulmonary venous flow velocities, peak atrial and diastolic forward velocities and peak atrial external velocity and duration remained unchanged after dialysis in comparison with baseline. There were correlations between E and a reduction in intravascular volume (r=0.108, p=0.024).

Effect of preloading on indices of the heart diastolic function

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Objective: Characteristic changes in the transmitral Doppler flow pattern are seen in the presence of impaired left ventricular filling. The aim of the present study was to examine the effect of preloading reduction by hemodialysis on new echocardiographic indices of diastolic function.

Methods and patients: Forty seven patients (age 50±17.1 years, 28 males) on maintenance hospital hemodialysis (4 times a week) underwent echocardiography. 30 min prior to, and approx. 30 min after, a routine hemodialysis session. The aim of fluid removal was to achieve a clinically determined “dry weight”.

Conclusions: Preload reduction by hemodialysis has an influence on diastolic function. The transmitral early inflow velocity is strongly influenced by preload and therefore needs no correction for blood pressure, heart rate, preload or afterload. Diastolic MPI did not change significantly in comparison with baseline. Doppler stroke volume as well as cardiac output decreased after HD (SV, 85±19.2 vs. 74±4.26±8 cm^3, p<0.05). Pulmonary venous flow velocities, peak atrial and diastolic forward velocities and peak atrial external velocity and duration remained unchanged after dialysis in comparison with baseline. There were correlations between E and a reduction in intravascular volume (r=0.108, p=0.024).

Effect of the other day vs conventional hemodialysis on left ventricular function

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Methods: Seventeen patients aged 60±12.3 (range 38-55, 11 males) on cHD for 87±3 months were studied. Eight patients (group I) were transferred to an eodHD program, while the other 9 patients (group II) continued on the cHD schedule. Echocardiography was performed at baseline and at 12 months. Cardiac function was assessed on a day of hemodialysis and in the early convalescence period (EF) and LV mass were measured using 2D and M-mode echocardiography. Diastolic function was assessed with conventional indices (E/A ratio, E deceleration time, isovolumic relaxation time and new preload-independent indices using tissue Doppler imaging (E/E'Em) and color M-mode echocardiography (E/Pv)). Tel index, an index of global cardiac function, was calculated from mitral inflow and outflow time using Doppler echocardiography.

Results: At baseline, demographic and clinical characteristics and echocardiographic indices of systolic and diastolic function were similar between the groups. At 12 months, the eodHD group demonstrated a marked reduction in EF (from 54.6±11 to 69.1±5.9%, p<0.001) and a decrease in Tel index (from 0.45±0.15 to 0.42±0.11, p<0.05), whereas in the cHD group, LV mass and Tel index remained unchanged (from 252±71 to 253±33 g and from 0.53±0.19 to 0.54±0.20, respectively, both p>0.05). EF decreased (from 59±2.6 to 54±2.7%, p<0.02). There were no significant changes in indices of diastolic function in either group at follow-up.

Conclusion: In end-stage renal disease patients, every other day compared to conventional hemodialysis may have a beneficial impact on left ventricular hypertrophy and on echocardiographic indices of systolic and global cardiac function, while it does not appear to have an effect on indices of diastolic function. Further research is needed to assess whether these changes are associated with an improvement in patient prognosis.

Effect of preloading on diastolic function in end-stage renal disease patients

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Objective: Doppler echocardiographic MPI, defined as the sum of isovolumic relaxation (IRVH) and contraction (IVCT) time divided by ejection time (ET), has been shown to reflect systolic as well as diastolic ventricular performance. Previous studies have shown that the myocardial performance index is less affected by age and by changes in heart rate and preload than conventional Doppler measurements, and therefore needs no correction for blood pressure, heart rate, preload or age. The aim of the present study was to examine the effect of preloading reduction by hemodialysis on MPI.

Methods and patients: Forty seven patients (age 50±17.1 years, 28 males) on maintenance hospital hemodialysis (4 times a week) underwent echocardiography. 30 min prior to, and approx. 30 min after, a routine hemodialysis session. The aim of fluid removal was to achieve a clinically determined “dry weight”.

Conclusions: Preload reduction by hemodialysis has an influence on diastolic function. The transmitral early inflow velocity is strongly influenced by preload and therefore needs no correction for blood pressure, heart rate, preload or afterload. Diastolic MPI did not change significantly in comparison with baseline. Doppler stroke volume as well as cardiac output decreased after HD (SV, 85±19.2 vs. 74±4.26±8 cm^3, p<0.05). Pulmonary venous flow velocities, peak atrial and diastolic forward velocities and peak atrial external velocity and duration remained unchanged after dialysis in comparison with baseline. There were correlations between E and a reduction in intravascular volume (r=0.108, p=0.024).
The prognostic value of left ventricular function after acute myocardial infarction

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Purpose: Risk stratification represents a fundamental moment in the management of patients with acute myocardial infarction. Echocardiography plays a key role in this process, permitting the evaluation of systolic, as well as diastolic, left ventricular function.

Aim: Aim of the study is to assess the prognostic value of left ventricular function in patients with acute myocardial infarction and persistent ST elevation (STEMI).

Methods: Echocardiography was performed in 247 consecutive patients admitted to the intensive care unit with the diagnosis of STEMI within 8 hours from symptom onset. Ejection fraction (EF%) and wall motion score index (WMSI) were used to study left ventricular systolic function, whereas diastolic function was assessed by mitral flow patterns (MF). The primary end-point was cardiac mortality.

Results: After 18 months of follow-up 37 out of 247 patients (15%) had deceased for cardiac causes (group A). EF% in group A was significantly lower than in remaining group (53.2±3 vs 62.2±8, p<0.001). WMSI was significantly higher in group A than in patients still alive (1.9±0.41 vs 1.69±0.54, p=0.004). Also a restrictive MFP was associated with cardiac mortality (p<0.001). After multivariate analysis including clinical parameters, EF% (OR=1.2, p=0.05) and a restrictive MFP (OR=1.5, p=0.002) remained the only two independent predictors of mortality.

Conclusions: The echocardiographic evaluation of systolic and diastolic function provides independent and valuable prognostic informations after STEMI; these parameters should be taken into consideration when deciding about the management of these patients.

Effects of levosimendan on left ventricular diastolic function after primary angioplasty for acute anterior myocardial infarction. A Doppler echocardiographic study

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Introduction: Levosimendan is a new Ca-sensitizing drug with combined positive inotropic and vasodilatory effects which offers new therapeutic possibilities in patients with severely heart failure. Compared to other inotropic agents, animal studies demonstrated that levosimendan does not impair left ventricular (LV) diastolic function.

We sought to evaluate the effects of levosimendan on LV diastolic function, using conventional transmural Doppler and Tissue Doppler Imaging (TDI) parameters, in patients with anterior acute myocardial infarction (AMI) undergoing primary angioplasty.

Methods: After a successful primary angioplasty, we randomized 52 consecutive patients with an anterior AMI to levosimendan or placebo infusion and analyzed the effects of levosimendan on LV diastolic and systolic function.

Results: Twenty-four hours after the index intervention, patients treated with levosimendan (n=26) showed a significant reduction of the IVRT (from 114.6±15.1 to 57.4±12.8; p<0.05), and a significant increase of the E/A ratio (from 0.86±0.32 to 1.52±0.88; p<0.05). On the other hand, only a significant increase in E/A ratio (from 0.97±0.32 to 1.64±0.51; p=0.002) has been observed in the placebo group (n=26).

Conclusions: In conclusion, levesinendan, after a primary angioplasty in patients with an anterior AMI, improves the Doppler echocardiographic parameters of left ventricular diastolic function, regardless the improvements in systolic performance.

Mitrval A-wave deceleration time predicts long-term adverse outcome in patients after myocardial infarction

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Purpose: Mitrval A-wave deceleration time (Adt) has been reported as a useful parameter for the prediction of elevated left ventricular (LV) filling pressure and detection of the type of LV diastolic dysfunction in patients (pts) with acute myocardial infarction (AMI). The aim of the present study was to investigate for the first time the long-term prognostic value of Adt in pts discharged from hospital after their first acute MI.

Methods: Conventional Doppler/echocardiographic study and Adt measurement were performed in 106 (aged 60±10 years, 77 males) consecutive pts on the 8.07±0.06 post-MI day. Pts were divided according the Adt duration in three groups: group 1 with Adt<70ms, group 2 with 70ms<Adt<115ms and group 3 with Adt>115ms. Cardiac death, heart failure or recurrent revascularization procedures following hospitalizations were designated as end points.

Results: Pts of group 1 (Adt=6±5ms, n=11) presented characteristics of restrictive filling pattern (E/A=3.5±0.5, E/E'=8.0±3.6, IRV=5.1±1.8, IRVT=120±20), while the pts of group 2 (Adt=70±12ms, n=58) presented almost normal diastolic function (E/A=1.1±0.4, E/E'=210±37ms, IRV=120±25), while the pts of group 3 (Adt=125±8ms, n=38) characterized by impaired relaxation (E/A=0.6±0.1, E/E'=276±55ms, IRV=141±28). Pts were followed up for a mean 1342 days. During this period 46 (64%) cardiac events were recorded, in detail 9 cardiac deaths (4 in group 1 (36%), 2 in group 2 (3.5%), 3 in group 3 (7.9%), p=0.002), 10 cases with heart failure (4 in group 2 (36%), and 6 pts in group 3 (10%), p=0.002) and 27 pts required revascularization procedures (PTCA, percutaneous transluminal coronary angioplasty or CABG; coronary artery by passing graft); (1 in group 1 (6%), 5 in group 2 (23%), and 15 in group 3 (34%), p<0.005). Kaplan Meier survival curves indicated that pts with Adt<70ms or Adt>115ms presented with more frequent cardiac events and with significantly shorter event free survival period in comparison with those with 70ms<Adt<115ms (log-rank test, p<0.0005).

Conclusions: 1) The simple and easy to calculate Adt appears as a strong predictor of cardiac events in pts following MI. 2) A shortened Adt <70ms is associated with a higher incidence of cardiac death or heart failure, while a prolonged Adt >115ms with heart failure during follow up.

The transplantation of autologous bone marrow-derived stem cells in patients with acute myocardial infarction does not improve global diastolic left ventricular function

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Background: Recent studies have suggested that intracoronary transfer of autologous bone marrow-derived stem cells (BMSC) have the potential to prevent LV diastolic dysfunction in patients after acute myocardial infarction (AMI). Because these data result from unblinded trials, we investigated the effect of autologous transplantation of autologous BMSC in the infarct-related artery on diastolic myocardial function after AMI in a randomized, double-blind and placebo controlled study.

Methods: We enrolled 67 pts (age 18-75y) who presented more than 2 hours after the onset of an ST-elevation AMI in the study. After successful mechanical reperfusion, bone marrow was aspirated in all patients who were randomized to BMSC (n=35) or placebo (n=32). Echocardiographic examination was performed at day 1 and 4 months after AMI using a Vivid7 ultrasound machine with 2.5 MHz probe (GE). Diastolic function was measured using the following variables: E (early filling), A (late filling), E/A ratio, Adt (duration atrial reversal), E' (tissue velocity septal annulus) and E/A' ratio. ANCOVA was performed to analyse differences between treatment groups at 4 months, adjusted for baseline variables and p-value of the treatment effect is reported.

Results: The mean values are displayed in the table.

Conclusions: In this randomized, double-blind and placebo controlled study, successful reperfusion of acute myocardial infarction was associated with a moderate improvement of diastolic function parameters. However intracoronary transplantation of autologous BMSC did not mediate incremental diastolic function recovery.

Exercise tolerance and neurohumoral activation in patients with isolated diastolic left ventricular dysfunction

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The role of diastolic dysfunction in genesis of heart failure is reaching an increasing interest. However, whereas the relationship between left ventricular (LV) systolic dysfunction and reduced exercise tolerance is well established, the relationship between the degree of LV diastolic dysfunction and symptoms in patients with heart failure and preserved or slightly reduced systolic function is still unclear. Furthermore, recent studies suggest the role of BNP as early biochemical marker of heart
failure, also in patients with diastolic dysfunction. The aim of the study was to evaluate a correlation between the degree of diastolic dysfunction estimated by transmitral and pulmonary vein flow velocities by Doppler Echocardiography, exercise tolerance estimated by six minute walking test (6MWT), and blood levels of BNP.

Methods: Thirty patients (aged 45-75 years), with left ventricular diastolic dysfunction and normal LV function (ejection fraction = 54%), were studied. The patients were divided into 2 groups according to the measured peak transmitral and pulmonary vein flow velocities by Doppler Echocardiography, early diastolic velocity (E') measured from the septal, lateral, and inferior wall of left ventricle.

Results: The 6MWT showed a distance of 402 ± 83 m in group A, 357 ± 78 m in group B and 264 ± 125 m in group C (group C vs group A & B: p < 0.05). During the test, patients were divided into 3 groups (group A: early filling, group B: mitral E/A > 1, and group C: mitral E/A < 1). The values of BNP were found in patients with more advanced stages of diastolic dysfunction (group A: 46 ± 56 pg/ml, group B: 72 ± 42 pg/ml, and group C: 251 ± 117 pg/ml: p < 0.01).

Conclusion: Our results show a correlation between the exercise tolerance and the degree of diastolic dysfunction in patients with heart failure and normal LV systolic function. A similar trend was found for BNP values, which were more elevated in patients with higher degree of diastolic dysfunction. Thus, the results of Doppler echocardiography and BNP values and their changes might be a useful index for clinical, prognostic and therapeutic evaluations.

1106
Effect of arterial wave reflection on left ventricular early diastolic performance from the viewpoint of mitral annular motion by tissue Doppler imaging

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It is known that stiffener arterial system has augmented arterial wave reflection, producing cardiovascular disorders. However, the effect of such stiff arterial system on left ventricular (LV) function has not been fully elucidated. Thus, we hypothesized that augmented arterial wave reflection deteriorates LV relaxation and tested whether we could impair the degradation of LV relaxation with invasive and non-invasive procedures.

Methods: We studied 101 consecutive patients who underwent cardiac catheterization for diagnosis of coronary artery disease (14 patients with acute chest pain, 54 with coronary artery disease with previous myocardial infarction, and 33 without previous myocardial infarction). A time constant of LV relaxation (tau) was calculated from the LV pressure waves obtained with a catheter-tipped micromanometer. The augmentation index (AI) was defined as the ratio of heights of late systolic peak and early systolic shoulder peak on the aortic pressure wave. The augmentation time index (ATI) was calculated as the ratio of times from aortic valve opening to late systolic peak and from early systolic shoulder to late systolic peak. Mitral annular velocity during early diastole (Ea) was obtained by color M-mode. Early diastolic longitudinal (E'lat) and radial (E'radial) velocities of mitral annulus were measured by TDI. All patients were divided into 3 groups (group A: early filling, group B: mitral E/A > 1, and group C: mitral E/A < 1).

Results: In patients with LVEF < 60% (n = 61), AI and ATI had weak but significant correlations with tau (r = 0.28, p < 0.05 and r = 0.35, p < 0.01), and AI also significantly correlated with Ea (r = 0.27, p < 0.05). In contrast, in patients with LVEF > 60% (n = 40), AI and ATI indicated significant and apparently closer correlations with tau (r = 0.67, p < 0.001 and r = 0.66, p < 0.001) and with Ea (r = 0.50, p < 0.01 and r = 0.53, p < 0.001), respectively.

Conclusion: The present study suggests that the arterial wave reflection impairs LV relaxation especially in patients with systolic LV dysfunction, provoking diastolic dysfunction. We can noninvasively recognize this pathophysiology using tissue Doppler imaging of the mitral annulus.

1107
Impact of mitral E/A ratio on the accuracy of different echocardiographic indices to estimate left ventricular filling pressure

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Purpose: To determine if the mitral inflow pattern influences the accuracy of different echocardiographic indices for estimation of left ventricular end-diastolic pressure (LVEDP).

Methods: Echocardiography with color tissue Doppler imaging (TDI) and LVEDP measurements using fluid-filled catheters were performed prospectively in 176 consecutive patients (pt) scheduled for elective coronary angiography. Mitral peak diastolic velocities (E, A) and the difference in duration between pulmonary vein (PVr) and pulmonary vein (PVl) were measured by pulsed Doppler. Propagation velocity of the early mitral inflow (Vp) was assessed using color M-mode. Early diastolic longitudinal (E'lat) and radial (E'radial) velocities of mitral annulus were measured by TDI. Pressure and comparison with E/E' ratio

Results: For E/A < 1 (98 pt, 46 with elevated LVEDP) the AUC values were: PVr-A: 0.914; E/E'lat: 0.780; E/E'radial: 0.729; ENp: 0.712 (p < 0.001). LVEDP correlated positively with PVr-A as an index of late diastole was the best predictor for elevated LVEDP, irrespective of mitral Doppler profile (Fig. 1). On the contrary, E/E'Ratio was not a significant predictor for LVEDP in the presence of early filling (E/A < 1), but remained useful for pt with mitral E/A > 1.

Conclusions: PVr-A as an index of late diastole was the best predictor for elevated LVEDP, irrespective of mitral Doppler profile (Fig. 1). On the contrary, E/E'Ratio failed to predict the accuracy for elevated LVEDP in the presence of slow early filling (E/A < 1).
higher E/E' ratio (13.8±3.4 vs 9.8±2.8, p<0.001) and lower mean systolic strain index (−1.36±0.23 vs −1.24±0.19 sec−1, p<0.01). However, diastolic lengthening in DR was not significantly different from NORM (SR 1.67±0.01 vs 1.62±0.02 sec−1, p=0.25). Despite similar average TEVEL in the four segments, variation between segments as TEVELSD was higher in DR than NORM (Table).

**Conclusion:** Patients showing delayed relaxation in the absence of overt LV dysfunction and CAD exhibit DD rather than reduced regional diastolic function.

### 1111 Development of the diastolic stress test: non-invasive assessment of left ventricular pressure post-exercise

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**Background:** A delayed relaxation (DR) pattern of LV filling is commonly found in older patients and those with hypertension or diabetes mellitus. This is often ascribed to alterations in myocardial function, as may occur in patients with coronary artery disease (CAD). In patients with no CAD and normal systolic function we sought whether altered relaxation may reflect non-ischemic diastolic dysfunction (DD) rather than reduced rate of myocardial diastolic lengthening.

**Methods:** Color tissue Doppler imaging was performed in 105 pts with diabetes mellitus (55±14 yrs, 60% male). LV systolic strain 62±5% with regional wall motion abnormality at rest or during dobutamine stress. Patients with pseudonormal or restrictive filling were excluded. Time from QRS onset to peak early diastolic tissue velocity (TEVEL) was measured from myocardial velocity curves in the basal, septal, lateral, anterior and posterior segment, and the standard deviation in TEVEL (TEVELSD) calculated as an index of DD. Magnitude of regional diastolic relaxation was measured as peak early diastatic strain rate (SR) in each segment.

**Results:** Patients were divided into 51 with DR (dilation time >240mm/sec, LV mass 105±41g/m2) and 54 with normal filling (NORM, dilation time <240mm/sec, LV mass <105g/m2). Despite preservation of LV systolic function there was evidence of abnormal systolic shortening in DR compared to NORM (systolic SR 1.24±0.19 vs 1.36±0.25sec−1, p<0.01). However, diastolic lengthening in DR was not significantly different from NORM (SR 1.67±0.01 vs 1.62±0.02 sec−1, p=0.25).

**Conclusion:** The close relationship between left atrial (LAP) and pulmonary capillary wedge (PCP) pressures is a better predictor of the decreased longitudinal function of left ventricle is related with altered filling may reflect regional diastolic dysfunction (DD) rather than reduced regional diastolic dysfunction (DD) rather than reduced regional diastolic dysynchrony.

### 1112 Estimation of end diastolic pressure with early mitral inflow peak velocity to early diastatic myocardial motion peak velocity ratio is limited in patients with severely depressed active relaxation

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**Objective** An impairment of left ventricular active relaxation results in diminishing of early mitral inflow peak velocity (E) and early diastolic myocardial motion peak velocity (E'). Stiffening of the left ventricle has the opposing effect on E' wave due to end-diastolic pressure (EDP) elevation but has no effect on E' wave. Hence, E/E' ratio is used as a predictor of EDP. However, we hypothesized that this ratio may not be applicable in predicting normal EDP when active relaxation is so severely depressed that it makes the increase of E wave caused by EDP elevation.

**Methods** We studied 32 patients aged 59±22.4 years with ejection fraction over 50%, in sinus rhythm, and with E/E' ratio less than 8 (suggesting normal EDP). E wave was measured with continuous wave Doppler imaging and E' wave with pulsed-wave Doppler tissue imaging (TDI). EDP was obtained invasively during diagnostic cardiac catheterizations before any contrast application. Patients were divided into normal EDP group (<15 mmHg, 16 pts) and elevated EDP group (>15 mmHg, 16 pts). Left ventricular stiffness was assessed echocardiographically by means of a semiquantitative formula (A) which is a product of E wave (early mitral inflow peak velocity at the level of mitral isthmus) and the radius of a virtual spheric from the mitral annulus to a cm below aortic valve. Left ventricular active relaxation was assessed indirectly with TDI as the time from the end of S wave to the beginning of E wave (IVRT). E and IVRT were compared between the above groups.

**Results** Atrial wave transit time was significantly shorter in the elevated EDP group (46.5±6.72 ms) as compared to normal EDP group (53.3±6.21 ms) (p=0.013). E wave was also significantly longer in elevated EDP group (135.2±23.25 ms) in comparison with normal EDP group (57.7±6.18 ms) (p<0.001).

**Conclusions**: These preliminary data suggest that severely depressed active relaxation is the mechanism of delayed relaxation pattern of left ventricular filling. The decreased longitudinal function of left ventricle is related with altered filling may reflect regional diastolic dysynchrony (DD) rather than reduced regional diastolic function.

**Purpose** The close relationship between left atrial (LAP) and pulmonary capillary wedge (PCP) pressures is widely accepted in clinical practice. Although the most widely used method for the assessment of LAP is the invasive procedure of right heart catheterization with PCP measurement, a method for estimating the LAP in patients with mitral regurgitation using Doppler echocardiography and a brachial sphygmomanometer has been devised.

**Methods:** The study group consisted of 25 patients (mean age 72.2±7 years) with severe mitral regurgitation (angiographic 3+ or 4+) in whom a distinct Doppler spectral envelope could be observed. Five patients (20%) had ischemic cardiomyopathy, 3 (12%) had diastolic diabetics cardiomyopathy, 15 (60%) had mitral valve prolapse, and 2 (8%) had nonspecifically thickened mitral valve leaflets. Simultaneous, continuous wave Doppler echocardiography from the apical four-chamber, left ventricular systolic pressure (LVP) and PCP (peak of the V wave) were measured by means of a Fijtagal and a Courmand catheter were performed during cardiac catheterization. The peak ventricular systolic gradient (PG) was obtained by measuring peak mitral relaxation velocity in suction and using the modified Bernoulli equation. This gradient was then subtracted from peak brachial systolic pressure (BASP), determined by sphygmomanometry and considered an estimate of LAP, to yield Doppler-derived LAP (LAP = BASP - PG). LAP was calculated from the two means (141±3.23 mmHg, the pressure gradient between LVP and PCP (PG) a mean of 106±24 mmHg, and PCP a mean of 30±14 mmHg). There was a good correlation (r=0.79) between Doppler-derived LAP and PCP by catheter, and this difference between the two means (36±18 vs 30±14 mmHg) was not significant (p=0.4), there was also a good correlation (r=0.72) between BASP and LAP. The difference between the two means (141±23 vs 138±18 mmHg) was also not significant (p=0.3).

**Conclusions:** Our study, although involving a small sample size, suggests that Doppler echocardiography and sphygmomanometry may be used in selected patients with mitral regurgitation for noninvasive assessment of LAP.
1115 Assessment of diastolic function using tissue Doppler echocardiography: what is the normal value of the mitral annulus early diastolic velocity (Ea)?

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Traditional Doppler-derived parameters of the diastolic function are obtained from transthoracic and transmural venous recordings, but are dependent upon loading conditions and heart rate. Mitral annulus Doppler (Tissue Doppler Imaging, TDI) is a preload-independent method. The early diastolic velocity (Ea) measured at the lateral border of the mitral annulus seems to be a useful marker differentiating patients with normal from those with abnormal diastolic function, but there is no consensus about the normal range of this parameter. The aim of our study was to determine the cut-off value and the diagnostic power of this parameter in a heterogeneous patients-group. Patients: 80 consecutive patients (44 male, 36 female, mean age 50±15 years) were studied. Inclusion criteria were: normal sinus rhythm, ejection fraction ≥50%.

Methods: In addition to the conventional transmural flow patterns pulmonary vein Doppler parameters were measured by ATL HDI 5000 ultrasound system. Using these results 4 patients-groups were specified. Group I: normal diastolic function, group II: impaired relaxation, group III: pseudonormal, group IV: restrictive pattern. Ea was measured on the lateral border of the mitral annulus by TDI. Receiver operator characteristic (ROC) curve was generated to determine the most useful cut-off value of Ea to discriminate between normal and abnormal diastolic function as well as to calculate their sensitivity and specificity using this cut-off value.

Results: Ea was higher in subjects with normal diastolic function (m=28, 15.2±1.7 cm/s) than in patients with either impaired relaxation (m=28, 8.1±2.4, pseudonormal filling (m=19, 8.0±1.9) or restrictive filling (m=5, 5.9±1.7) Ea values in group I were significantly higher (p<0.01), in group IV were significantly lower (p<0.05) than in other groups. ROC curve analysis showed that an Ea=12 cm/s as cut-off value had the highest discriminating power between normal and abnormal diastolic function. The sensitivity and specificity to detect normal and abnormal diastolic function were 96.1% and 96.4%, respectively.

Conclusion: Ea measured by TDI is a useful complementary parameter in the evaluation of diastolic filling and in discriminating between normal subjects and those with various stages of diastolic dysfunction.

Table 1

<table>
<thead>
<tr>
<th>Regression equation (mmHg)</th>
<th>R</th>
<th>Mean difference/SD</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Doppler-catheter, mmHg</td>
<td>Doppler vs catheter</td>
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<td></td>
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<tr>
<td>CVPm</td>
<td>0.95±0.7</td>
<td>0.3</td>
<td>0.02</td>
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<tr>
<td>CVPd</td>
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<tr>
<td>CVPm</td>
<td>1.02±0.2</td>
<td>1.65</td>
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<tr>
<td>CVPm</td>
<td>0.91±0.4</td>
<td>0.65</td>
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Conclusion: In the present study we showed that the cut-off pressure gradient for normal diastolic function was 9 mmHg.