VENTRICULAR FUNCTION *Chairman:* Peter Mills

ON-LINE ECHOCARDIOGRAPHIC AUTOMATIC BOUNDARY DETECTION ASSESSMENT OF LEFT VENTRICULAR CARDIAC CONTRACTILITY.

L Michalis, M R Thomas, D E Jewitt, M J Monaghan
Department of Cardiology, King's College Hospital, London

An echocardiographic automatic boundary detection (ABD) system was used for the on-line assessment of left ventricular (LV) function in 50 unselected patients undergoing cardiac catheterisation (28 ischaemic heart disease, 17 normal coronary arteries and cardiac function and 5 dilated cardiomyopathy). ABD parameters measured in the parasternal short axis (sa) and the four chamber (4ch) views (fractional area change [FAC], +dA/dt, -dA/dt) were correlated with established invasive parameters (ejection fraction [EF], left ventricular end-diastolic pressure [LVEDP], +dP/dt and -dP/dt). Adequate images were acheived (>75% of endocardium detected) in 40/50 (80%) in sa, 41/50 (82%) in 4ch and 34/50 (68%) in both views. In the whole group correlation (r=Pearson's coefficient) was found between $FAC_{sa, 4ch}$ and mean and EF (r=0.51, 0.36 and 0.62 respectively) and $+dA/dt_{4ch}$ and -dP/dt (r=0.50). Further, the patients were divided into group A (normal coronaries and EF>45%) and group B (EF<45%). In group A, ABD parameters correlated positively with LVEDP (FAC_{4ch}=0.77, FAC_{mean}=0.87, $+dA/dt_{sa}$=0.49, $-dA/dt_{sa}$=0.50, $+dA/dt_{4ch}$=0.58 and $-dA/dt_{4ch}$=0.79) but not with EF suggesting ABD parameters are more sensitive than EF in reflecting improved cardiac function with increased filling pressures in the normal ventricle. In group B, ABD parameters correlated negatively with LVEDP (FAC_{sa}=-0.52, FAc_{mean}=0.60, $-dA/dt_{sa}$=-0.43, $+dA/dt_{4ch}$=-0.47) indicating the failing contractility in these patients with low EFs. In conclusion ABD parameters show potential in the assessment of cardiac function and, when used in conjunction with the EF, these parameters appear to provide highly sensitive indicators of cardiac function in both the normal and failing ventricle.

ASSESSMENT OF EJECTION FRACTION BY ECHOCARDIOGRAPHIC AUTOMATIC BOUNDARY DETECTION FOLLOWING MYOCARDIAL INFARCTION: COMPARISON WITH RADIONUCLIDE ANGIOGRAPHY.

M R Thomas, L Pruvulovich, D E Jewitt, M J Monaghan
Department of Cardiology, King's College Hospital, London

The assessment of left ventricular function, using radionuclide angiography (MUGA), following myocardial infarction (MI) is used to guide drug therapy such as angiotensin converting enzyme (ACE) inhibitors (eg. "SAVE" study). We have used on-line echocardiographic automatic boundary detection (ABD) to assess left ventricular ejection fraction (EF) in 51 unselected patients (mean age 62 years, range 39-84 years) 3-5 days following MI. Echocardiographic studies were performed at the bedside (mean duration 12 minutes). Results were compared with those obtained by MUGA. Endocardial detection was adequate for EF analysis in 43/51 (84%) in the apical 2 chamber view (2chEF), 43/51 (84%) in the apical 4 chamber view (4chEF) enabling a mean value (meanEF) in 42/51 (82%). Mean end systolic volumes tended to be higher after anterior compared to inferior MIs (anterior 83±44 v inferior 60±46 ml, p=0.1). Correlation (r=Pearson's coefficient) with MUGA EF was good using all 3 methods; 2chEF (r=0.71, p<0.0001), 4chEF (r=0.76, p<0.0001) and meanEF (r=0.81, p<0.0001). MeanEF identified 17/18 (94%) of patients with a MUGA EF of <40% and 21/24 (88%) with a MUGA EF of >40%. The positive predictive value of a meanEF <40% was 85% (17/20) and 95% (21/22) for a meanEF >40%. In conclusion ABD derived EF can be successfully and reliably obtained in most patients after MI. The investigation can be performed at the bedside, results are immediately available and ABD EF correlate well with conventional radionuclide studies successfully identifying those patients likely to benefit from ACE inhibitors. This new echocardiographic technique has the potential to replace radionuclide studies and allows the routine bedside assessment of left ventricular function following MI. This may have important implications in patient management.

MEASUREMENT OF ISOVOLUMIC RELAXATION TIME BY DOPPLER AND DUAL M-MODE TECHNIQUES: COMPARISON AND PITFALLS

HJF Why, PJ Richardson, MJ Monaghan
King's College Hospital, London

Measurement of isovolumic relaxation time (IVRT) is commonly used as a parameter of diastolic function. This is frequently done utilising Doppler techniques (IVRT-D) to simultaneously obtain aortic valve closure artefact and transmitral valve flow. However doubt has been recently cast upon the validity of this methodology.
In 45 echo Doppler studies performed for evaluation of diastolic function, IVRT was measured by IVRT-D and a gold standard method using simultaneous dual M-mode recordings of the aortic and mitral valve leaflet motion (IVRT-M). IVRT-D was measured from the aortic valve closure artefact to the onset of transmitral flow from a modified apical Doppler transducer placement. Dual M-mode recordings were obtained from a parasternal long axis view using a phased array ultrasound system equipped with this facility. M-mode cursors were positioned across both the aortic and mitral valve leaflets. IVRT-M was defined as the time interval between absolute aortic valve closure and separation of the mitral valve leaflets. All recordings were made with a paper speed of 100 mm/second.
Mean IVRT-M was 95 ms (range 70-123) and mean IVRT-D 115 ms (range 76-176). A good correlation between IVRT-D and IVRT-M was obtained (r = 0.65, p<0.0001). However, the regression equation IVRT-M = 0.5(IVRT-D) + 39 demonstrates that a significant offset exists between the two methodologies which is confirmed by the difference in mean values of 20 ms (21%).
In conclusion IVRT-D correlates well with the gold standard IVRT-M. However IVRT-D are significantly prolonged and this limits its utility as a "one-off" measure. This error may be considered less important when serial changes in IVRT are being assessed in individual subjects.

TWO-DIMENSIONAL ECHO-GUIDED INVASIVE CARDIOLOGICAL PROCEDURES IN THE DISTRICT GENERAL HOSPITAL

M Appleby, M Martin
Manchester Royal Infirmary, Manchester and Stepping Hill Hospital, Stockport

We report on the use of echocardiography in pericardiocentesis, temporary pacing wire insertion, and Swan-Ganz catheter positioning in a district general hospital. Insertion of a pericardial drain under echo control was undertaken in five patients over a six month period, three of whom had tamponade. The subcostal view was very useful for choosing the best angle of approach for the pericardial aspiration needle. Once fluid was aspirated, a pigtail guidewire was introduced, using the apical four-chamber view to check the guidewire position in the pericardial fluid, before the dilator was inserted. The echo scanning time was 1-4 minutes. All of the effusions were successfully drained, with no complications. One patient with an underlying aortic dissection underwent a successful aortic root replacement. Three patients had malignant cells on pericardial fluid aspirate cytology. In one patient there was underlying infection. Temporary pacing wire insertion under echo control was undertaken in 3 patients. The subcostal view was used to follow crossing the tricuspid valve. The apical four-chamber view was used to visualise positioning in the right ventricular apex. The total echo scanning time was 2-4 minutes, and there were no complications. The positions gained were stable and satisfactory on chest *x* ray, with thresholds less than 1 volt. Pacing under echo control, which avoids radiation exposure, could be used in the district general emergency setting, particularly if there would be delay in making alternative arrangements. Swan-Ganz catheter insertion was monitored by echocardiography in 4 cases. The balloon was easily visualised from the right atrium to the pulmonary artery, checking on the position of the catheter during the procedure. The catheter was followed from the right atrium across the tricuspid valve using the subcostal or apical views, and up to the pulmonary artery using the parasternal short-axis view. In one case, right ventricular looping was identified on echocardiography as the cause of failure of advancement, and appropriate action was taken under echo control. The total scanning time was 1-4 minutes. The final positions were satisfactory on wedging and chest *x* ray. With more widespread availability of echo machines, and adequate expertise, district general interventional cardiological procedures could be effectively undertaken using echo-guided control.

The Effect Of Successful Coronary Angioplasty On Left Ventricular Compliance.

P.A. Dodds, K.F. Robotham, B.A. Perry and R.A. Perry, The Cardiothoracic Centre, Liverpool, L14 3PE.

Pulsed transmitral Doppler echocardiography has demonstrated left ventricular diastolic dysfunction in patients with ischaemic heart disease. Successful PTCA improves left ventricular diastolic function and it has been proposed that this is due to an improvement in ventricular relaxation. However a number of factors influence diastole including left ventricular compliance. This study uses Doppler echocardiography to assess the changes in left ventricular compliance following successful PTCA in patients with coronary artery disease.

23 patients undergoing elective PTCA for chronic stable angina underwent transmitral Doppler echocardiography 2-6 hours prior to and 48 hours following successful PTCA whilst remaining on the same medication. All Doppler studies were recorded onto videotape and analyzed at a later date by two blinded observers.

Resting heart rate (HR) was significantly higher following PTCA (HR pre PTCA 60 +/- 7.6 $min.^{-1}$, HR post PTCA 68 +/- 12.1 $min.^{-1}$; $p = 0.0002$). There were no significant changes in either systolic or diastolic blood pressure. Following PTCA there was a significant decrease in the E wave maximum velocity (pre PTCA 79.0 +/- 17.2 $cmsec^{-1}$, post PTCA 71.3 +/- 17.1 $cmsec^{-1}$; $p = 0.014$), and the E/A ratio (pre PTCA 1.2 +/- 0.3, post PTCA 1.1 +/- 0.4; $p = 0.048$). There was a significant increase in the % atrial contribution to filling following PTCA (pre PTCA 33.3 +/- 6.7 %, post PTCA 39.1 +/- 10.6%; $p = 0.008$). There were no significant changes in the A wave maximum velocity, the E wave acceleration or deceleration times, or the E wave acceleration or deceleration slopes.

As the compliance of a previously "stiff" left ventricle improves, then atrial contraction will eject an increased amount of blood into the more compliant ventricle. Following atrial contraction there will be a smaller residual volume in the atrium and this will result in a decrease in the left atrial volume and pressure prior to ventricular filling. This fall in left atrial pressure will result in a decrease in the rate and volume of filling during early diastole.

The results of our study are consistent with this theory, and therefore we conclude that the improvement in left ventricular diastolic function following successful PTCA is at least in part due to an improvement in left ventricular compliance.

DIASTOLIC FUNCTION IN AORTIC STENOSIS VERSUS SYSTEMIC HYPERTENSION: A DOPPLER ECHOCARDIOGRAPHIC STUDY.

N. Eleftherakis, I. Ikonomidis, V. Kirolivanou, P. Nihoyannopoulos. Department of Medicine, Clinical Cardiology, Hammersmith Hospital, RPMS, London .

Objective. Diastolic function was assessed and compared in aortic stenosis and hypertensive patients matched for left ventricular (LV) hypertrophy. Aim of the study was to test the hypothesis that additional mechanisms, other than LV hypertrophy due to pressure overload, are involved in diastolic dysfunction in aortic stenosis.

Design and Method. Diastolic function was assessed by Doppler echocardiography in 47 patients with aortic stenosis and 45 patients with hypertension. The two groups were matched for age, heart rate, LV wall thickness and fractional shortening. All patients were in sinus rhythm, had no mitral or tricuspid valve disease, no aortic regurgitation, had good LV systolic function and no clinical evidence of coronary artery disease. The following echocardiographic indices were measured:
Isovolumic relaxation time (IVRT), Acceleration (AT) and Deceleration Time of LV slow filling, E/A ratio and Atrial Filling Fraction (AFF).

Results. IVRT was markedly prolonged in aortic stenosis when compared with the hypertensive group (103.9±24.8 ms vs 90.3±19.3 ms, $p<0.005$). DT was also prolonged (253.9±65.8 ms vs 224.7±41.5 ms $p<0.05$). No significant difference was noted between the two groups for AT, E/A ratio and AFF.

Conclusion. Active relaxation and slow diastolic filling are depressed in aortic stenosis in comparison with systemic hypertension. Subendocardial ischaemia and fibrosis may be additional contributing factors.

DOPPLER ECHOCARDIOGRAPHIC ASSESSMENT OF EARLY CHANGES IN DIASTOLIC FUNCTION AFTER AORTIC VALVE REPLACEMENT FOR AORTIC STENOSIS

I. Ikonomidis, V. Kirolivanou, N. Eleftherakis, P. Nihoyannopoulos. Department of Medicine, Clinical Cardiology, Hammersmith Hospital RPMS, London.

To evaluate the early changes in diastolic function after aortic valve replacement (AVR) for aortic stenosis (AS), 30 patients with isolated AS were studied retrospectively. Each patient underwent 2-D echocardiography and Doppler examination of the left ventricular (LV) inflow before and after AVR. Studies were performed within 6 months before (2.17±1.88 months) and 6 weeks after (1.92±1.69 weeks) the intervention. All patients had cardiac catheterization and angiography. Nine were found to have additional coronary artery disease (CAD) and had one or more bypass grafts. Twenty one patients (6 with CAD and 15 without) had mechanical prostheses while 9 (3 with CAD and 6 without) had bioprosthetic AVR. The following measurments were performed from Doppler LV inflow recordings: isovolumic relaxation time (IVRT), peak velocity of the LV early filling (peak E), peak velocity of the LV late filling (peak A), acceleration time (AT), deceleration time (DT) of the LV early filling, E/A ratio and atrial filling fraction (AFF). Patients with mechanical AVR had no significant change in any of the diastolic parameters and LV mass between pre- and post-operative studies. IVRT (75.71±22.17 vs 78.09±13.16 ms), AT (59.61±27.87 vs 49.23±22.09 ms), DT (239.76±77.53 vs 238.33±83.27 ms), E/A (1.366±0.845 vs 1.134±0.422), peak E (0.677±0.275 vs 0.730±0.233 m/s), AFF (0.390±0.149 vs 0.441±0.152), LV mass (262.62±65.70 vs 243.76±58.22 g). Conversely, in patients with aortic bioprostheses, IVRT and AT were shortened early postoperatively. (104.33±20.01 vs 74.44±11.02 ms $p<0.005$ and 67.44±24.09 vs 48.67±14.79 ms, $p<0.05$, respectively). The remaining diastolic indices and LV mass were similar pre- and post-operatively. DT (212.55±85.43 vs 230.44±64.93 ms), E/A (0.989±0.681 vs 1.111±0.931), peak E (0.568±0.128 vs 0.690±0.169 m/s), AFF (0.451±0.16 vs 0.467±0.111), LV mass (280.44±72.79 vs 258.44±69.01 g).

It is concluded that, IVRT and AT are early indices of improved relaxation after AVR bioprostheses. In patients with mechanical AVR this improvement of diastolic function may be delayed.