310A  ABSTRACTS - Noninvasive Imaging  JACC  March 3, 2004

when the balloons were mechanically contracted. They were inflated to 7 different vol-
umes (30-115 cc) over which the aneurysm area was measured. The wall thickness var-
ed gradually from 5.6 mm towards the thin (0.5 mm) aneurysm segment. Scanning was per-
formed using a 5MHz multilplane transesophageal probe (GE/VingMed System FiVe).
Long-axis images taken from two orthogonal views were transferred to an analysis pro-
gram (EchoPac 3.3). Cine loops at 30° rotational steps over three cycles were analyzed for
tissue Doppler (TDI) and strain rate (SRI). Separability was tested by using peak values
derived from TDI and SRI, compared as a ratio of apex aneurysm to normal segment val-
ues.

Results: The mean ratio for TDI aneurysm/normal segment bipline area was 0.79 ±
0.19(DI) and for SRI 0.36 ± 0.09, p<0.05, with better separation. Moreover, using “time
variable” area determined over arcs for the rotational planes with SRI which showed
cleaner transitions and less effect of tethering, yielded a closer agreement with measured
aneurysm area for the balloons and the filling volumes (r = 0.71 for TDI and r = 0.93 for
SRI reconstructions).

Conclusions: SRI was more sensitive than TDI for assessing LV aneurysm in our model.

POSTER SESSION
1017 Contrast Echocardiography: Novel Uses
Sunday, March 07, 2004, 9:00 a.m.-11:00 a.m.
Morial Convention Center, Hall G
Presentation Hour: 10:00 a.m.-11:00 a.m.

1017-156  Color M-Mode Doppler Flow Propagation Velocity Is a New Echocardiographic Method for Quantification of Mitral Regurgitation
Laurent Colas, Bouchra Colas, Perla Raharitsoa, Hamza Mohsinaly, Van Huong Chuong, Christian Krichen, Felix Gruyón Hospital, Saint - Denis, Reunion

Background: The color M-mode Doppler flow propagation velocity (Vp) has been reported as a preload-independent measure of left ventricular diastolic function and as a method for the assessment of the severity of aortic regurgitation. The aim of this study was to assess the use of color M-mode Doppler Vp to determine the severity of mitral regurgitation (MR) and to compare its reliability with angiography and other echocardiographic methods.

Methods: We prospectively studied 45 patients (62 ± 13 years, 22 male and 23 female) who had cardiac catheterization for various reasons. For each patient, we recorded the angiographic grade of MR and measured thereafter, by transthoracic echocardiography, Vp with color M-mode Doppler in the apical 4-chamber view (M-mode cursor parallel to MR color Doppler flow) and other echocardiographic parameters: regurgitant flow rate (Qr), regurgitant orifice surface (SOR) and regurgitant volume per beat (VR) by the prox-
imal isovelocity surface area method, right upper pulmonary venous flow morphology and ratio of time-velocity integral mitral/aortic.

Results: 15 patients had an angiographic grade 1 MR, 15 patients grade 2, 8 patients grade 3 and 7 patients grade 4. No statistical differences were seen in age, gender, angiographic ejection fraction or left ventricular end-diastolic pressure among the four groups. The mean values of Vp were respectively 36.5 ± 10.4 cm/s, 54.6 ± 6.7 cm/s, 77.4 ± 4.2 cm/s, 83 ± 5.4 cm/s (p<0.0001). A high significant correlation was found between angiographic grades of MR and Vp (r = 0.91, p< 0.0001), Qr (r = 0.96, p< 0.0001), SOR (r = 0.91, p< 0.0001), VR (r = 0.95, p< 0.0001), pulmonary venous flow morphology (r = 0.87, p< 0.0001) and ratio of time-velocity integral (r = 0.74, p< 0.0001). Furthermore, significant correlation was observed between Vp and proximal isovelocity surface area method parameters: r = 0.9, p< 0.0001 with Qr, r = 0.85, p< 0.0001 with SOR and r = 0.9, p< 0.0001 with VR.

Conclusion: The color M-mode Doppler Vp is an easy, fast and reliable parameter for the quantification of MR.

1017-157  Measurements of Contrast Intensity in Systole Are More Accurate Predictors of Myocardial Blood Flow: Validated by Microspheres
Xuedong Shen, Feng Xie, David Cloutier, John Lof, Thomas R. Porter, Leng Jiang. The Cardiac Center of Creighton University, Omaha, NE

Background: Previous studies have demonstrated cyclic variation of myocardial signal intensity with a higher systolic value. Methods: To further evaluate the predictive value of systolic and diastolic measurements of myocardial blood flow (MBF) on real-time myocardial flow imaging, nine open chest dogs were studied by myocardial contrast echocardiography with power pulse imaging (PPI) and by Neutron Activated Microspheres (MIC).

Perfluorocarbon microbubbles were administered as a constant infusion. The images were obtained from left ventricular short axis view at papillary muscle level. The regions of interest (ROI) were placed on the endocardial (END) and epicardium (EPI) of the anterior wall. PPI derived MBF (PPI_MBF) was calculated by the product of the rate of replenishment and the plateau of myocardial acoustic density, which was corrected by the corre-
sponding acoustic intensity in the central point of left ventricular cavity. Three sets of PPI_MBF were obtained during systole, diastole and whole cardiac cycle, and compared with MIC derived MBFs (MICMBF). Results: PPI_MBF was 1.23±0.71 ml/min/g at END and 0.91±0.51 ml/min/g at EPI. The PPI_MBF in systole was greater than that in diastole and was the most correlated with MICMBF (Table).

Conclusions: There is consistent cyclic variation of myocardial signal intensity on real-
time myocardial perfusion imaging. Systolic measurements are more accurate predictors of myocardial blood flow measured by Microspheres.

\[
\begin{array}{cccc}
\text{R} & \text{SEE} & \text{P} \\
\text{Systole} & 0.87 & 0.79 & 0.81 & 0.38 & 0.47 & 0.45 & 0.002 & 0.012 & 0.009 \\
\text{Diastole} & 0.85 & 0.81 & 0.82 & 0.39 & 0.32 & 0.31 & 0.004 & 0.009 & 0.007 \\
\end{array}
\]

1017-158  Myocardial Contrast Echocardiography Provides a Noninvasive Estimation of Fractional Flow Reserve
Amr E. Abbas, Carlos A. Moreno, Steven J. Lester. Mayo Clinic Scottsdale, Scottsdale, AZ

Background: The ratio of maximal hyperemic coronary flow in the presence of an epi-
cardial stenosis to normal maximum hyperemic flow, fractional flow reserve (FFR), is an
invasive index useful to determine the severity of coronary stenosis. Myocardial contrast
echocardiography (MCE) can evaluate parameters of myocardial flow and blood volume
(MBV). We hypothesized that FFR could be assessed non-invasively by using MCE.

Methods: In an open chest dog model a specially designed metal occluder was applied to
the proximal LAD and varying degrees of epicardial stenosis were created. Fourteen
experiments were performed. A high fidelity micromanometer catheter was placed in the
ascending aorta for measurement of MAP and pressure distal to the created stenosis
(Pd) was measured by placing a distal pressure catheter. The invasive measure of FFR
was calculated by dividing Pd/PAP during adenosine injection at each degree of stenosis.
MCE was performed during a hyperemic period using contrast during a constant intravenous infusion of Definity at baseline and during hyperemia. Myocardial video intensity signal plateau (VPeak) is a measure of MBV. Therefore, the ratio of VPeak during adenosine (VPeak) to VPeak at
baseline (VPeak0) was correlated to FFR.

Results: The ratio VPeak/VPeak0 correlated well with FFR (r = 0.14, r = 0.897, 95% CI 0.45 -
0.96, p = 0.015). Using ROC curves, a ratio of 0.65 had a 87.5% sensitivity and a 66.7%
Specificity to determine FFR < 0.75.

Conclusion: MCE can provide a noninvasive estimate of FFR.

1017-159  Myocardial Contrast Echocardiography Can Detect Changes in Myocardial Blood Volume During Acute Changes in Blood Pressure
Amr E. Abbas, Carlos A. Moreno, Steven J. Lester. Mayo Clinic Scottsdale, Scottsdale, AZ

Background: Autoregulation (AR) occurs through changes in arteriolar resistance in
order to maintain myocardial blood supply under varying perfusion pressures. During
hyperemia induced by adenosine, arteriolar resistance is markedly reduced and AR is
absent. Myocardial blood volume (MBV) has been studied using myocardial contrast
echocardiography (MCE). We hypothesized that MBV changes during acute rises in
blood pressure, with and without intact AR, could be evaluated using MCE.

Methods: MCE was performed on 9 open-chest dogs using ultraharmonic imaging dur-
ing a constant intravenous infusion of Definity. A high fidelity micromanometer was
placed in the aorta for measurement of mean aortic pressure (MAP). Methoxamine was
infused to achieve variable degrees of BP (baseline, 110, 130, and 150 mmHg) at basal
flow (intact AR), and during adenosine infusion (absent AR). Images were obtained at
every step and analyzed to determine myocardial video intensity signal plateau, which
represents MBV.

Results: With intact AR, MBV significantly decreases starting at a MAP of 130 mmHg.
However, with absent AR, significant decline in MBV from baseline occurred at MAP of
150 mmHg.

Conclusion: MBV is influenced by BP. Since capillary blood constitutes the majority of
MBV, the decline in MBV may be explained by capillary derecruitment. With intact AR,
Noninvasive Vessel-Selective Perfusion Imaging With Intravenous Myocardial Contrast Echocardiography

Takomo Fujihara, Tomohico Miki, Kentaro Otani, Fuminobu Ishikura, Shintaro Beppu, Osaka University, Suita, Japan

Background: Intravenous myocardial contrast echocardiography (IV-MCE) cannot indentify each perfusion area of coronary vessels separately. During IV-MCE, low- by destroying microbubbles passing through specific vessels with high power ultrasound, vessel-selective perfusion imaging (SPI) could be feasible.

Methods: In 8 open-chest dogs, short-axis images were obtained every 8 cardiac cycles during Definity® continuous infusion using Sequoia 512. For SPI, an S3 probe coupled to an intermittent mode (1:1) and low MI (0.1 for all coronary vessels and 0.3 for arterioles) were used. Combination of the intermittent mode (1:1) and low MI (0.1 for all coronary vessels and 0.3 for arterioles) was applied to avoid the influence of cyclic variation or possible destruction of bubbles. The backscatter from bubbles in the ventricular septum was measured as dB and AU². The replenishment curve was fit to an exponential function:

\[ y = A(1 - e^{-\beta t}) \]

To correct the influence of acoustic field or attenuation, AU² at the septum/(AU² LV) and the adjacent part of LV cavity (AU² LV) were measured and the blood volume was calculated as 100×AU²/aU² (ml/100g).

Results: The blood volume of all coronary vessels (MI=0.1) measured by AU² was over 4 times higher than that of arteries (MI=0.3) (2.91±1.06 vs. 0.63±0.10 ml/100g; p<0.005). However, A value at MI=0.1 measured by dB unit was not so significantly higher than that at MI=0.3 (17.7±4.08 vs. 15.9±4.22). The blood flow velocity presented as dB unit at arteriolar level was significantly higher than that at capillary level (1.07±0.37 vs. 0.35±0.09; p<0.001).

Conclusion: MCE reflects the blood flow and volume in each level of coronary arteries. At analyzing them quantitatively, the value may be varied depending on the unit. The blood flow velocity can be evaluated from the backscatter by using dB unit. The blood volume can be measured accurately by using AU² unit.

Quantitative Myocardial Contrast Echocardiography Is Useful to Evaluate Transmural Extent of Microvascular Damage in Patients With Myocardial Infarction

Yoshimune Hiramoto, Hiroshi Ito, Katsuomi Iwakura, Shigeo Kawano, Atsunori Okamura, Koichi Iino, Koji Tanaka, Noryuki Hanibuchi, Kenshi Fuji, Sakurabashi Watanabe Hospital, Osaka, Japan

Ischemic myocardial damage initially appears in subendocardium but the relationship between severity of subendocardial damage and wall motion abnormality remains unclear in MI patients. We developed a new calibration technique to quantitate microvascular integrity using myocardial contrast echocardiography (MCE). We aimed to establish quantitative relationship between subendocardial and subepicardial microvascular damage and wall motion abnormality.

Method: We performed triggered MCE with injection of Levovist and recorded end-systolic 1:5 harmonic (Toshiba) or ultraharmonic (Philips) images (4C view) in 24 patients with anterior MI. Relative myocardial contrast intensity (RMCI, dB) was calculated as the difference of contrast intensity of myocardium minus that of the adjacent LV cavity with VoluMap system. Ventricular septum was divided into 4 segments and RMCI was measured in RV half and LV half in each segment. From RMCI value, we estimated myocardial blood volume fraction (ml/100gmyo) of each segment, since the blood volume of LV cavity is 100 ml/100g.

Results: RMCI decreased with worsening of asynergy both RV- and LV-halves. Estimated MBV in hypokinetic segments was about 50% of normal segments and MBV reduced to 25% in normals in akinesia.

Conclusion: It is the first clinical to quantitate transmural extent of microvascular damage in MI patients with MCE. RMCI provides an estimate of MBV, that is determined by capillary volumes, and MBV reduces with worsening of wall motion abnormality.