Title: SIMULTANEOUS MEASUREMENTS OF CARDIAC VOLUMES, AREAS AND EJECTION FRACTIONS BY TRANSESOPHAGEAL ECHOCARDIOGRAPHY AND FIRST PASS RADIONUCLIDE ANGIOGRAPHY

Authors: F.M. Clements, M.D., D. Hazpole, M.D., T. Quill, M.D., R.H. Jones, M.D., J. Aladj, M.D., and R. McCann, M.D.

Affiliations: Departments of Anesthesiology and Surgery, Duke University Medical Center, Durham, N.C. 27710

Introduction: Monitoring of global and regional left ventricular (LV) function by transesophageal echocardiography (TEE) is done most frequently with a short axis imaging plane at a mid-papillary muscle level. This offers the most information about LV function in a single imaging plane. The cavity of the LV is therefore represented by an area marked by the endocardial border; an "area ejection fraction" (AEF) can be easily calculated at any time by tracing the endocardial borders to measure the end-diastolic area (EDA) and the end-systolic area (ESA). Then AEF = ESA / EDA. The validity of TEE-derived EDA, ESA and AEF as representative of volume-derived LV measurements has not been established, although it is well-established that stroke volume in normal hearts is largely a result of fibre shortening in the short axis. We therefore compared TEE measurements with simultaneous LV volume and ejection fraction measurements using first pass radionuclide angiography.

Methods: With informed consent 14 patients undergoing resection of infrarenal abdominal aortic aneurysms were studied. Following induction of anesthesia a 5MHz 6A element esophageal transducer (Hewlett-Packard Co.) was positioned to provide a 2-dimensional short axis image of the left ventricle at the mid-papillary muscle level. Images were recorded onto 1/2 inch videotape with a concomitant electrocardiogram (Lead II) at selected times before, during and after aortic cross-clamping. Simultaneously, first-pass radionuclide angiograms (RNA) were performed using intravenous injection of 10mCi Technetium 99m DTPA (diethylene-triamine pentaacetic acid). During imaging, mechanical ventilation was interrupted. Echocardiographic images were examined using software available on the standard echocardiograph. End-diastole was selected as the videotape frame corresponding to the peak of the R wave on the ECG. End-systole corresponded to the frame showing the smallest left ventricle following end-diastole. The mean of 3 cardiac cycles was used for each measurement; AEF was calculated according to the formula above, for each cycle. RNA studies were evaluated with commercially available software for EDV, ESV and LV EF. The accuracy and reproducibility of these measurements have been verified with previous work (2).

Results: Imaging by echocardiography or RNA could not be completed in two patients. Imaging by both techniques was accomplished in 49 instances in 12 patients. RNA EFs varied from 11 - 82%. 4 patients had a history of myocardial infarction. There was a good correlation between echo-derived areas and RNA-derived volumes at end-systole and end-diastole. The correlation coefficients for AEF-RNAEF and EDA-RNAEDV were 0.96. and 0.85 (see figs 1 and 2).

Discussion: Unlike many measurements of left ventricular function that can be obtained with echocardiographic images, EDA, ESA and AEF are easily obtained in the clinical setting, and require only a single imaging plane. The correlation of these measurements with RNA estimates of LV volume suggests that they may be reliably used to assess preload and LV EF, even in patients with abnormal and asynergic left ventricles.

References: