THE USE OF BOLUS INTRAVENOUS NITROGLYCERIN TO ALTER LOAD ON A BEAT-BY-BEAT BASIS TO GENERATE LEFT VENTRICULAR PRESSURE-VOLUME RELATIONSHIPS IN PATIENTS WITH CONGESTIVE HEART FAILURE

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Infusions of sodium nitroprusside, methoxamine, or inferior vena cava occlusion are routinely used to alter left ventricular (LV) loading conditions and generate maximum elastance (E_{max}) and diastolic LV pressure-volume relationships. However, drug infusions may activate baroreflexes and alter myocardial contractility while inferior vena cava occlusion is invasive. Accordingly, we evaluated the use of bolus intravenous nitroglycerin (i.v. NTG) as a new method to alter load on a beat-by-beat basis to generate LV pressure-volume loops (P-V loops). In pilot studies, the amount of bolus i.v. NTG sufficient to generate at least a 10 mmHg decrease in systolic blood pressure was determined to be 400 μg in patients with congestive heart failure (CHF) and 200 μg in normal (NL) patients. In follow-up studies, LV pressure and volume were recorded with Millar and Impedance catheters in 22 patients with (n=11, EF=19±3%) and without (n=11, EF=62± 5%) CHF. LV P-V loops were recorded following bolus i.v. NTG on a beat-by-beat basis prior to a 5% increase in heart rate. The number of loops generated (#LOOPS), peak reduction of systolic blood pressure (↓BP), and E_{max} obtained prior to the activation of baroreflexes are shown below.

	E_{max}	#LOOPS	↓BP (mmHg)
NL (n=11)	5.80±0.96	18±3	31±5
CHF (n=11)	1.01±0.17	30±4	18±2
p value (NL vs CHF)	p<0.0001	p<0.05	p<0.02

The slope of the diastolic compliance curves was increased in patients with CHF compared to NL.

In conclusion, bolus i.v. NTG is an effective method to alter load and generate P-V loops in CHF and NL patients. This new technique allows for the accurate identification of systolic and diastolic dysfunction in patients with CHF.

LEFT VENTRICULAR FILLING AND WALL MOTION ASYNCHRONY IN MYOCARDIAL INFARCTION

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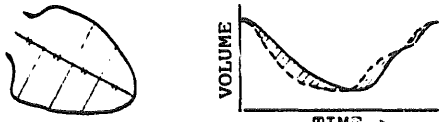
To assess the influence of wall motion asynchrony (ASY) on filling of the left ventricle with myocardial infarction (MI) and to compare it with other hemodynamic parameters, we analyzed left ventriculograms (LVG) with left ventricular pressure (LVP) in 15 patients with MI and 8 control subjects. The LVG was divided into 8 segments. The discrepant area (▨) between the segmental volume-time curve (—) and global volume-time curve normalized for the segmental stroke volume (---) was obtained at each segment. ASY was quantitated as the sum of the discrepant areas and normalized for a global stroke volume and cycle length.



The MI group had greater ASY (19±2 vs 10±1*) and atrial filling fraction (AFF) (46±5 vs 22±4%*) compared to controls(*p<.01). The multiple regression analyses, with 4 variables (ASY, LVP at mitral valve opening (MVOP), the time constant of isovolumic LVP fall and LV chamber stiffness constant), showed that ASY and MVOP were significant determinants of AFF in MI group, while MVOP was the only significant determinant in controls.

We conclude that ASY is one of the major determinants of LV filling in patients with MI.

SIMULTANEOUS NONINVASIVE CHARACTERIZATION OF BIVENTRICULAR SYSTOLIC AND DIASTOLIC FUNCTION USING FAST COMPUTED TOMOGRAPHY

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Relatively few imaging techniques allow the simultaneous noninvasive evaluation of biventricular dynamics. To this purpose we evaluated right (R) and left ventricular (LV) volume changes using fast computed tomography in ten normal volunteers (age 26±4 years). Early diastolic filling data were fit to a third order polynomial curve and the peak rate of tomographic diastolic filling determined. Despite different RV and LV volumes (end-diastolic: 157±17 vs 133±14 cc; end-systolic: 67±10 vs 43±9 cc, p<.05, respectively) the stroke volumes and the absolute tomographic peak filling rate (PFR) were the same (stroke volume: 89±10 vs 90±9 cc, PFR: 439±78 vs 480±77 cc/sec, p=NS, respectively). When these indexes were referenced to RV and LV end-diastolic volumes, ejection fractions and PFRs were statistically different (ejection fraction: 57±4 vs 68±5%; PFR: 2.7±.4 vs 3.6±.5 end-diastolic volumes/sec, p< .05, respectively). In conclusion: 1) As absolute measurements, a close volumetric match exists in systolic and diastolic function between the two ventricles. 2) When referenced to end-diastolic volume, the right ventricle can be considered a lower dynamic chamber. 3) Fast computed tomography allows the simultaneous evaluation of R and LV dynamics.

NON-INVASIVE PREDICTION OF PULMONARY CAPILLARY WEDGE PRESSURE

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Reports in the literature have indicated that the strain phase of the arterial wave-form response to the Valsalva maneuver is related to the pulmonary capillary wedge pressure (PCWP). We therefore developed a simple bedside method using a modified digital pulse volume recorder (DVR) to measure and analyze the reflected arterial pulse wave response to the Valsalva maneuver and assessed the ability of this response to predict the PCWP noninvasively. As a means of quantifying the strain-phase contour, a pulse amplitude ratio (PAR) was determined by dividing the late by the early strain phase impulse amplitude as inscribed by DVR. Simultaneous, blinded DVR tests and measurements of PCWP were obtained on 43 occasions in 22 patients (pts) at routine cardiac catheterization. Determinations were made at baseline (20 pts), post-sublingual nitroglycerin (NTG) (13 pts), and post-volume (10 pts). Results: PCWP at baseline, post-NTG, and post-volume were statistically different to p=0.023 (two-way ANOVA). PAR at baseline, post-NTG and post-volume were statistically different to p=0.0025 (two-way ANOVA). Using linear regression analysis, we found that PAR strongly correlated with measured PCWP over a range of values from 4 to 40 mmHg (R=0.87, p<0.0001).
Conclusions: We conclude that this simple bedside noninvasive method can accurately predict the PCWP over a wide range of clinically relevant values and can detect increases and decreases in PCWP in response to therapy and volume expansion.