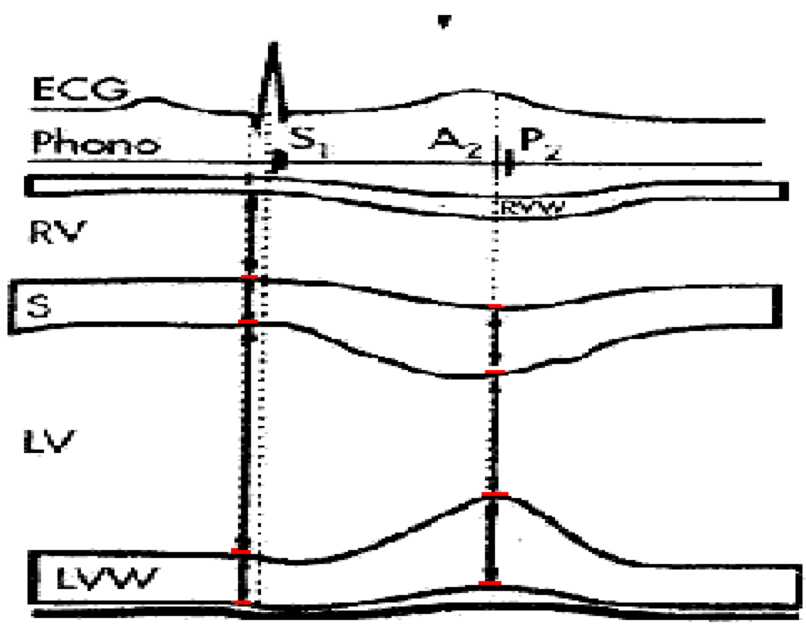
CVCA

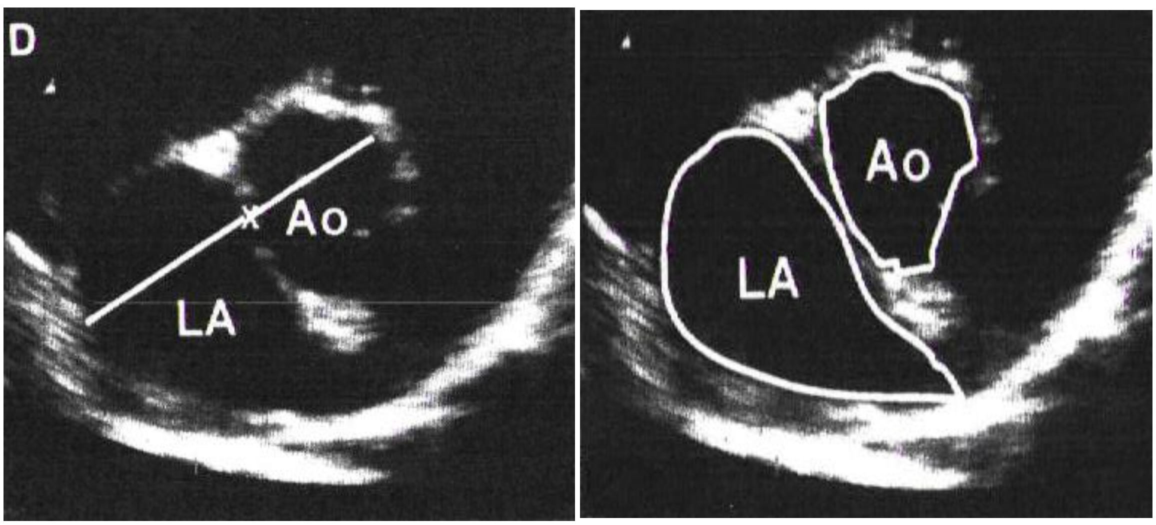
Cardiac Care for Pets

Manual of Echocardiography

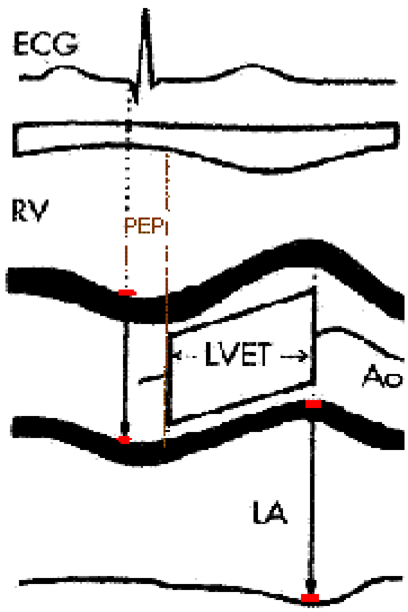
1) <u>Left Ventricle M-mode and 2D</u>
   a. Right apical short axis with cursor at level of chordae attachment to papillary muscles
   b. Right apical long axis with cursor perpendicular to IVS/LVPW between papillary muscles and tips of MV leaflets
      i. M-mode measurements using leading edge technique
         1. (ie: IVSd from interface with RV to IVS endocardium)
      ii. Diastolic measurements taken at start of QRS
      iii. Systolic measurements taken at end of T wave or smallest apparent LVIDd at peak downward septal motion
   c. Use 2D to confirm M-mode or if reasonable angle is not obtainable



2) <u>Aorta/Left Atrium 2D and Left Atrial area</u>
   a. Right apical short axis at level of aortic root. Largest LA dimensions with aortic valve closed
   b. M-mode measurements > 2D measurements
   c. Pulmonary veins are not included in LA area
   d. <u>Left auricular area</u> from oblique left apical long axis– endocardial surface traced from entrance of LAA at the body of the LA

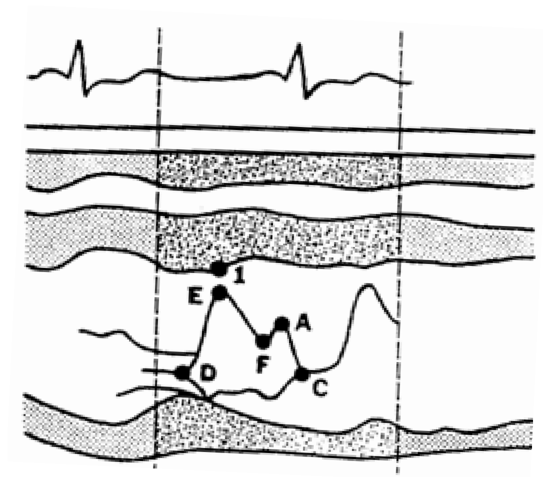


3) Aorta/Left atrium - M-mode
   a) Right apical short axis at level of aortic root
      a. Aortic root from top of anterior wall to top of posterior wall at end-diastole (just at the onset of QRS)
      b. Left atrium from top of posterior aortic wall to pericardium at end of ventricular systole (after T wave at maximal aortic upward excursion)



4) Systolic Time Intervals - if simultaneous ECG present. May be better indicator of global LV function than FS%, but still affected by preload, afterload, HR and contractility.
   a) Pre-Ejection Period (PEP) – measured from beginning of QRS to opening of aortic valve. Corresponds to isovolumetric contraction (close association with dP/dt)
      a. Normal Dog – 47-70 msec   Normal Cat – 39-53 msec
   b) Left Ventricular Ejection Time (LVET) – measured from the time of aortic valve opens to time aortic valve closes
      a. Normal Dog – 130 – 170 msec   Normal Cat – 105-140 msec
   c) PEP/LVET – reduces effects of heart rate
      a. Normal Dog – 0.23-0.30   Normal Cat – ~0.40
   d) Velocity of circumferential fiber shortening (Vcf) – Really an ejection phase indice (LVIDd – LVIDs)/(LVIDd x LVET)
      a. Normal Dog – 2.0 – 3.0 circ/sec   Normal Cat – 2.7 – 4.3 circ/sec

5) Mitral valve M-mode
   a. Right apical short or long axis
   b. Slope D-E – early LV diastolic filling
   c. Slope E-F – middiastolic closure rate of mitral valve
   d. E point excursion should exceed A point excursion
   e. E point septal separation (EPSS) – shortest distance from E point to the ventricular septum. Strong negative correlation with ejection fraction and poor cardiac output

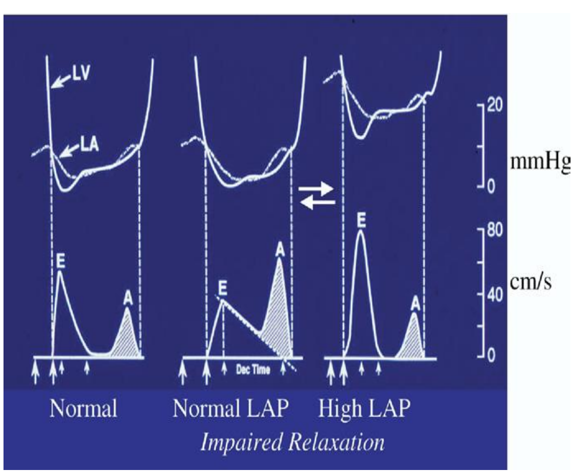


6) Ejection Fraction – Modified Simpson's Rule
   a. Measure of volume leaving LV – does not imply forward stroke volume
   b. Left apical 4 chamber or 2 chamber view
   c. LV endocardial surface traced at end diastole (frame just before MV closure or start of QRS)
   d. LV endocardial surface traced again at end systole (frame just before MV opens)

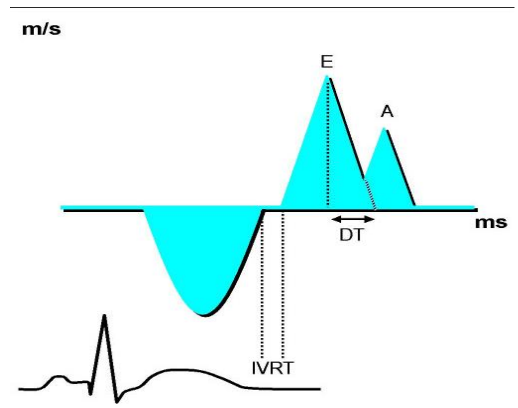
7) Index of Spherocity – an indication of the degree of LV rounding
   a. LV length from optimized right apical long axis without LVOT
   b. LVIDd measured from M-mode short axis
   c. LV length/LVIDd (increased spherocity if < 1.6)

8) <u>Right Atrial Area</u>
   a. Left apical 4 chamber
   b. Trace endocardial surface

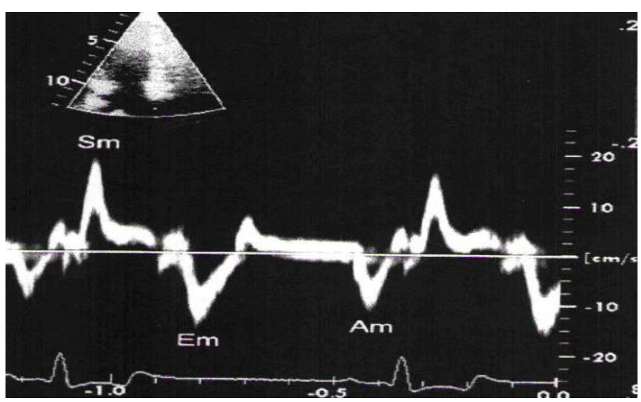
9) Mitral Valve – left apical 4 chamber
   a. LV Inflow – PW sample gate between tips of MV at full excursion
      i. <u>E wave velocity</u> – rapid ventricular filling
      ii. <u>A wave velocity</u> – atrial contraction
      iii. <u>E wave deceleration time</u> – measure the slope that extends from point of maximal E velocity to baseline
         1. Normal E:A – 1.0-2.0
         2. Impaired relaxation E:A - <1.0
         3. Restrictive filling E:A - >2.0



b. Isovolumic Relaxation Time (IVRT) – PW sample gate between LVOT and MV
    i. Measured as the time interval between the cessation of aortic outflow and beginning of mitral inflow.
        1. Normal Dogs – 40-80 msec   Normal Cats – 37-55 msec



10) Tissue Doppler – assessment of LV diastolic dysfunction and left atrial pressures
a. Taken at the lateral mitral valve annulus
b. Estimate of Mean Left Atrial pressure – E:E' > 9.0 indicates elevated LAP
c. TDI E:A pattern to confirm impaired relaxation and restrictive profiles

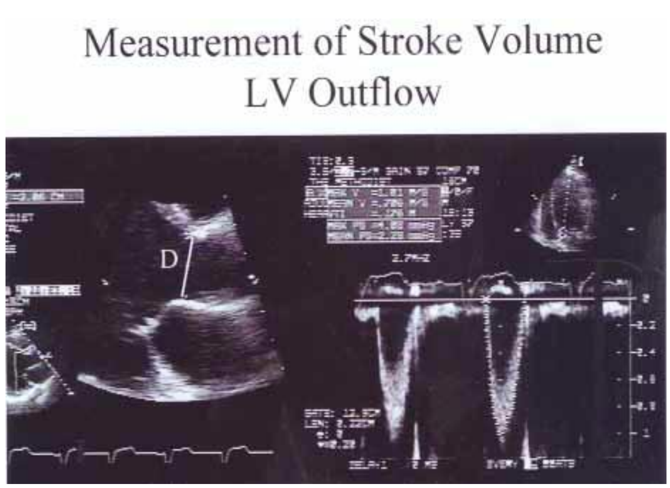


11) <u>Mitral Regurgitation</u> – CF used to align CW cursor with jet direction

i. Velocity – can be used to estimate LV pressure (PG = $4V^2$) Estimate of systemic blood pressure
ii. L V dP/dt – relatively load independent measure of LV contractility if no indication of LBBB
    1. High sweep speed needed (~ 150 mm/sec)
    2. Measure time required for velocity to increase from 1 m/sec to 3 m/sec (32 mm Hg pressure increase)
    3. Time between 2 points m/sec divided by 32 mm Hg (mm Hg/sec)

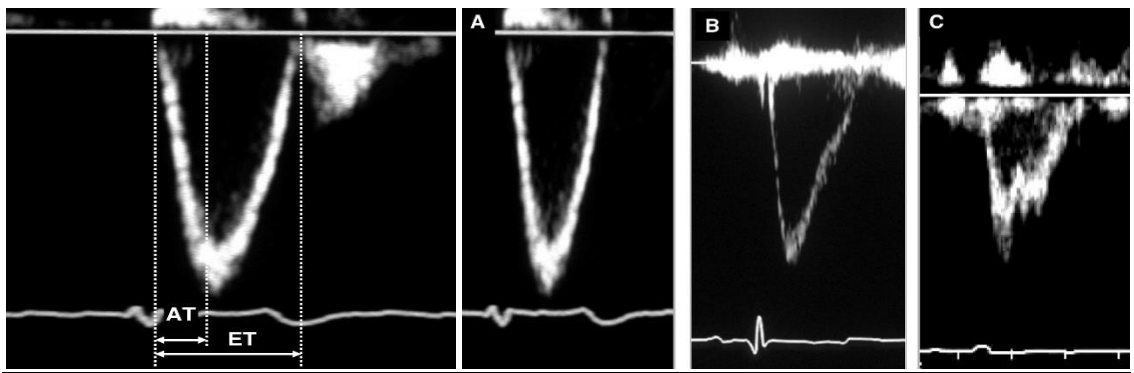
12) <u>Aortic Outflow</u>

a. Velocity – left apical 5 chamber or subcostal
b. Time Velocity Integral (TVI) – sum of all instantaneous velocities throughout ejection period. Used to calculate stroke volume and shunt ratios



13) Pulmonic Outflow

a. Velocity – right parasternal short axis or modified obliqued left apical
b. Time Velocity Intergral (TVI) – Used to calculate stroke volume and shunt ratios
c. Systolic Time Intervals – Acceleration and Decelerations rates as a helpful indicator of pulmonary hypertension

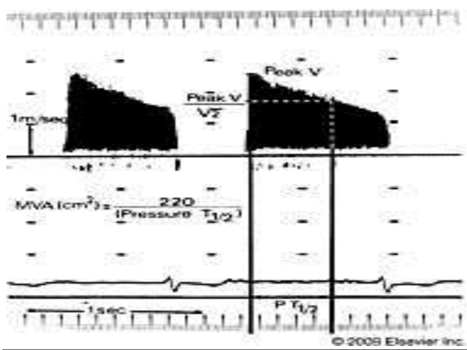


14) Shunt Ratio - used to determine if a shunting defect is hemodynamically significant

a. Determine LV stroke volume = Aortic TVI x cross sectional area of AV
b. Determine RV stroke volume = Pulmonic TVI x cross sectional area of the PV
    i. Cross sectional area = $\pi(\text{radius})^2$
c. Qp/Qs = PAsv/Aosv - > 1.5 being significant
d. For PDA Qp/Qs = Aosv/PAsv

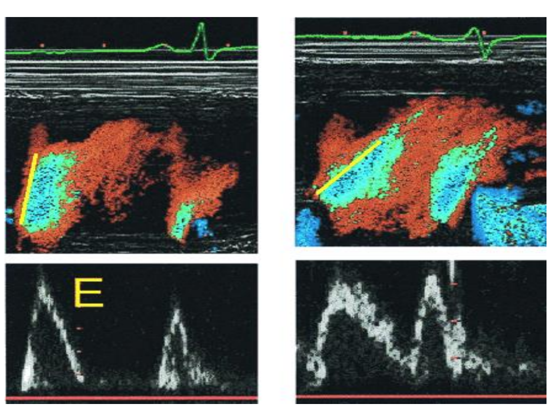
15) Pressure Half-Times – time for peak pressure gradient to decline by half

a. Aortic and Pulmonic Insufficiencies – short pressure half time indicates that ventricular diastolic pressures have increased rapidly secondary to the regurgitation.
b. Mitral and Tricuspid Inflow – long pressure half times indicative of more severe AV valve stenosis



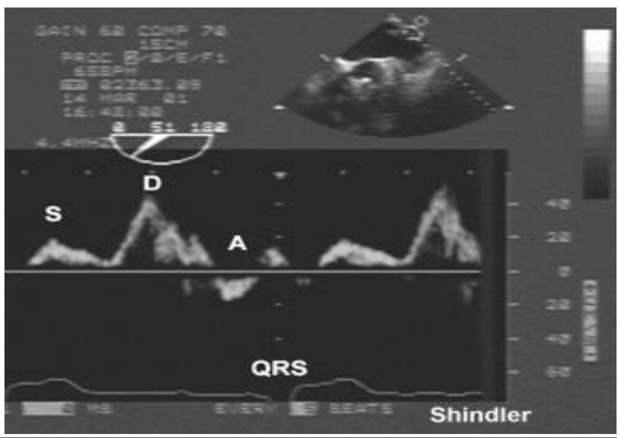
16) Transmitral Flow Propagation Velocity

a. Loss of the normal intraventricular pressure gradient (pressures at apex lower than base) that occurs with a decrease in myocardial relaxation
b. Color M-mode obtained by placing cursor line along central part of mitral inflow
c. Lower Nyquist limit so that central highest velocity jet is blue
d. Trace slope of first aliasing velocity (red to blue)
    i. Normal Dog – 45-70 cm/sec   Normal Cat – 55-111 cm/sec



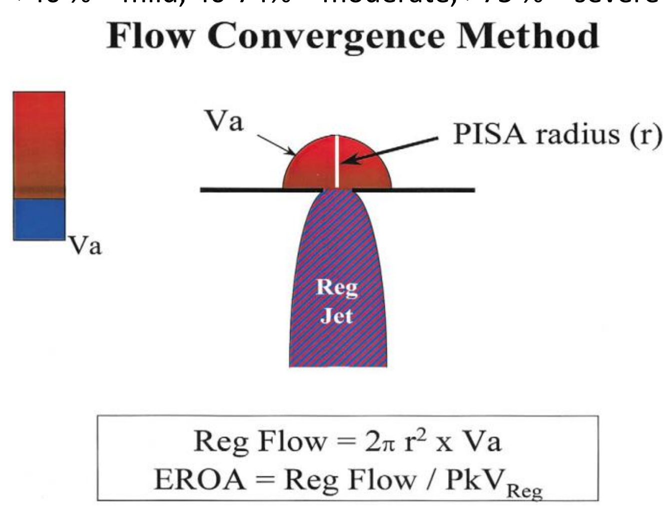
17) Pulmonary Vein Flow Velocities

a. obtained from left apical 4 chamber
b. four velocity components
    i. PVs1 – first systolic forward flow during atrial relaxation
    ii. PVs2 – second systolic forward flow during mid to late systole from increase in pulmonary venous pressure (PVs1 and PVs2 usually summated)
    iii. PVd – diastolic velocity
    iv. PVa – atrial flow reversal – extent and duration related to LV diastolic pressure, LA compliance and heart rate



18) <u>Proximal Isovelocity Surface Area</u> – calculation of regurgitant fraction in MVD

a. Shift Nyquist lime to 25-60 cm/s in direction of flow adjusting to find the most symmetrical hemicircle
b. Find best hemicircle in the middle of systole
c. Calculate the flow rate through the MV:
    i. Flow rate (ml/s) = $(2\pi r^2) \times V_{al}$
        1. r= radius of hemicircle V_{al} = aliasing velocity cm/s
d. Using CW Doppler calculate peak MR velocity and TVI
e. Calculate effective regurgitant orifice area
    i. EROA (cm^2) = flow rate (ml/s)/ V (cm/s)
        1. V = peak velocity of jet
f. Calculate regurgitant volume (RSV)
    i. Regurgitant stroke volume (ml) = EROA (cm^2) x TVI (cm)
g. PW Doppler to calculate aortic TVI
h. Measure diameter of aorta and calculate Ao area (πr^2)
i. Calculate aortic SV = aortic area (cm^2) x TVI (cm)
j. Calculate Regurgitant Fraction
    i. RF% - RSV (ml) / RSV (ml) + AoSV
    < 40 % = mild, 40-74% = moderate, >75 % = severe



E/E_a	Predicted MLAP (mm Hg)	95% CI for prediction (mm Hg)
5.0	3.6	-6.4 to 13.6
6.0	10.0	0.0 to 20.0
7.0	16.4	6.4 to 26.4
8.0	22.8	12.8 to 32.8
9.0	29.2	19.2 to 39.8
10.0	35.6	25.6 to 45.6
11.0	41.9	31.9 to 51.9
12.0	48.3	38.3 to 58.3