When there is an isolated thickening of the basal IVS (referred to as a sigmoid septum or a septal bulge), LV measurements should be performed slightly apically or inferior to this septal bulge.

LV Mass

The LV mass is determined from the LV muscle volume and the specific gravity of muscle. LV muscle volume is equal to the total ventricular volume contained within the epicardial boundaries of the ventricle [epicardial volume] minus the chamber volume contained by the endocardial surfaces [endocardial volume] (Fig. 9.9). LV mass is then calculated by multiplying the LV muscle volume by the specific gravity of muscle (1.04 g/mL or 1.05 g/mL).

Via 2D echocardiography, LV mass can be estimated from linear measurements, or by the area-length or truncated ellipse methods. Due to the one-dimensional limitations of linear measurements, which do not account for asymmetric hypertrophy or alterations in ventricular geometry, the preferred method for estimating LV mass is either the area-length or truncated ellipse methods.

LV Mass via Linear Measurements

Both the total epicardial volume and the endocardial volume can be estimated from the 2D measurements of the LVEDD, IVS and PW (Fig. 9.10). Volumes are determined by the D^3 method which assumes that the shape of the LV approximates a prolate ellipse with a long-axis to short-axis ratio of 2:1. Based on this cube function formula, the epicardial volume is equal to $[LVEDD + IVS + PW]^3$ while the endocardial volume is equal to $LVEDD^3$. Furthermore, to account for an overestimation of LV mass as observed during the original validation studies, a 'correction factor' is added to the equation. Therefore, the LV mass is derived as:

Equation 9.1

$$LVM = 1.04\,([LVEDD + PW + IVS]^3 - LVEDD^3) \times 0.8 + 0.6$$

where LVM = left ventricular mass (g)
1.04 = specific gravity of muscle (g/mL)
LVEDD = left ventricular end-diastolic dimension (cm)
PW = left ventricular posterior wall thickness (cm)
IVS = interventricular septal thickness (cm)
0.8 + 0.6 = 'correction factor'

LV mass has been shown to correlate with BSA and is significantly different between men and women. Therefore,

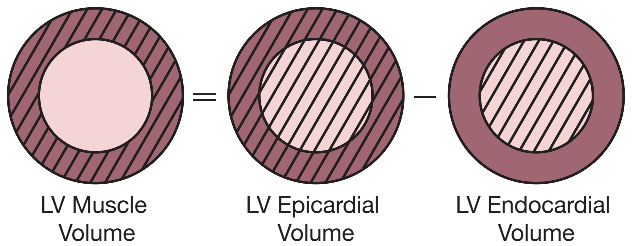


Figure 9.9 The left ventricular (LV) mass is estimated as the difference between the total ventricular volume (LV epicardial volume) and the chamber volume (LV endocardial volume).

LV mass should be indexed for the BSA by simply dividing the calculated LV mass by the BSA. The normal values and experience-based partition values for LV mass are listed in Table 9.3.

LV Mass via the Area-Length

Using the area-length method, the volume of the LV myocardium is calculated from the myocardial area, the average myocardial wall thickness, and the LV length (Fig. 9.11). From these measurements the LV mass is estimated as:

Equation 9.2

$$LVM = 1.05\,[5/6\,A_1\,(L + t)] - [5/6\,A_2\,L]$$

where LVM = left ventricular mass (g)
A_1 = epicardial area at end diastole (cm^2)
A_2 = endocardial area at end diastole (cm^2)
L = ventricular length at end diastole (cm)
t = average wall thickness (cm)
1.05 = specific gravity of muscle (g/ml)

Limitations in the estimation of LV mass via the linear method are based on geometric assumptions and the cubing of measurements. In particular, small measurement errors will be amplified to the third power. In addition, this method assumes that the LV length is twice its diameter with a long-axis to short-axis ratio of 2:1. Therefore, the accuracy of LV mass via this method is significantly affected by: (1) alterations or distortion in LV shape which may occur with chronic severe right or left ventricular volume overload, (2) massive myocardial infarction or ventricular aneurysm, or (3) asymmetric septal hypertrophy. In these instances, 2D estimation of LV mass is considered more accurate.

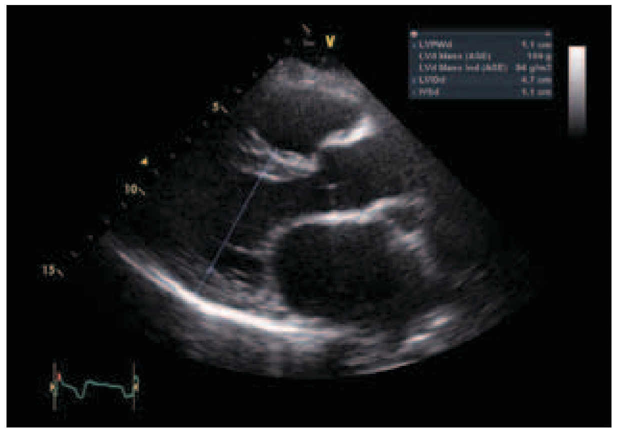
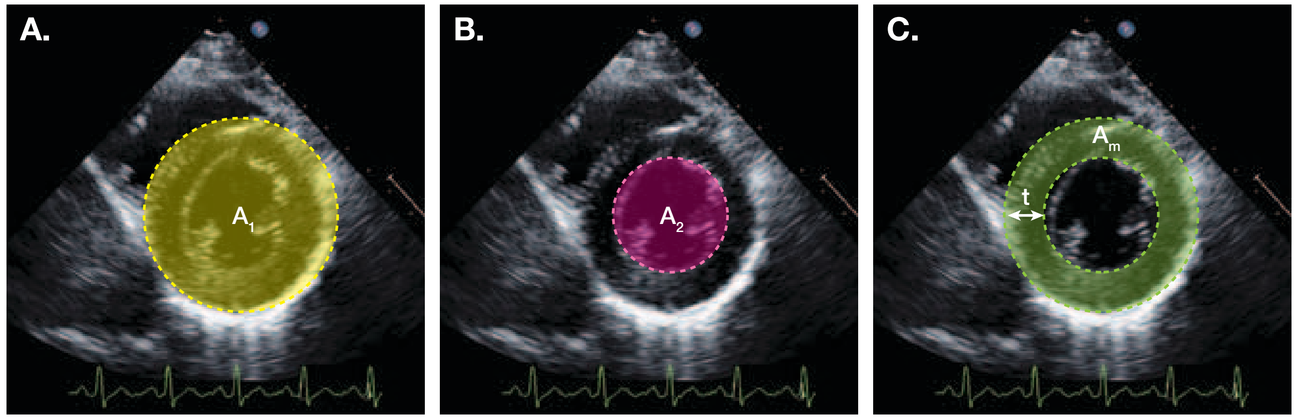


Figure 9.10 For the linear estimation of left ventricular (LV) mass, measurements of the interventricular septum (IVSd), the LV cavity (LVIDd) and the posterior wall (LVPWd) are performed at end-diastole and at the blood-tissue interfaces. In this example the LV mass (LVd Mass) is calculated as:

$$LVd\ Mass = [1.04\,([LVIDd + LVPWd + IVSd]^3 - LVIDd^3) \times 0.8] + 0.6$$
$$= [1.04\,([4.7 + 1.1 + 1.1]^3 - 4.7^3) \times 0.8] + 0.6$$
$$= 189\ g$$

The body surface area (BSA) was 2.01 m^2, so the indexed LV mass (LVd Mass Ind) is calculated as:

$$LVd\ Mass\ Ind\ (g/m^2) = LVd\ Mass \div BSA$$
$$= 189 \div 2.01$$
$$= 94\ g/m^2$$



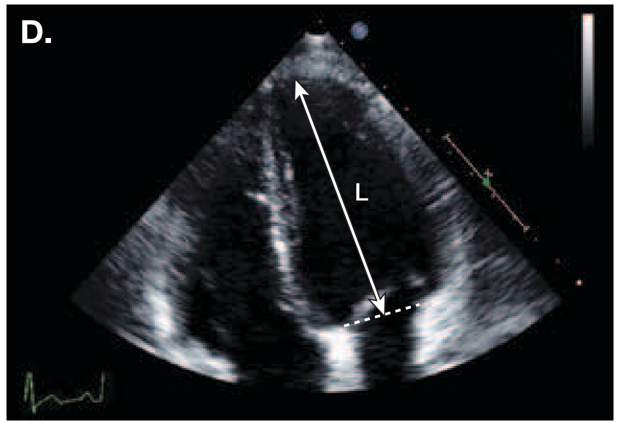


Figure 9.11 These images demonstrate calculation of left ventricular (LV) mass via the area-length method. From the parasternal short axis view at the papillary muscle level, the total epicardial area (A_1) and the total endocardial area (A_2) are traced at end-diastole (A & B). The endocardial area trace includes the papillary muscles; that is, the papillary muscles are included in the cavity area. The myocardial area (A_m) is obtained by subtracting the total epicardial area (A_1) and the LV cavity area (A_2) (C). By assuming a circular area, the average myocardial wall thickness (t) is calculated from the difference between the radii of the epicardial endocardial area (A_1) and the endocardial area (A_2): $t = [\sqrt{(A_1 \div \pi)}] - [\sqrt{(A_2 \div \pi)}]$. From the apical 4-chamber view, the LV length (long axis) is measured from the mitral annulus to the LV apex at end-diastole (D).The LV mass can then be calculated using Equation 9.2.

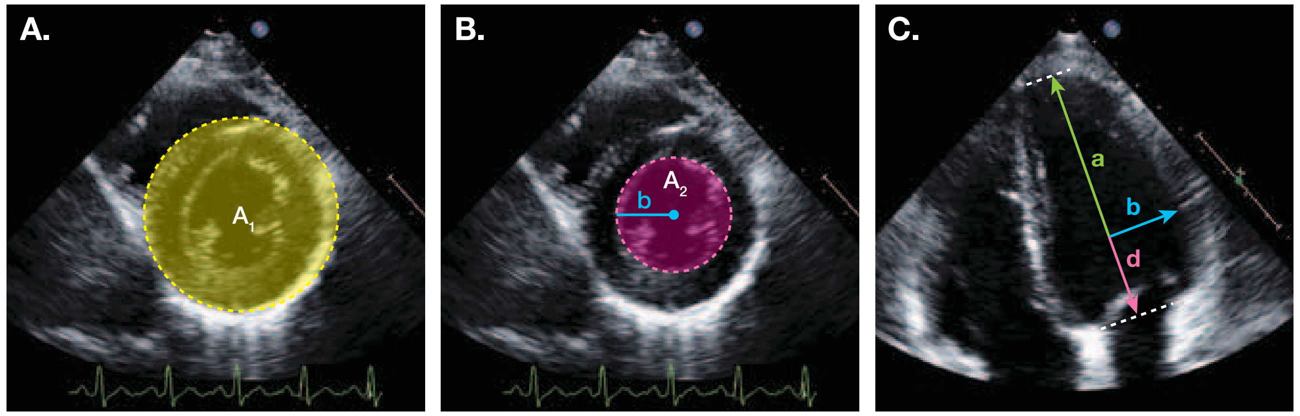


Figure 9.12 These images demonstrate calculation of left ventricular (LV) mass via the truncated-ellipse method. From the parasternal short axis view at the papillary muscle level, the total epicardial area (A_1) and the total endocardial area (A_2) are traced at end-diastole (A & B). The endocardial area trace includes the papillary muscles; that is, the papillary muscles are included in the cavity area. The myocardial area (A_m) is obtained by subtracting the total epicardial area (A_1) and the LV cavity area (A_2) (C). By assuming a circular area, the average myocardial wall thickness (t) is calculated from the difference between the radii of the epicardial endocardial area (A_1) and the endocardial area (A_2): $t = [\sqrt{(A_1 \div \pi)}] - [\sqrt{(A_2 \div \pi)}]$. From the apical 4-chamber view, the LV length (long axis) is divided into a semi-major axis (a) and a truncated semi-major axis (d) at the level of the short axis radius (b) which is derived as $\sqrt{(A_2 \div \pi)}$ (d). LV mass is then calculated using Equation 9.3.

LV mass calculations via the area-length and truncated ellipsoid methods rely on accurate tracing of endocardial and epicardial borders. Hence, suboptimal image quality, the inability to identify these borders, and off axis images will compromise the accuracy of these calculations. In particular, overestimation of LV wall thickness due to oblique cuts through the LV will result in an overestimation of LV mass while underestimation of the LV length due to foreshortening of the apical views will lead to an underestimation of the LV mass.