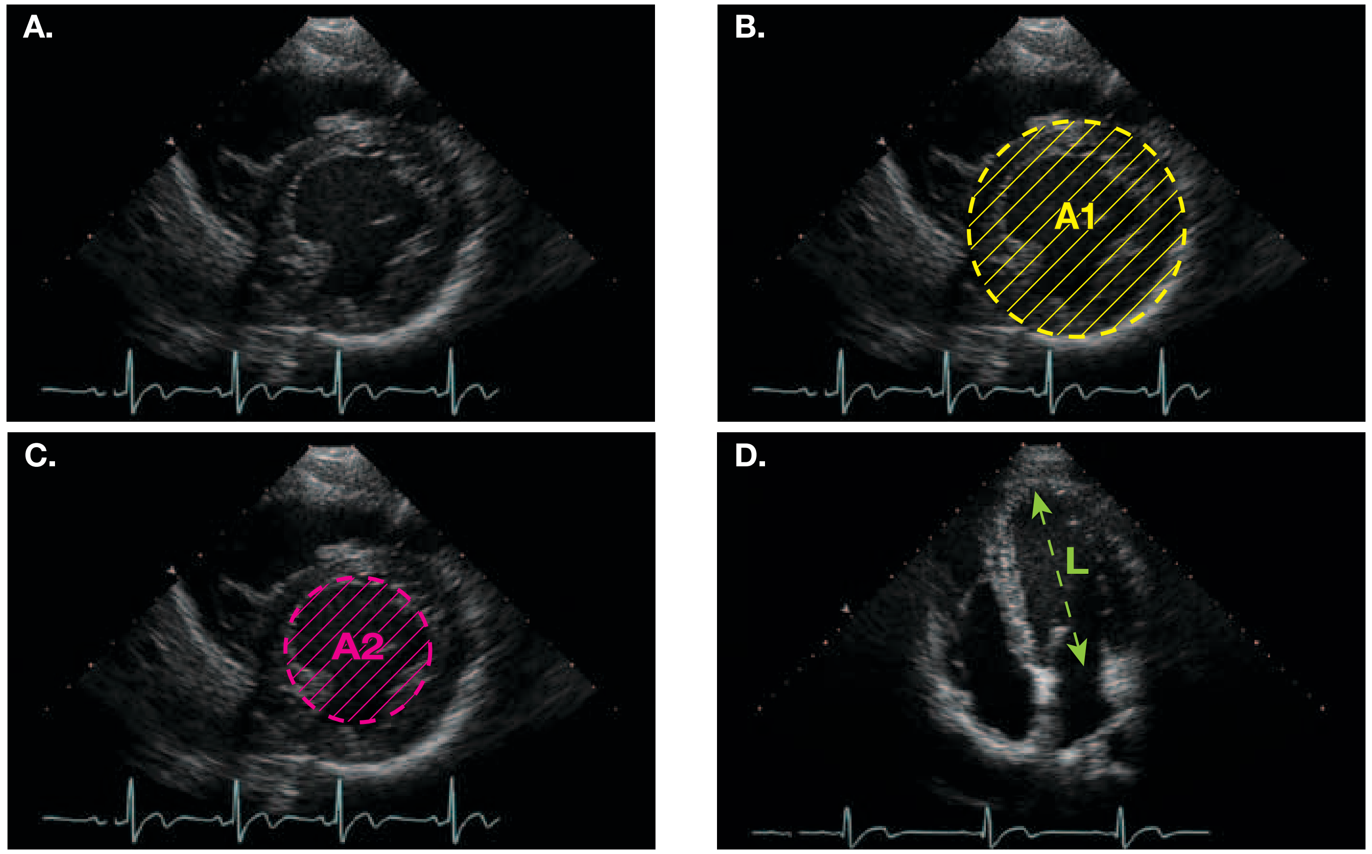

Figure 4.7 To calculate the LV mass via the area-length method a parasternal short axis of the left ventricle (LV) at the papillary muscle level is acquired at end-diastole **(A)**. Because the mitral valve cannot be seen from this view, end-diastole is identified as the onset of the QRS complex of the ECG. From this image the total epicardial area (A_1) and the total endocardial area (A_2) are traced (**B** and **C**). The endocardial area trace includes the papillary muscles; that is, the papillary muscles are included in the cavity area. From these traces and assuming a circular area, the radius (b) is derived as $\sqrt{(A_2 \div \pi)}$ and the mean wall thickness (t) is calculated as $\sqrt{(A_1 \div \pi)} - b$. From an end-diastolic frame acquired from the apical 4-chamber view, the LV length (long axis) is measured from the mitral annulus to the LV apex **(D)**.The LV mass can then be calculated via the area-length equation: *LVM (g) = 1.05* $[5/6\,A_1\,(L + t)] - 5/6\,A_2\,L]$.

Based on the LV mass and the RWT the pattern of LV geometry can be classified into the four groups: concentric hypertrophy, eccentric hypertrophy, concentric remodelling and normal geometry (Fig. 4.9). The normal geometric pattern is defined as a normal LV mass and normal RWT. The concentric hypertrophy pattern, which is the "typical" hypertensive concentric hypertrophy pattern, is defined as both an increase in LV mass and RWT. The eccentric hypertrophy pattern is defined as an increased LV mass with normal RWT; in this group, the LV mass is increased due to chamber dilatation rather than increased wall thickness. The concentric remodelling pattern is defined as having increased RWT with normal LV mass.

Limitations

Measurement accuracy of LV wall thickness is highly dependent upon image quality and the technical skill of the operator. In addition, M-mode may overestimate LV wall thickness if the M-mode cursor transects the LV walls at an oblique angle. There is also the potential that measurements performed via second harmonic imaging may overestimate LV wall thickness when compared to fundamental imaging; however this limitation has become less of a problem due to the improved spatial resolution at the harmonic frequency.

As linear LV mass calculations rely on accurate measurements of LV walls, the limitations described above will also apply to these LV mass calculations. In particular, because the linear LV mass is estimated by the cubing of these measurements, small measurement errors will be amplified to the third power (refer to Equation 4.7).

2D LV mass calculations rely on accurate tracing of endocardial and epicardial borders so suboptimal image quality, the inability to identify these borders and off axis images will compromise the accuracy of these calculations. For example, 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 2D LV mass. Furthermore, LV mass calculations are based on geometrical assumptions that represent obvious limitations to these calculations.

LV Systolic and Diastolic Function

LV systolic and diastolic function in patients with HTN is important due to the structural changes that occur within and surrounding cardiac myocytes which may inhibit normal LV contraction and relaxation. In particular, with long-term HTN heart failure and subsequent LV systolic dysfunction may develop. LV systolic function is assessed in the usual manner (see Chapter 2).

LV systolic function is often hyperdynamic in patients with HTN and this in conjunction with LVH may result in dynamic left ventricular outflow tract (LVOT) obstruction. On the continuous-wave (CW) Doppler signal dynamic LVOT obstruction is identified as a late-peaking systolic, dagger-shaped signal (Fig. 4.10).

The diastolic filling profile in HTN typically reveals an impaired relaxation pattern (Fig. 4.11). A triphasic mitral inflow profile with mid-diastolic flow may also be seen in patients with LVH (Fig. 4.12). When present in the setting of LVH, the L-wave appears to be a marker of pseudonormal LV filling. The proposed mechanism for this mid-diastolic flow (or the L-wave) relates to markedly abnormal LV relaxation. The comprehensive assessment of LV diastolic function is performed in the usual manner (see Chapter 3).

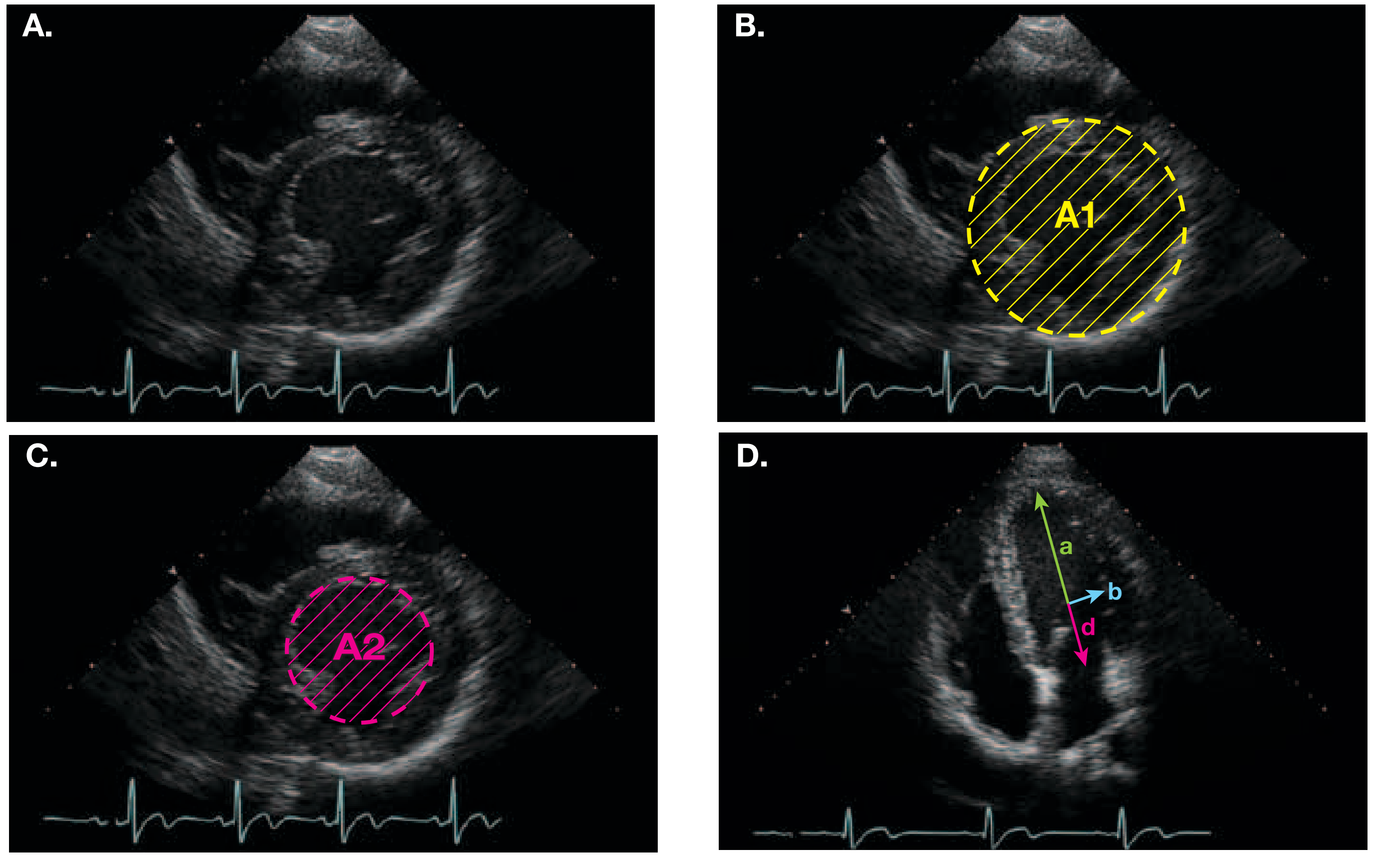

Figure 4.8 To calculate the LV mass via the truncated ellipse method a parasternal short axis of the left ventricle (LV) at the papillary muscle level is acquired at end-diastole **(A)**. Because the mitral valve cannot be seen from this view, end-diastole is identified as the onset of the QRS complex of the ECG. From this image the total epicardial area (A_1) and the total endocardial area (A_2) are traced (**B** and **C**). The endocardial area trace includes the papillary muscles; that is, the papillary muscles are included in the cavity area. From these traces and assuming a circular area, the radius (b) is derived as $\sqrt{(A_2 \div \pi)}$ and the mean wall thickness (t) is calculated as $\sqrt{(A_1 \div \pi)} - b$. From an end-diastolic frame acquired from the apical 4-chamber view, the LV length is divided into a semi-major axis (a) and a truncated semi-major axis (d) **(D)**. The radius (b) or minor axis, derived from the parasternal short axis view, is used to divide the LV length into semi-major axis (measured from the radius b to the LV apex) and a truncated semi-major axis (measured from the radius b to the mitral annulus). From these measurements the LV mass can then be calculated via the truncated ellipse equation:
LVM (g) = $1.05\,\pi\,(b + t)^2\,[\,2/3\,(a + t) + d - d^3/3(a + t)^2\,] - b^2\,[\,2/3\,a + d - d^3/3a^2]$

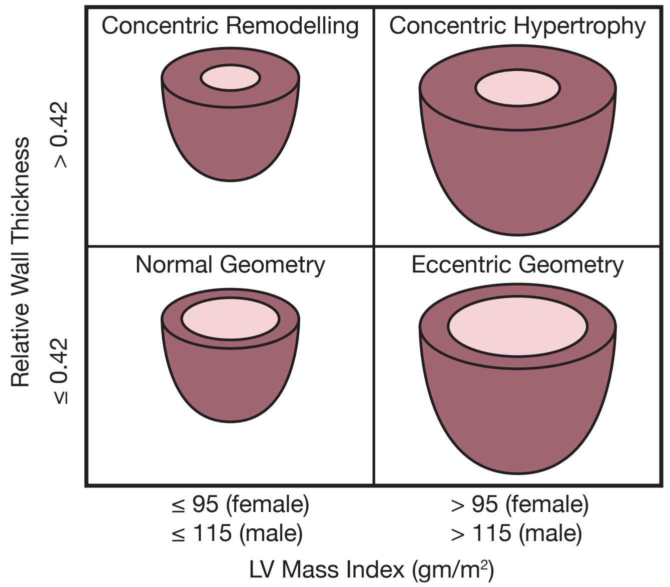

Figure 4.9 The patterns of LV geometry and LVH are based on the LV mass and the RWT. A normal RWT is defined as ≤0.42 and a normal LV mass is defined as ≤95 g/m² for females and ≤115 g/m² for males. An increased LV mass and an increased RWT is classified as concentric hypertrophy while an increased LV mass and a normal RWT is classified as eccentric hypertrophy. A normal LV mass and an increased RWT is classified as concentric remodelling while a normal LV mass and a normal RWT is classified as normal geometry.

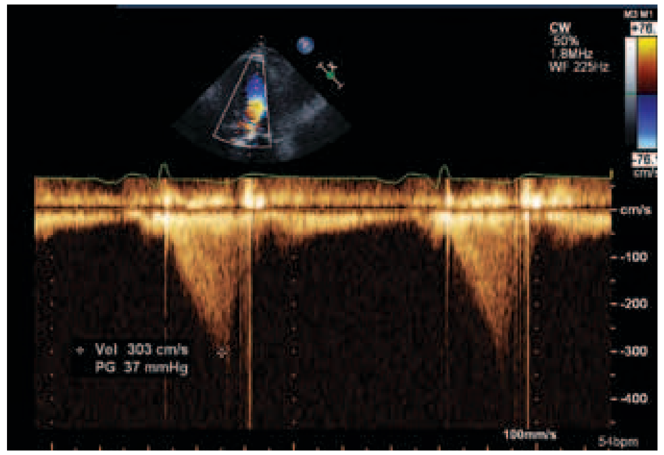

Figure 4.10 This CW Doppler profile was recorded in a patient with concentric LVH secondary to HTN. This profile is consistent with dynamic LVOT obstruction as evident by the characteristic systolic late-peaking and dagger-shaped profile of this signal. The peak velocity is 3 m/s yielding a gradient of 37 mm Hg.