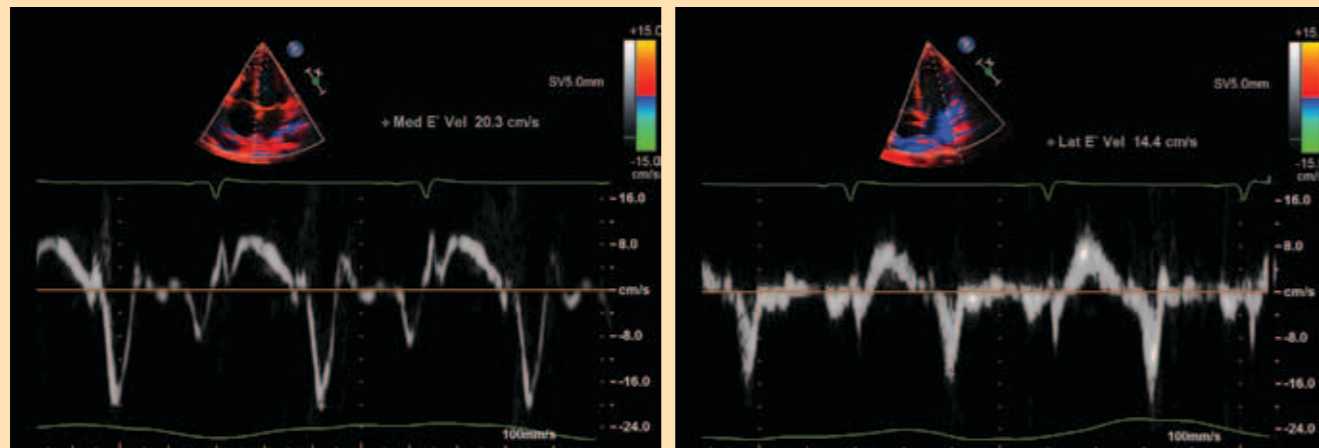


### Technical Tips for Mitral DTI

#### Sampling of Both the Septal and Lateral Annulus

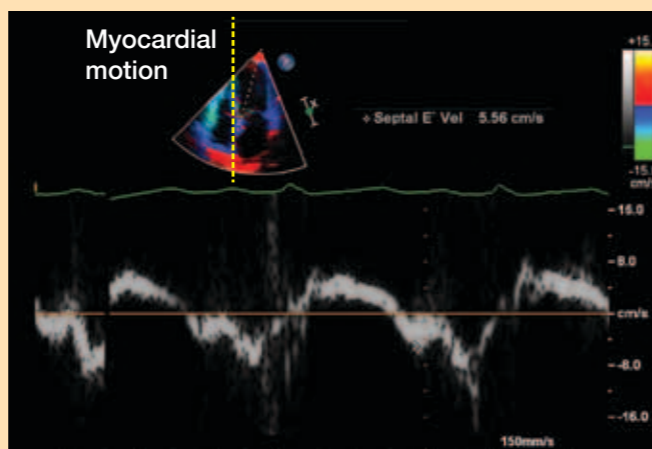
It is recommended that sampling of both the septal (medial) and lateral annular sites is performed in the routine examination as this is especially useful in aiding the diagnosis of constrictive pericarditis. As stated previously, in the normal individual, the lateral  $e'$  velocity is normally slightly higher than the septal (medial)  $e'$  velocity. In patients with constrictive pericarditis, the reverse occurs; that is, the septal  $e'$  velocity is higher than the lateral  $e'$  velocity (see the examples below; the septal DTI is shown to the left and the lateral DTI is shown to the right). This phenomenon is referred to as annulus reversus and is thought to occur due to tethering of the lateral annulus to the adjacent fibrotic and scarred pericardium.



#### Correct Alignment with Myocardial Motion

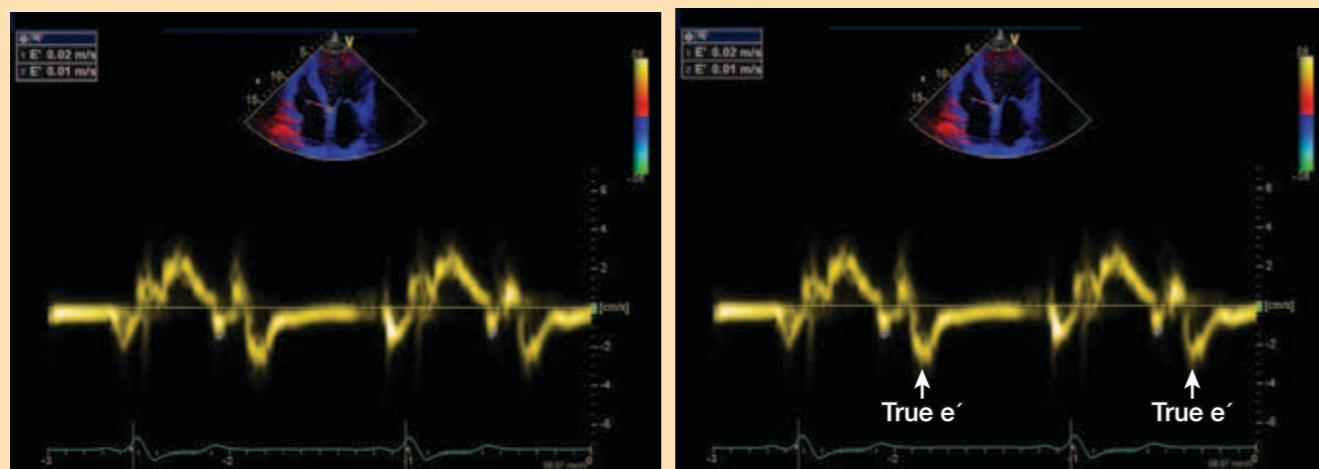
Parallel alignment with myocardial motion is important to ensure accurate velocities are measured. When there is a significant intercept angle between the ultrasound beam and longitudinal myocardial motion, velocities will be underestimated. In the adjacent example, it can be appreciated that there is a significant intercept angle between the Doppler cursor (white dotted line) and the myocardial motion (yellow dashed line); this will result in an underestimation of the DTI velocities.

While parallel alignment is not always feasible, as long as the incident angle between the ultrasound beam and blood flow is  $\leq 20^\circ$ , cosine is close to 1 and the percentage error is  $\leq 6\%$  (see Table 5.1 in Chapter 5) and this is considered acceptable.



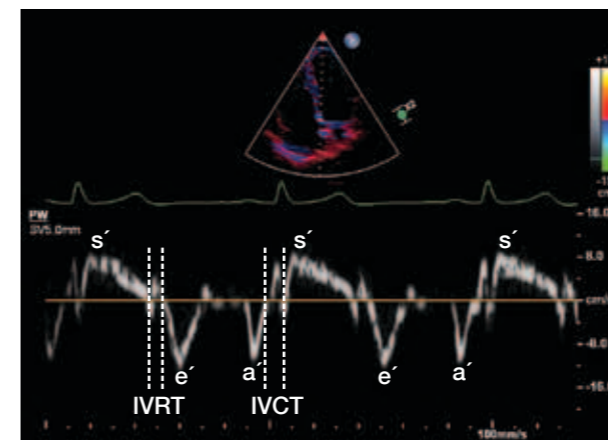
#### Correlate Timing of Measurements with the ECG

As stated previously, additional velocity spikes may be noted during isovolumic relaxation and isovolumic contraction. Measurement errors such as the measurement of an isovolumic relaxation spike for the  $e'$  velocity (below left) can be avoided by observing the timing of signals with respect to the ECG. The true  $e'$  velocity occurs after the T wave of the ECG (below right).

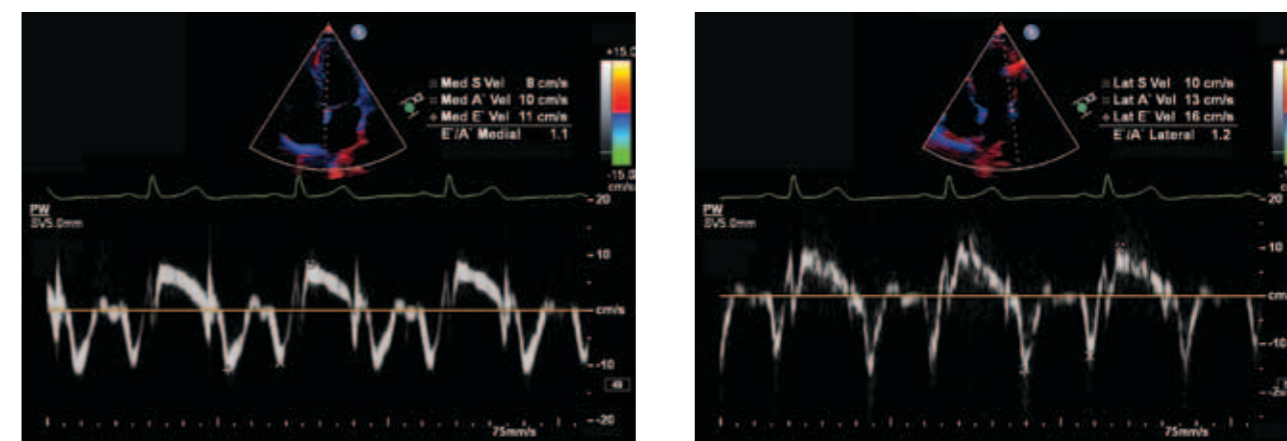


### Routine Measurements

The measurements that can be performed from the DTI trace include the peak  $e'$  velocity, the peak  $a'$  velocity, the  $e'/a'$  ratio, and the peak  $s'$  (Fig. 6.10). Most commonly, the  $e'$  velocities are routinely measured for the assessment of LV diastolic function (see Chapter 15). The IVRT may also be measured from the DTI signal; however, more commonly the IVRT is measured via spectral Doppler (see Fig. 6.7). Measurement of the  $s'$  may be considered for the assessment of LV systolic function; other time interval measurements can also be measured to calculate the myocardial performance index (MPI) (see Chapter 14).



**Figure 6.9** This Doppler tissue imaging trace shows a profile acquired at the septal (medial) mitral annulus. Observe that there is one prominent peak above the zero baseline and two prominent velocity peaks below the zero baseline. The peak above the baseline corresponds to the systolic myocardial velocity ( $s'$ ); this peak coincides with the T wave of the ECG. The peaks below the zero baseline correspond to the early diastolic myocardial velocity ( $e'$ ) and the atrial myocardial velocity ( $a'$ ). The  $e'$  velocity occurs after the T wave of the ECG while the  $a'$  velocity peaks just after the P wave of the ECG. Less prominent peaks are also noted between the  $a'$  and  $s'$  peaks and between the  $s'$  and  $e'$  peaks; the intervals between these less prominent peaks are the isovolumic contraction time (IVCT) and the isovolumic relaxation time (IVRT), respectively.



**Figure 6.10** Mitral annular Doppler tissue imaging measurements are performed from the septal (medial) annulus (left) and from the lateral annulus (right). Measurements performed include: the peak  $e'$  velocity, the peak  $a'$  velocity, +/- the  $s'$  velocity. The  $e'/a'$  ratio is derived as the peak  $e'$  velocity divided by the peak  $a'$  velocity. Observe that the velocities at the lateral annulus are slightly higher than the velocities at the septal (medial) annulus.

The normal values for the mitral annular DTI velocities vary according to the sampling site and patient age; in addition, the peak  $s'$  also varies with gender. In particular, peak  $e'$  at the lateral annulus is normally higher than the  $e'$  at the septal (medial) annulus, and the  $s'$  velocity is higher in men than in women. The normal values are listed in Table 6.3.

### Doppler Examination of Pulmonary Venous Flow

The pulmonary venous flow profile provides important information regarding the haemodynamic events that occur during the cardiac cycle. An understanding of how this flow pattern is produced will allow an easier interpretation of this signal.

#### Phases relating to Pulmonary Venous Flow

As with all venous flow, pulmonary venous flow is continuous throughout the cardiac cycle; that is, flow occurs throughout diastole and systole. Normal pulmonary venous flow is characterised by three distinct waveforms: (1) systolic forward flow, (2) diastolic forward flow, and (3) atrial flow reversal (Fig. 6.11).

#### Systolic Forward Flow

Systolic forward flow occurs as a result of LA relaxation and the descent of the mitral annulus toward the cardiac apex with ventricular systole; this flow corresponds to the x descent on the LA pressure curve.

Systolic forward flow is biphasic in approximately one third of normal individuals<sup>[6.1]</sup>. In the presence of a biphasic S signal, the first early peak (S1) is related to LA relaxation. LA relaxation lowers the LA pressure which increases pulmonary venous return into the LA. The second peak (S2) which occurs in mid to late systole occurs as the mitral annulus descends toward the cardiac apex with ventricular systole.

Pulmonary venous systolic forward flow is closely related to the LA pressure. On the Doppler spectral trace, systolic forward flow is seen to coincide with the T wave of the ECG.

[6.1] Klein AL, Burstow DJ, Tajik AJ, Zachariah PK, Bailey KR, Seward JB. Effects of age on left ventricular dimensions and filling dynamics in 117 normal persons. *Mayo Clin Proc.* 1994 Mar;69(3):212-24.