Perrino and Reeves'

PRACTICAL APPROACH TO

Transesophageal Echocardiography

Fifth Edition

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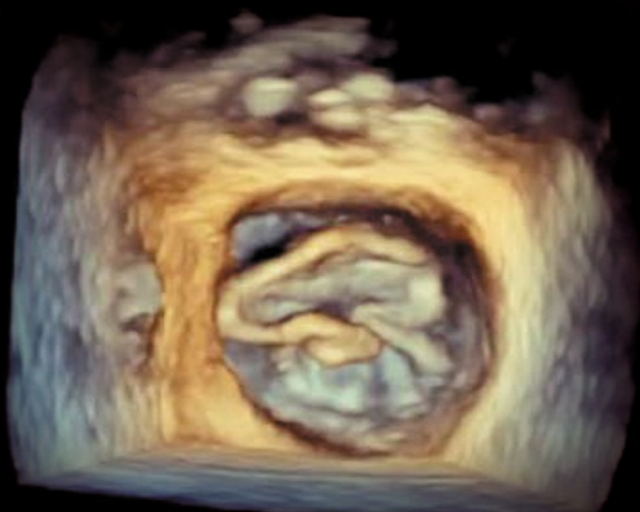

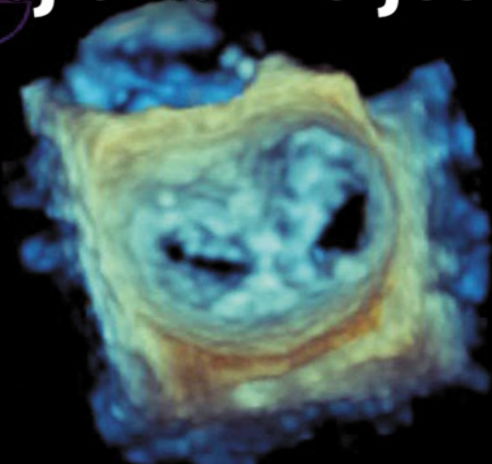

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APPENDICES

Lateral (Azimuth) Resolution

Lateral resolution is the ability of the ultrasound system to distinguish between objects that are horizontally aligned and perpendicular to the path of the ultrasound beam. Beam width is a primary determinant of lateral resolution. Wide beams produce a “smeared” image of two such objects, whereas narrow beams can identify each object individually. Signal frequency and transducer size impact lateral resolution, but for typical cardiac ultrasound transducers the beam width is approximated as depth/50, yielding at 10 cm of depth a beam width of approximately 2 mm.

Elevational Resolution

Elevational resolution is the ability of the ultrasound system to distinguish between objects that are vertically aligned and perpendicular to the emitted ultrasound beam. Although 2D images appear to display a thin slice of cardiac anatomy, in actuality the information gathered from the entire thickness of the beam is averaged and displayed. For this reason, the thinner the ultrasound beam, the better the elevational resolution of the system (see Figure 1.7). Signal frequency and transducer size impact elevational resolution, but a typical cardiac ultrasound transducer has a beam height approximated as depth/30. Accordingly, at 10-cm depth the beam height is approximately 3.3 mm. Note that axial resolution offers 50% greater fidelity than that achieved in the lateral and elevational planes.

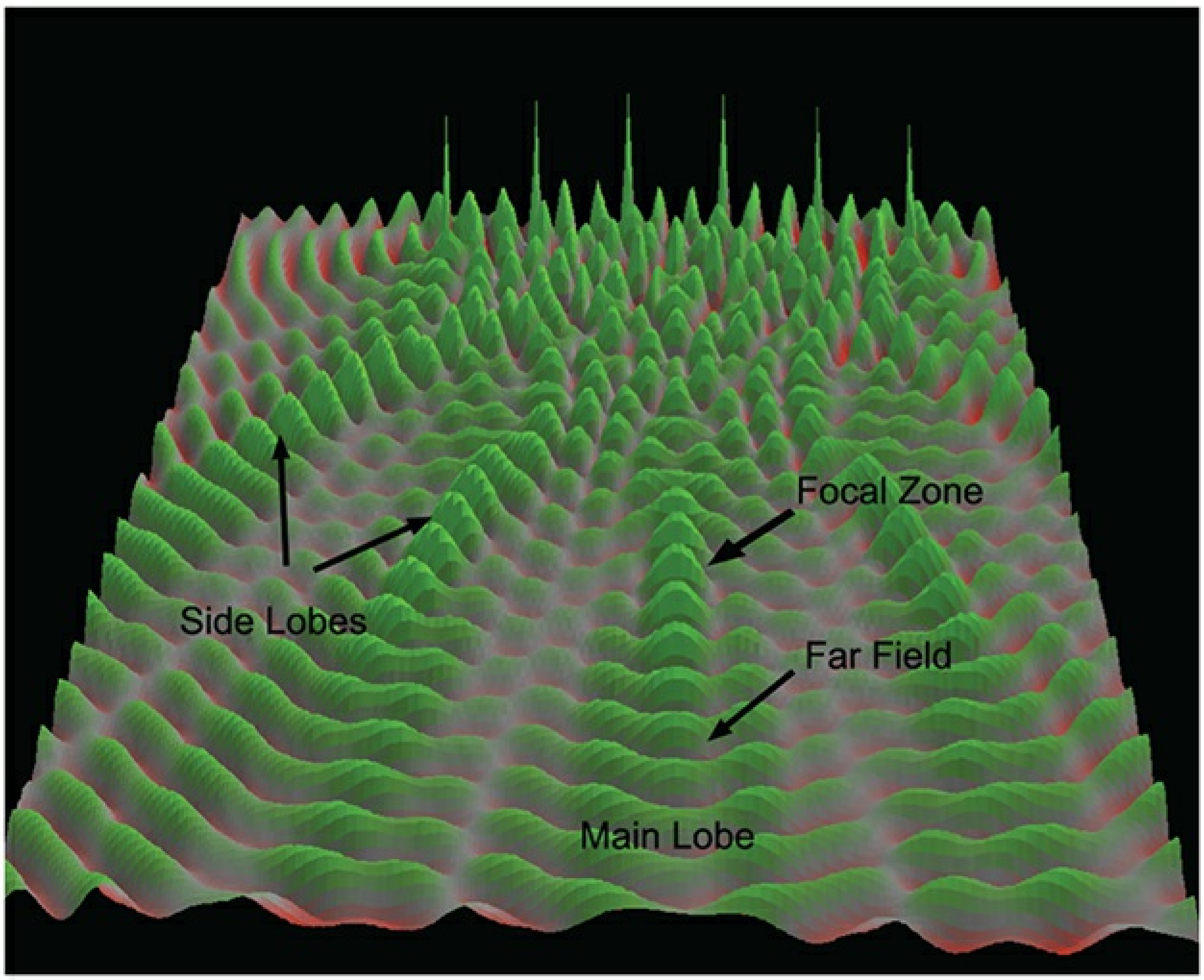
Optimizing Resolution

The interplay of the transducer size, signal frequency, and focal length and the distance of the structure of interest determine beam width and height. The beam is narrowest in the near-field or focal zone and divergent in the far field. Resolution is therefore better in the near field and decreases in the far field. Factors that lengthen the near field, such as a higher transducer frequency and a larger transducer radius, improve lateral and elevational resolution. Focusing further decreases the width of the ultrasound beam and improves lateral and elevational resolution at the focal point. However, focusing often increases beam divergence distal to the focal zone, with an associated loss of lateral and elevational resolution. These factors explain why it is preferable to position a transducer with a relatively high frequency (smaller wavelength) close to the target of interest to optimize both lateral and elevational resolution. More precise measurements are made along the axial plane due to the superior resolution in this orientation.

Extraneous Sound Beams

Side Lobes

Unfortunately, in addition to the powerful forwardly directed beam of sound energy produced by linear array transducers, additional beams of sound are emitted that travel off-axis to the main beam (Figure 1.9; Video 1.1). These extraneous beams of sound, called side lobes, can significantly affect imaging quality because the transducer incorrectly processes their reflections as reflections of the main beam. Consequently, structures off-axis to the imaging plane appear incorrectly located on the 2D image.



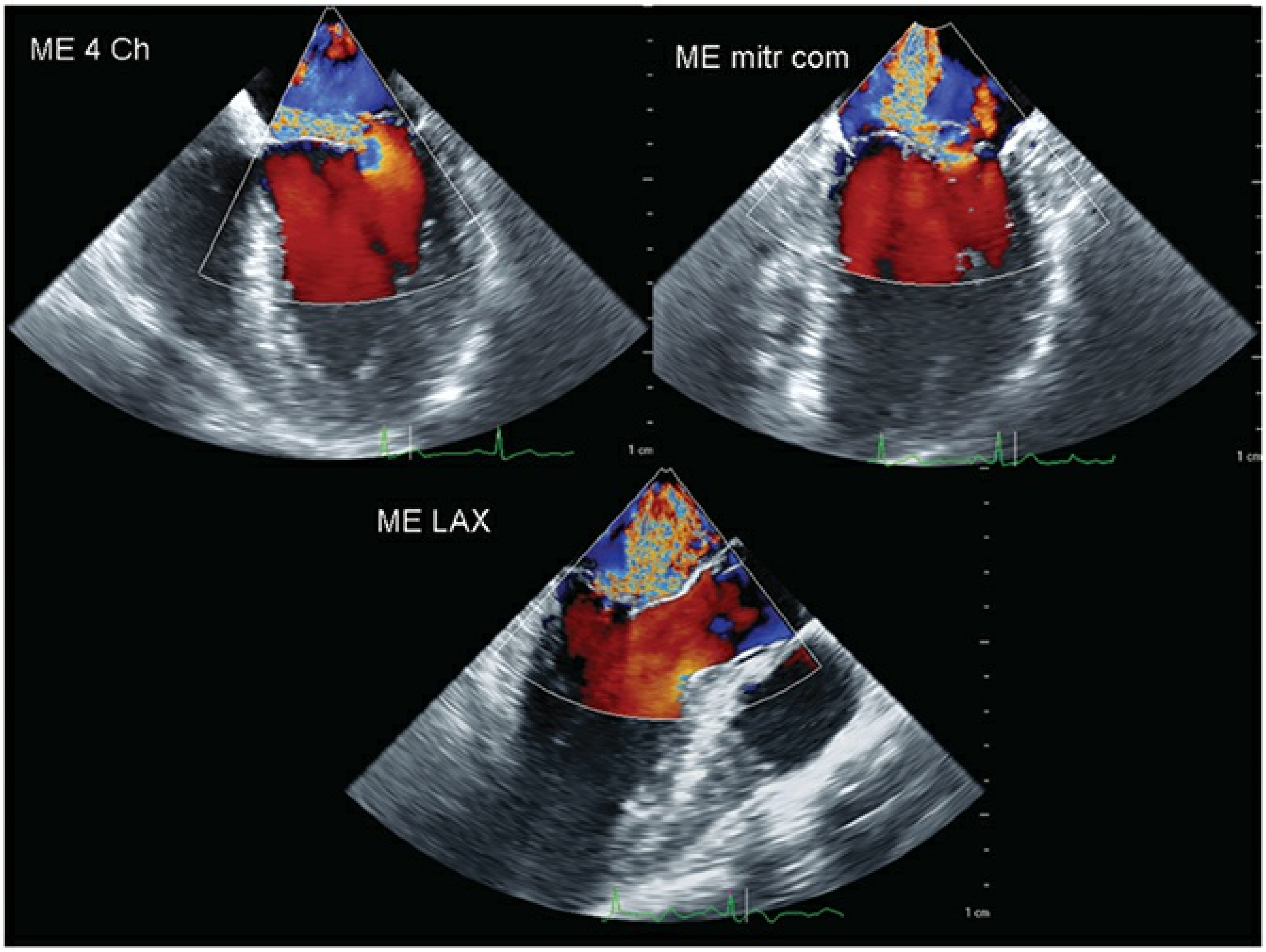


FIGURE 10.23 Color flow Doppler of type II regurgitation, caused by excessive leaflet motion, in this case prolapse affecting the P2 segment. The resulting jet is eccentric, and blood is directed over the corresponding, nonaffected (A2) leaflet. ME LAX, midesophageal long axis.

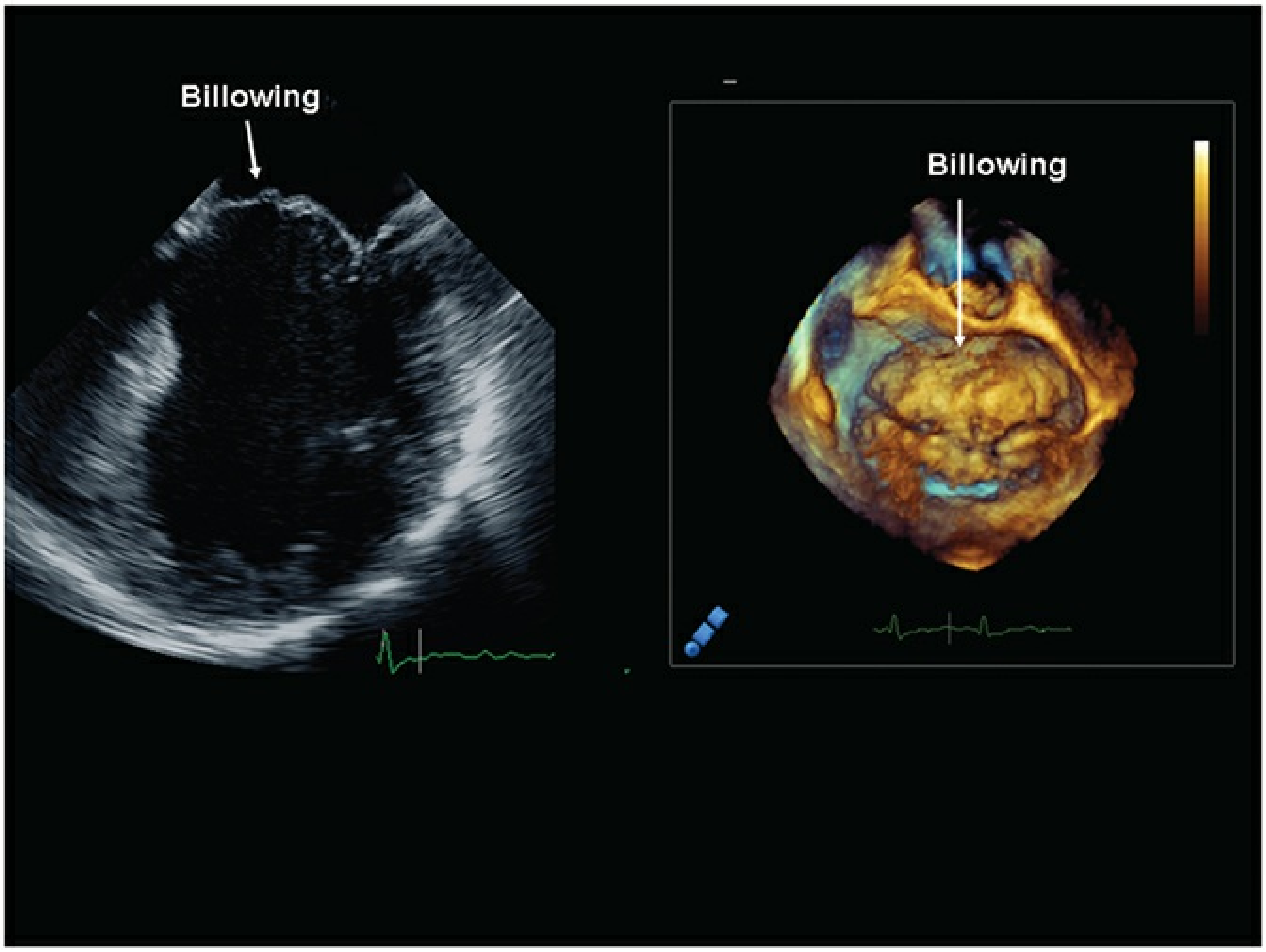


FIGURE 10.25 ME four-chamber view (left) and 3D en face view of the mitral valve from the left atrium (right) both showing extensive billowing of the anterior mitral leaflet. The body of the leaflet, but not its free edge, is pushed over the level of the mitral annulus.

2. Prolapse describes displacement of one or both leaflet edges above the plane of the mitral annulus where the free margin is directed to the left ventricle (Figure 10.26). It is often associated with chordal elongation but can also be associated with chordal rupture (Videos 10.8-10.13). The regurgitant jet seen with color flow Doppler is always directed over the noninvolved segments in patients with type II dysfunction (Videos 10.9-10.11).