DOPPLER
ECHO BOARD REVIEW

SELF-ASSESSMENT QUESTIONS

QUESTION 1

The best approach to improve resolution in the near field of a 2D ultrasound image is:

A. Increase gain
B. Decrease power output
C. Increase transducer frequency
D. Decrease dynamic range
E. Narrow the 2D sector

ANSWER 1: C

Resolution is improved with a higher transducer frequency; this effect is most pronounced in the near field because penetration decreases with a higher frequency transducer so distant structures are less well visualized. When the 2D sector is narrowed, scan line density is higher, which improves resolution. However, the wedge shape of the image field limits the value of this approach for near-field structures. Changing the gain, power output, and dynamic range will affect the appearance of the image in terms of brightness and contrast but will not improve image resolution, defined as the ability to separately identify two nearby structures on the ultrasound image.

QUESTION 2

The best approach to improve the resolution of a structure at a depth of 9 to 10 cm from the transducer is:

A. Increase gain
B. Decrease depth
C. Increase transducer frequency
D. Decrease dynamic range
E. Narrow the 2D sector

ANSWER 2: E

At this depth, the first approach to improving resolution is to narrow the 2D sector, which increases the scan line density. The zoom function of many instruments (which eliminates the near and far field as well as narrowing the sector) also may be helpful. The potential benefit of a higher frequency transducer is typically offset by decreased ultrasound tissue penetration at this depth. Decreasing the depth of the image does not substantially affect resolution and is only helpful when the structure of interest is still in the image plane. Gain and dynamic range affect the contrast and brightness of the image but do not affect resolution per se.

QUESTION 3

Choose the most appropriate Doppler modality (A, B, C) for clinical evaluation of each intracardiac flow signal (I through V).

I. Left ventricular diastolic inflow
II. Direction of mitral regurgitant jet
III. Aortic stenosis velocity
IV. Pulmonary vein flow velocity
V. Tricuspid regurgitation velocity

A. Pulsed Doppler
B. Continuous wave Doppler
C. Color Doppler flow imaging

ANSWER 3: I, A; II, C; III, B; IV, A; V, B

Normal intracardiac flows (LV inflow and pulmonary vein flow) that have a maximum velocity less than the typical Nyquist limit at that depth are best evaluated with pulsed Doppler ultrasound because this provides localization of the flow signal and a quantitative spectral velocity curve. High velocity flows, either antegrade across a stenotic valve (aortic stenosis) or retrograde across a regurgitant valve (tricuspid regurgitation), are best evaluated with CW Doppler. CW Doppler allows accurate measurement of high velocities without signal aliasing. However, the lack of range resolution means that the origin of the high velocity signal must be inferred from other imaging or Doppler data or from the characteristics of the flow signal itself. Identification of the presence of an intracardiac flow disturbance or characterization of the spatial distribution of flow, for example, the direction and shape of a mitral regurgitant jet, are best evaluated with color Doppler, which provides a "map" of flow superimposed on the 2D image, albeit with only limited velocity data.

QUESTION 4

Which one of the following would be the best initial approach for increasing the frame rate with color Doppler flow imaging?

A. Decrease depth
B. Widen color sector
C. Shift color baseline
D. Decrease color velocity scale
E. Use a smaller height color box

ANSWER 4: A

The depth of the color Doppler image determines the pulse repetition frequency, based on the time needed for ultrasound to reach and return from the maximum depth on the image. Thus a decrease in depths means a shorter time interval for generating the color image and a faster frame rate. A wider color sector results in a lower frame rate because of the time needed to generate Doppler data across the image plane. Shifting the color baseline or decreasing the color velocity scale have no effect on frame rate because the total velocity range (and pulse repetition frequency) are unchanged; these parameters simply change the colors assigned to each Doppler velocity value. Pulse repetition frequency and frame rate are determined by the maximum depth displayed on the image; reducing the height of the color box simply removes the color display from the near field–the pulse repetition frequency is unchanged.

QUESTION 5

For the Doppler flow shown in Figure 1–15, the most appropriate next step for measuring velocity accurately is:

A. Increase sample volume length
B. Decrease gain
C. Increase the velocity scale
D. Shift the baseline upward
E. Correct for intercept angle

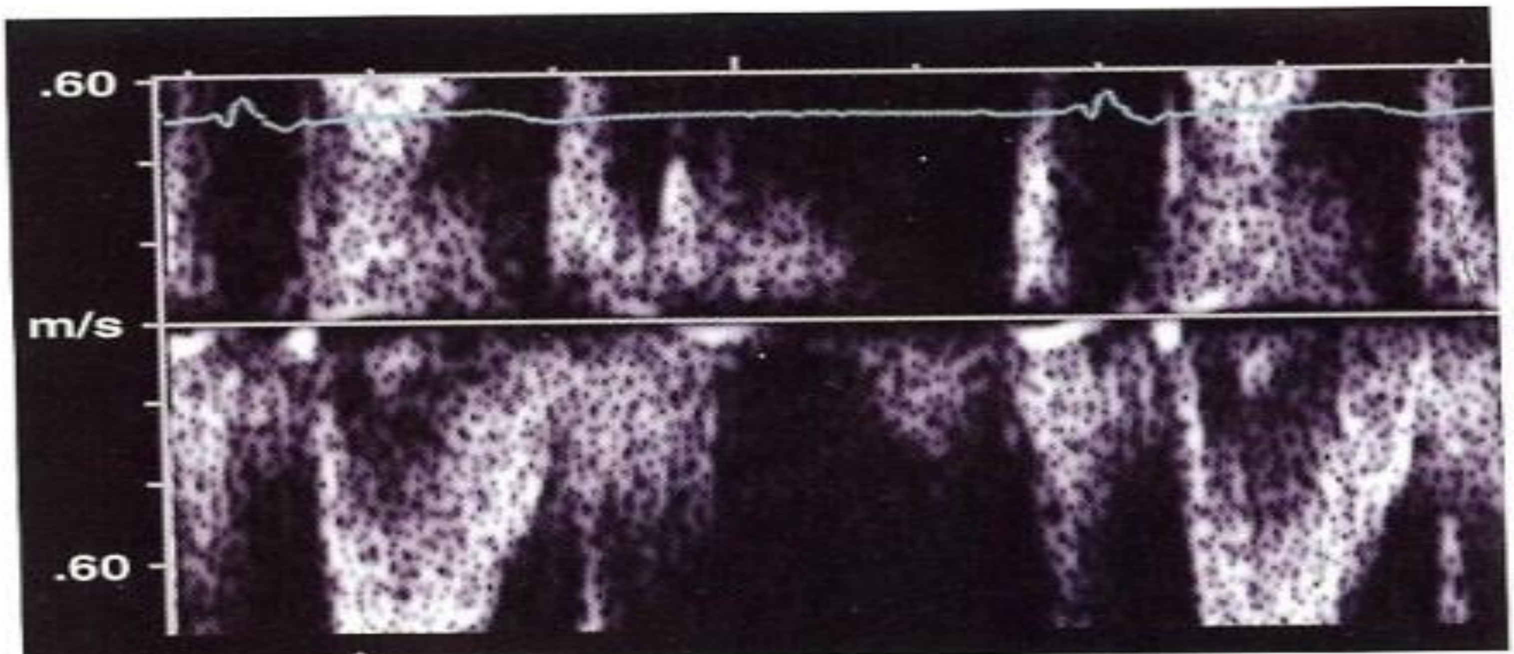

Figure 1–15

ANSWER 5: D

This figure shows signal aliasing with the higher velocities displayed in the opposite channel. Because the top of the velocity curve can be seen "wrapping around" the spectral display, the simplest approach to resolving this velocity is to shift the baseline until the entire velocity curve is intact, directed away from the transducer. Higher velocity flows with severe signal aliasing and no discernible peak velocity would require CW Doppler for accurate velocity measurement. Increasing sample volume length would increase signal strength, and decreasing gain would reduce signal strength, but neither would resolve the aliased signal. The velocity scale cannot be increased past the Nyquist limit with pulsed Doppler and so is not applicable in this case. For cardiac applications, "correction" for intercept angle is not recommended because the exact 3D angle between the ultrasound beam and direction of flow cannot be accurately determined. In any case, a nonparallel intercept angle results in underestimation (not overestimation) of blood flow velocity.

QUESTION 6

For the Doppler tracing in Figure 1–16, match the numbered signals with the answers below:

A. Left ventricular diastolic filling
B. Aortic regurgitation
C. Aortic antegrade flow
D. Subaortic left ventricular outflow velocity
E. Doppler artifact

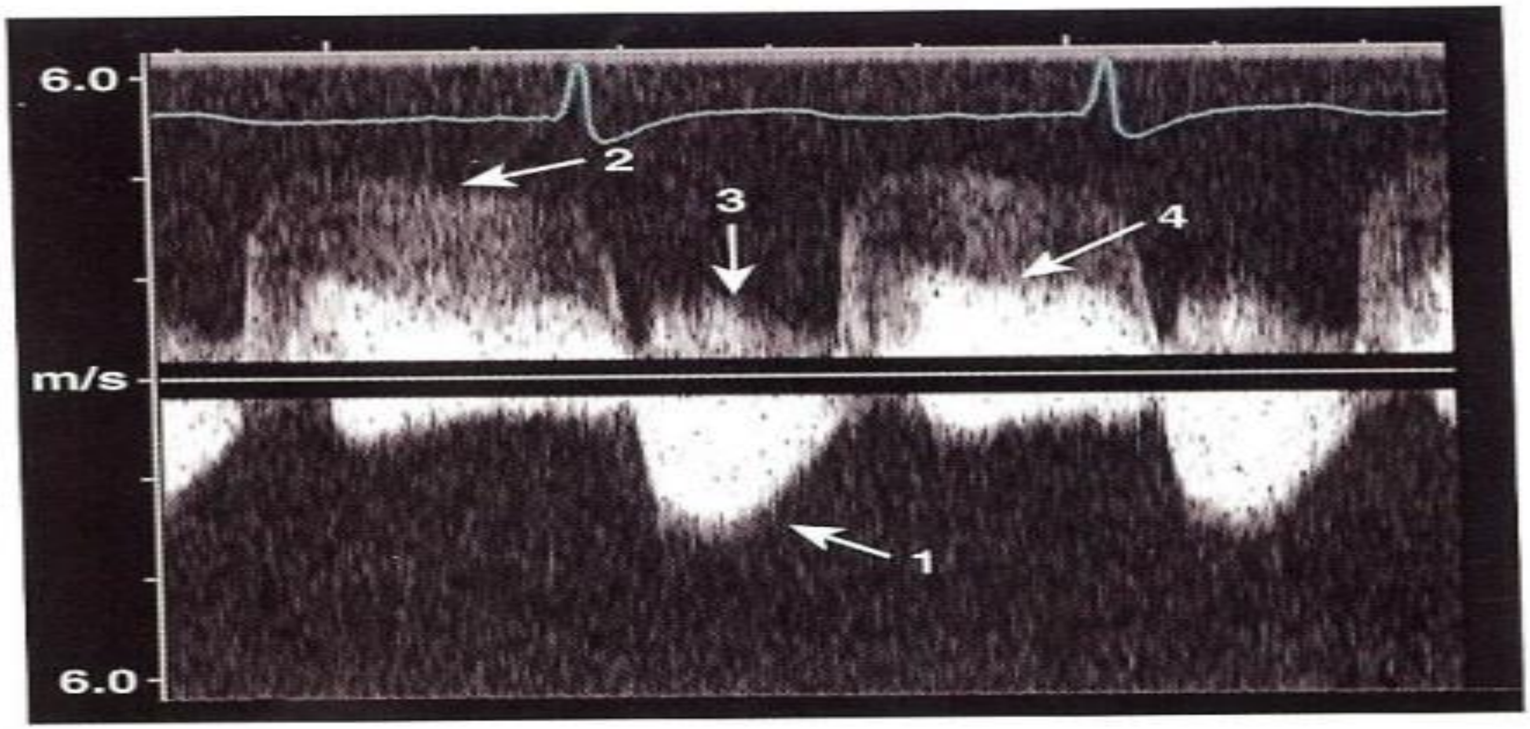

Figure 1–16

ANSWER 6: 1, C; 2, B; 3, E; 4, A

This is a CW Doppler spectral recording of antegrade and retrograde flow across the aortic valve recorded with a dedicated CW transducer from the apical window. In systole (after the QRS on the electrocardiogram) the smooth rounded curve of mild aortic stenosis with a maximum velocity of about 3 m/s is seen. In diastole, there is a faint signal of aortic regurgitation with the typical high velocity reflecting the aortic to left ventricular diastolic pressure difference, which declines slightly over the diastolic period. An irregular signal in systole is seen in the channel opposite the aortic jet signal, most consistent with a Doppler recording artifact called channel "cross-talk." The CW Doppler beam is broad at the level of the aortic valve, so the left ventricular inflow signal across the mitral valve, with the typical two-peaked early and late diastolic filling velocity curve, is seen superimposed on the aortic regurgitant signal.