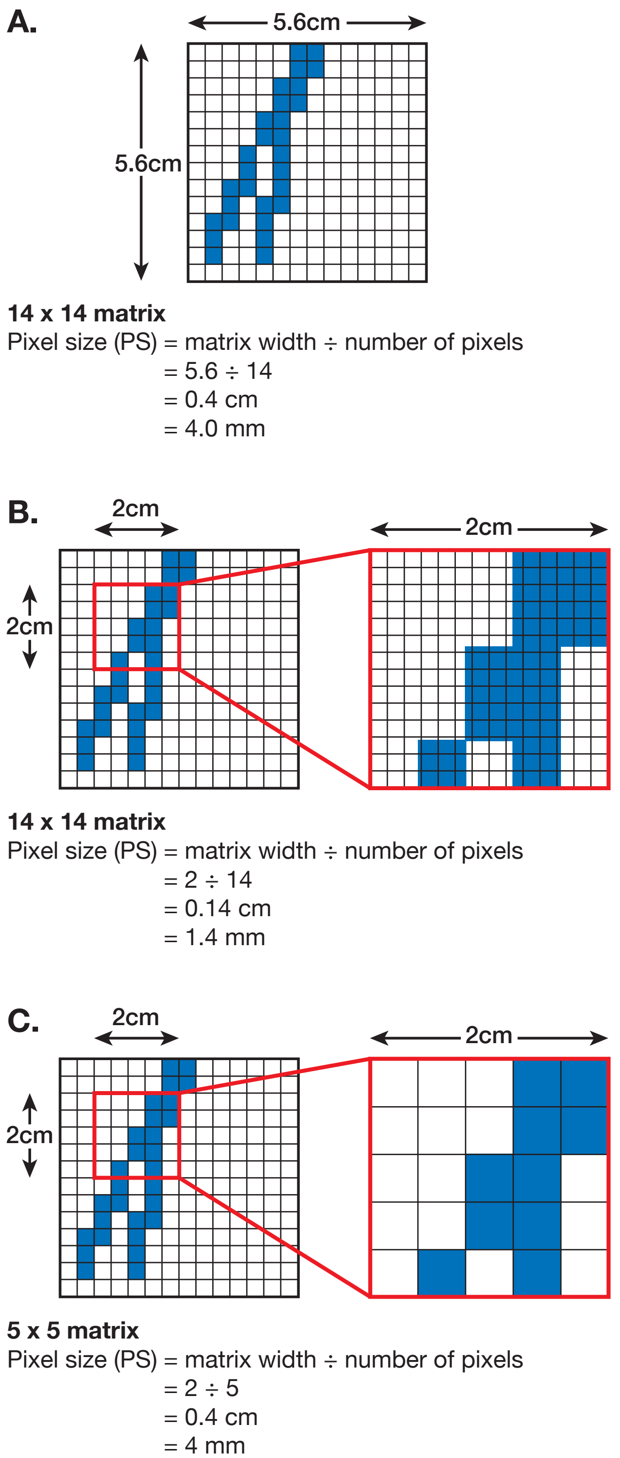

Figure 1.19 These schematics illustrate the concept of write-zoom and read-zoom. **A:** If there is a square matrix consisting of 14 x 14 pixels and the matrix width represents 5.6 cm x 5.6 cm of tissue then each pixel (square) represents 4 x 4 mm. **B:** With write-zoom a 2 cm square zoom box is selected before data storage so the entire 14 x 14 matrix is used to display just 2 x 2 cm of tissue. So now each pixel is 1.4 x 1.4 mm; this results in improved spatial resolution. **C:** With read-zoom a 2 cm square zoom box is selected but in this case, the 2 x 2 cm of tissue is a section of the already stored 14 x 14 matrix. As each pixel in the 14 x 14 matrix is 4 x 4 mm in the 2 x 2 cm zoomed section the actual matrix is now 5 x 5. So while each pixel appears larger on the display, each pixel is still only 4 x 4 mm; therefore, the resolution of each pixel is unchanged and there is no improvement in the spatial resolution.

In particular, increasing the dynamic range increases the range of echo intensities displayed so that weaker signals are included and the image is softened; therefore, the dynamic range can be increased when there are good quality images. Conversely, decreasing the dynamic range results in the production of high contrast images such that weaker signals are eliminated, noise is reduced, and the strongest echo signals are enhanced; therefore, the dynamic range may be decreased when image quality is poor.

Edge Enhancement

Edge enhancement, also known as Sharpness or Enhance, is a filtering technique that attempts to sharpen the image by identifying and enhancing the interfaces or boundaries between structures. As a result sharpening of the edges or borders of structures leads to "crisper" images.

B-Colour

Brightness colour (B-colour) may improve the contrast resolution by enhancing subtle soft tissue differences. This is achieved by using a colour scale rather than a greyscale display (Fig. 1.20). Essentially, B-colour images are created by converting greyscale information into various levels of colour intensity. The theory behind this concept is based on the premise that the human eye can only appreciate a limited number of grey shades but is able to distinguish a greater number of different colour hues. Hence, "changing the colour" or "tint" of the image may allow an enhanced appreciation of soft tissue structures and boundaries and, therefore, improve the contrast resolution. Importantly, B-colour does not change the ultrasound information displayed but may improve the perception of that information.

Reject

The reject control is effectively a filter which sets the minimum echo level which will be displayed. As a result, only echo amplitudes greater than the set level will appear in the display while signals below this threshold are suppressed. As a result, the reject control enables the removal of electronic and acoustic noise from the display and potentially improves the spatial and contrast resolution. Importantly however, reject settings may also result in the removal of low amplitude tissue echoes so this control should be used with caution. The reject control is also referred to as Threshold or Suppression.

Post-processing Curves

Post-processing curves define the relationship between actual echo amplitude and the displayed pixel intensity; therefore, by adjusting these curves the greyscale display of echo signals can be altered. The post-processing curve can be adjusted to smooth the greyscale images by adding more grey shades and, therefore, reduces greyscale contrast. Likewise, the post-processing curve can be adjusted to increase the contrast of greyscale images by removing grey shades, which in effect increases greyscale contrast. The primary aim of adjusting the post-processing curves is to manipulate the greyscale display of echo data which can improve the presentation and the perception of small echo strength differences, therefore, improving contrast resolution.

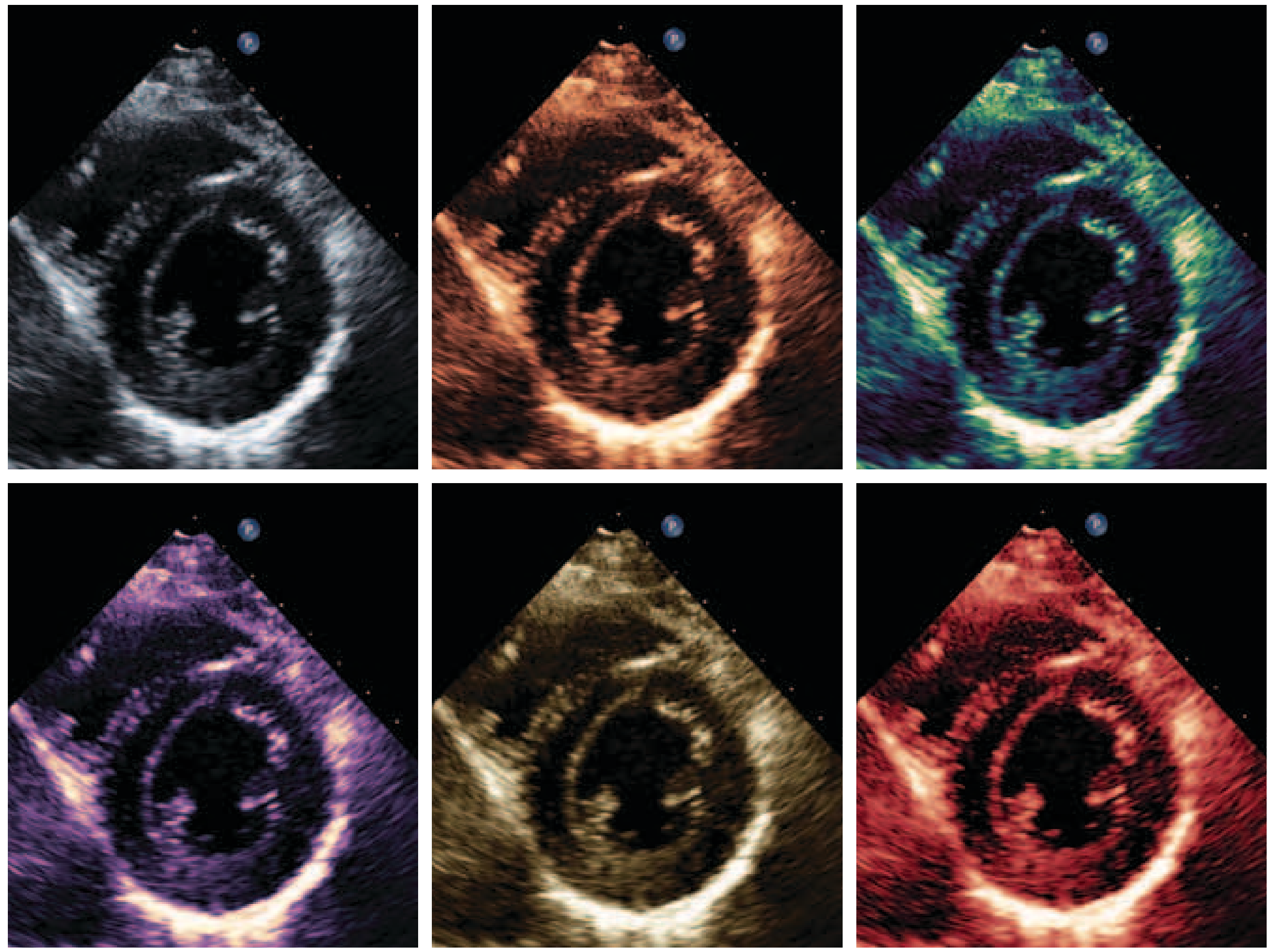

Figure 1.20 This series of images acquired from the parasternal short axis view at the level of the papillary muscles displays a greyscale map (*top left*) and various B-colour maps.

2D Imaging Artefacts

Imaging artefacts may be defined as false or misleading information introduced by the ultrasound machine. Imaging artefacts can be categorised based on the interaction between the ultrasound beam and tissue, faulty or damaged instrumentation or sonographer related variables such as the improper use of the equipment and its controls. This section covers some of the commonly encountered imaging artefacts which occur when the basic assumptions relating to the ultrasound beam and its interaction with tissue are violated; these artefacts are summarised in Table 1.8.

While there are many assumptions that ultrasound machines use to produce 2D images, the five key assumptions of ultrasound machines are: (1) "there is a constant rate of attenuation of 1 dB/cm/MHz", (2) "all echoes arise from the centre of a razor-thin beam", (3) "the propagation speed in soft tissue is 1540 m/s", (4) "the round trip time, of a given echo, is directly related to the depth of the reflector from the transducer" and (5) "the ultrasound beam travels in a straight line and reflects just once". Therefore, 2D imaging artefacts can be categorised based on the violation of these assumptions; these four major categories include attenuation artefacts, beam dimension artefacts, depth of origin artefacts and beam path artefacts.

Attenuation Artefacts

The ultrasound machine assumes that there is a constant rate of attenuation of 1 dB/cm/MHz. However, if the expected rate of attenuation of the ultrasound beam does not occur through a particular structure or tissue, distal structures will display a different brightness compared with the surrounding tissue of similar acoustic properties. Therefore, attenuation artefacts affect the image by displaying echoes too bright or too dark or by omitting genuine echoes altogether. Common attenuation artefacts include acoustic enhancement and acoustic shadowing.

Acoustic Enhancement

Acoustic enhancement occurs when the ultrasound beam passes through a structure that has a low level of attenuation relative to that through adjacent structures. As a result, the structures beyond a low attenuating structure will appear brighter than adjacent structures of similar acoustic properties. Acoustic enhancement is commonly seen beyond fluid-filled structures because these structures tend to attenuate sound to a much lesser degree than solid structures (Fig. 1.21).

This type of artefact may be useful to assist in clinical diagnosis. For example, the presence of acoustic enhancement is helpful in differentiating between fluid-filled and solid lesions. The disadvantage of acoustic enhancement is that the increased brightness beyond these low attenuating structures may saturate the display and distal information may be obliterated.