Ultrasound Image Optimisation

Modern ultrasound machines come with a wide range of functions. Whilst the layout of the controls may differ among makes and models, this guide shows the most important controls and is not specific to one machine type. Each of the controls detailed should be easily identifiable on every ultrasound machine.

1 Presets

Ultrasound machines allow for the storage and selection of customisable presets prior to or during an examination. These are often found under a "transducer", "exam" or "patient" setting. The presets available may change depending on the ultrasound transducer selected or attached at that time.
Choosing a preset based on the patient and/or anatomy being examined selects predefined parameters and gives a good starting point for the average patient. The image will still need to be optimised for the individual using the other settings!

2 Depth

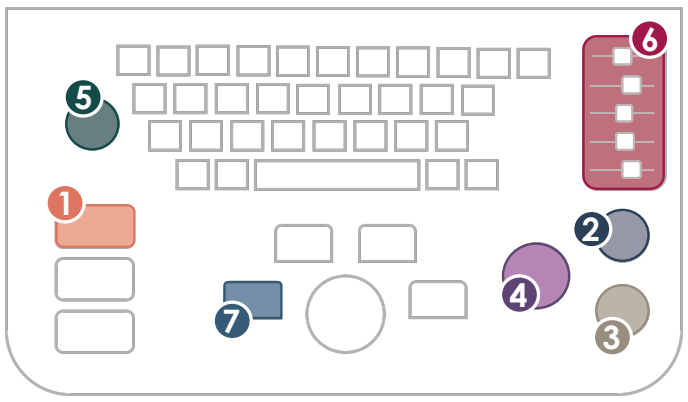
The depth control adjusts the depth of image displayed on the screen. As it is altered, the depth scale seen on the screen will change, showing the centimetres of depth shown on the screen.
We should try to **set the depth so that the region of interest occupies ~75% of the screen.** Having the region you want to assess occupy a small proportion of the screen makes analysis and measurement more difficult!

3 Frequency

This control alters the frequency of the ultrasound pulses emitted by the transducer. Increased frequency improves the axial resolution of the image. However, higher frequency ultrasound waves attenuate over a shorter distance and do not travel as deep as lower frequency pulses.
We should always try to **use the highest frequency possible, that gives us the depth of penetration needed to visualise the region of interest.**

4 Gain

The overall gain control changes the amplification of all returning echoes received. Altering the gain alters the overall image brightness.
How the gain is set will vary based on what we are imaging at the time, the environment (a bright room will require a higher gain) and personal preference.
However, **too low a gain setting will result in a dark image and detail will be lost. Too high a gain setting will result in an overly bright image, with amplified 'noise' causing high gain artefact.**



5 Focus/Focal Zone

This control changes the position of the focal zone(s) - the area of the image with the highest lateral resolution. The focal zone is indicated by a marker on the depth scale shown on the screen - often a triangle or an hourglass shape. By altering the focus position, we can move the focal zone closer or further away from the transducer.
The focal zone should be positioned level with the region of interest, or for larger organs, positioned at the deep margin of the organ being assessed. This is because lateral resolution worsens deep to the focal zone.
Some ultrasound machines can utilise multiple focal zones at once. While this improves resolution over a wider depth range, it also decreases the frame rate and can make the image 'sluggish'.

6 Time Gain Compensation (TGC)

The TGC controls are usually a series of sliders. Each slider represents a section of the image displayed on the ultrasound machine and altering them changes the gain of the corresponding area of the imaging field.
Adjustment of the TGC controls is important to achieve a balanced brightness from the near field to the far field and to compensate for the greater attenuation of signals returning from deeper tissue.

7 Harmonic Imaging

Modern ultrasound machines can detect and utilise harmonic frequencies produced by the primary ultrasound pulse as it travels through tissue. This feature is sometimes automatically applied in certain scanning modes or enabled via a button.
Images generated using harmonics are higher resolution and contain less artefact and scatter. However, in practice the effect of harmonic modes is variable. For some patients and structures, it can be beneficial however in others, the mode may reduce image quality.
Be aware of the harmonic setting and assess image quality with the feature enabled/ disabled.

Remember to save images of every structure in at least two orthogonal planes, label the location, and save measurements. Saving video clips as well as static images can be very useful if seeking a second opinion.

Starting the examination

1. Input patient/examination data
2. Attach/select the most appropriate transducer
3. Choose a preset
4. Perform your examination, using a routine which is thorough and repeatable

For each structure/region evaluated during the examination

1. Set the **depth** so that the region of interest occupies as close to 75% of the screen as possible
2. Adjust the **frequency** to the highest setting that gives the depth of penetration required to view the region of interest
3. Set the **focal zone** so it is level with, or at the deep margin of the region/ structure of interest
4. Adjust the **gain** and/or **TGC** to achieve an appropriate and even brightness throughout the image

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