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Obstetrics and Gynaecological Ultrasound for Beginners



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Chapter

2

Know Your Machine

Aniruddh Badade, Alia K Zaidi

INTRODUCTION

Though all models of ultrasound machines look different, there is a basic commonality to all of them. An ultrasound beam is generated by the probe, the ultrasound waves reflected from the insonated tissue are received by the transducer, and this signal is processed by the processing unit and displayed as an image upon the screen.

The basic physics is the same for all machines and therefore the controls on the ultrasound machine have an underlying commonality.

Human beings can listen to frequencies of 20–20,000 Hz. Ultrasound is a sound frequency of over 20,000 Hz. For the purpose of diagnostic ultrasound, we use frequency usually of 1–17 MHz.

Ultrasound waves are produced by the piezoelectric effect. Piezoelectric materials change their size and shape in response to a potential difference applied across them and this property permits a production of ultrasound waves. The ultrasound waves reflected from the tissues are called as echoes and are picked up by the transducer. These echoes are represented in the ultrasound image as dots. A strong echo is represented as a bright white dot and a weak echo is represented by grayer dot. A black dot represents no returning echo. The echoes from superficial objects come back to the machine earlier and those from a deeper object are received by the machine later.

The ultrasound image is therefore made up of many dots of different grayness and at different distance from the transducer surface.

Transducers differ in their shape and frequency. Higher frequency transducer gives better resolution but limited tissue depth penetration. Low frequency transducer gives better tissue penetration but their resolution is less than the high frequency transducer.

It is imperative to appreciate that a better image quality gives better diagnostic yield and a greater diagnostic yield and a higher degree of diagnostic confidence to the operator. Needless to say, image optimization is of paramount importance while doing ultrasound. Image optimization means getting an optimum image and this is possible by the use of various knobs and buttons provided on the machine by the manufacturer. The knobology

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refers to understanding of the various knobs on the machine, the underlying theme being obtaining an optimum image.

The knobs on different machines vary but the basic physics does not. Location of knobs will vary based on design of the machine so do not worry if you do not find the required knobs easily.

We should inspect the console and controls of the machine to familiarize ourselves before starting scanning. An integral part of ultrasound is learning the knobology and probe handling **(Fig. 2.1)**.

The probes in common use today are the convex array transducer usually of 1–6 MHz, the transvaginal convex array transducer of 3–10 MHz and the linear array transducer of 1–15 MHz.

The important knobs of the machine are power, gain, time gain compensation (TGC), depth, zoom/magnification, freeze, calculations, acquire, print, dynamic range, and other controls.

To get started put on the "power" button.

Enter patient data usually by pressing a button labeled as "patient". Patient data includes name and clinical details such as last menstrual period (LMP).

Select the correct preset by pressing a button usually labeled as "preset". The transducer may be changed by a button using labeled as "transducer" or "probe".

In order to optimize the image first adjust the "depth", next adjust the "focus".

If necessary, next use "gain" and/or TGC.



Fig. 2.1: Recent ultrasound equipment.

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The image may be zoomed using the "zoom" function. If necessary, dynamic range may be adjusted, though this will be required far less frequently.

PARTS OF THE MACHINE (FIG. 2.2)

Knobs and Buttons

- *ON/OFF button*: It is located near the alphanumeric keyboard on the front of the machine or on the left side of the panel.
- *Mode buttons*: The machine can be operated on different modes like the B-mode,[1] the M-mode and Doppler mode.

Doppler modes are color Doppler, spectral/pulse Doppler and power/energy/amplitude Doppler. There are different buttons on the machines which allow us to select the desired mode. And so we have an M-mode button, a B-mode or 2D button, a color Doppler button, a pulse wave Doppler button and a power Doppler button.

In modern machines, pressing the mode button causes selection of that mode and rotating the mode button allows gain control for that particular mode. For example, rotating the 2D button alters the overall gain; rotating the color Doppler button alters the color gain; rotating the pulse wave Doppler button alters the brightness of the spectral waveform; rotating the power Doppler button alters the color of the power Doppler image.



Fig. 2.2: A close-up view of different buttons of the machine.

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The use of color Doppler and pulse Doppler together is called as duplex Doppler probe setting button.

- *Depth*: The area of interest (e.g., embryo) should fill most of the screen to see adequate detail. If the depth is too much, our object will look like a small object near the surface of the probe. If the depth is too less, it will not be possible to image the object in the perspective of other tissues. Depth should be such that the area of interest occupies the center screen and a small area should be left behind to observe artifacts such as shadowing and enhancement.
- *Focus*: The focal zone gives the best lateral resolution. The focus can be shifted up and down and should be placed at the level at the point of interest. Most machines these days have a button which can give multiple focal zones. Increase in number of focal zones causes reduction of the frame rate. The focus is an important button and it can make a dramatic difference in the resolution and clarity of the image; however, it is a button which is often not used by the beginners. It is important to emphasize the use of this button.
- *Zoom button*: This button is used to magnify the point of interest whereas the right zoom improves image quality and the read zoom contributes only to magnification and leads to pixelization of the image. Zoom can be used for example to magnify a tiny gestational sac or a tiny fetal pole during a first trimester examination.
- *Dynamic range*: Dynamic range is a kind of contrast and is often difficult for the beginner to understand, appreciate, and use judiciously. It decides how white is white and how black is black. A high dynamic range leads an image with low contrast because a high number of shades of gray are depicted in the image. A low dynamic range leads to an image with high contrast because a low number of shades of gray are depicted in the image. A high dynamic range for example is used in studying the fetal heart.
- *Gain*: The gain button is a kind of a "volume control" which alters the brightness of the entire image more or less uniformly. It allows an overall amplification of the returning ultrasound signal received from all depths. Too high a gain can obscure details by giving excessive whiteness to the image. A gain which is too low obscures details by giving excessive blackness to the entire image. Therefore, the gain must be just right, not too high and not too low. Wrong gain adjustment may affect image interpretation. For instance, too high a gain may create echoes in an anechoic structure and too low a gain may cause echoes from the area of interest to disappear. This can make anechoic fluid to appear echogenic and vice versa.
- *Time gain compensation*: The TGC is used to correct gains at different depths in the image. So it allows us to adjust gains selectively in the near field or in the mid field or in the far field. The TGC is not often needed but may be at times required, usually to increase the brightness of echoes coming from deeper objects. Usually the transition of the TGC knobs should be gradual.

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- *"Acquire" function*: Images can be acquired using this button. It is possible to acquire both still images and video clips. To acquire a still image, we need to freeze the image first and then press the acquire button. The duration of video clips to be acquired can be adjusted by using "soft keys".
- *Freeze button*: To freeze an image for measurement.
- *"Frequency" button*: This button may be called by different names by different manufacturers. It essentially allows us to choose a higher or lower portion of the frequency of the probe—if the object is superficial, operating at the higher end of the spectrum of the frequency of the probe may give a better image; if the object is placed deep, operating at the lower end of the frequency spectrum of the probe may give a better image.
- *Print button*: To print a hard copy of the image.
- *Electronic calipers:* Used for measurements.
- *Trackball*: The trackball which usually occupies the center place in the console is a vital and versatile kind of a "mouse" which allows placement of cursors for measurements, moving the cursor across the screen, adjustment of points to take ellipsoidal measurements, adjust the size of the color box, adjust the sector width, etc. Around the trackball are placed different important keys such as "set" which vary between models and manufacturers.

GETTING STARTED

Prerequisites of performing a scan:

- *Information regarding the patient*: Name, hospital no., gestation/LMP, etc.
- *The reason for the scan*: Viability, booking, fetal growth, placental localization, etc.

MANEUVERING THE MACHINE

- Select "new patient"—this clears the previous patient's data and measurements.
- Select transducer type—transvaginal/transabdominal.
- Select examination type—first trimester, second/third trimester or gynecology.
- Localize image with the transducer using correct orientation **(Fig. 2.2)**. *Orientation*: The transducer marker enables consistent and correct orientation of the probe. The marker located on one side of transducer corresponds to an orientation marker on the screen. Always keep anatomy in mind.
- Optimize the image by the following functions:
  - *Adjust the depth*—the image should occupy two-thirds of the screen
  - *Adjust the focus*—have a maximum of two focus points positioned around the middle of the image.

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Measuring a Length

- Select caliper (measurement on most machines)
- Move the caliper marker with the trackball to correct position and press set.
- Move the other end of the caliper to the other end of the structure you are measuring and press set.
- Select option "Store image"

Manufacturers also install set calculations for various structure measurements, for example, crown-rump length or abdominal circumference, which can be accessed using the "calc" button.

The process is the same as using caliper measurements, although most machines use an ellipse to measure round structures.

Measuring an Ellipse

- Set caliper to one side of structure.
- Set other caliper to opposite side of structure.
- Use trackball to widen or narrow the ellipse.

ANTICIPATING DIFFICULTIES

Empty Bladder

- If transabdominal scan is essential, then allow more time for bladder filling and rescan after 30 minutes.
- In other cases, transvaginal scan may be done.

Obesity

- Ensure that the bladder is full and use as a window to allow increased resolution.
- A low-frequency probe may be used. This may decrease resolution but will increase penetration.
- Use a narrower beam on the area of interest which increases resolution.
- Optimize other settings such as focus.
- Where appropriate, use of transvaginal scan may be advantageous due to use of a high-frequency probe, thereby increasing the resolution on the area of interest.

Fibroids

A transabdominal scan may provide a good overview and allow you to visualize the anatomy prior to doing a transvaginal scan.

Ovaries

- Small ovaries in postmenopausal or patients with low ovarian reserve may be difficult to visualize even on transvaginal ultrasound.

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- It may be helpful to elevate the patients hip with a pillow in order to improve mobility of the probe.
- Also you may bring the ovaries medially towards your probe by asking the patient to lightly press a hand on the abdomen which will improve your visualization by bringing the ovaries closer to your probe.

Uterus

It may sometimes be difficult to visualize an acutely retroverted or acutely anteverted uterus. In such situation you may lightly press the patients abdomen to correct the version or in case of an adherent anteverted uterus transabdominal scan may be done.

PATIENT CARE

The most important aspects of patient care include patient dignity, safety and communication. To enable cooperation by the patient and to make sure the patient clearly understands, the findings are key elements of communication.

SAFETY

Although medical ultrasound examination is generally a safe procedure for women and their unborn babies, there are some factors that need to be considered and are as follows:

- Thermal effects[2,3]
- Mechanical effects[4]
- As low as reasonably achievable (ALARA)
- Cross infection.

Thermal Effects

Tissues produce heat as ultrasound is absorbed. Although there is no experimental evidence of damage at diagnostic intensities, there is a theoretical risk of tissue damage. Thermal index (TI) can be calculated by W/Wdeg, where W = output power and Wdeg is the power that would lead to a 1°C rise in temperature.[5]

- If TI is equal to 1, then there is a possible rise in tissue temperature of 1°C.
- In general, if TI is <1.5, it can be used without reservation.
- If TI >4 for over 5 minutes, this is potentially hazardous.
- If TI >3, scanning of an embryo or fetus is not recommended.

The WFUMB (7) recommends that ultrasound causing a temperature rise of no more than 1.5°C may be used without reservation on thermal grounds.

- Thermal exposure can be teratogenic. A rise of even 2.5 degree has been found significant in guinea pigs.
- A diagnostic exposure that elevates embryonic and fetal in situ temperature to 4°C (4°C above normal temperature) for 5 minutes or more should be considered potentially hazardous.[6]

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Mechanical Effects

The two common mechanical effects include: (1) cavitation and (2) microstreaming.

Cavitation: It occurs at certain frequencies when gas bubbles grow, oscillate and sometimes collapse under the influence of ultrasonic field. This principle is utilized in ultrasonic scalpels.

Microstreaming: It is the transfer of energy causing small scale, local circulation of intercellular and intracellular fluid, leading to effects on cell metabolism. The mechanical index (MI) is an estimate of the maximum amplitude of pressure pulse in the tissue and indicates the likelihood of cavitation arising within exposed tissue.

Mechanical index can be calculated by $MI = p/\sqrt{f}$, where p = pressure amplitude in MPa and f = frequency in MHz. It should be <1.9, but aim for <0.3.

As Low as Reasonably Achievable

As low as reasonably achievable is a principle of radioprotection stating that whenever ionizing radiation has to be applied to humans, animals or materials, exposure should be ALARA. B-mode provides the lowest power output and intensity and therefore the lowest TI and MI. Use of color flow Doppler increases the power output and therefore the potential for heating tissue in the region being scanned. It is important to minimize the time taken to gather necessary information to decrease the possibility of thermal or mechanical effects. Its use is avoided in embryos.

Cross Infection

Probe must be cleaned before and after procedure to decrease the chance of cross infection but care must be taken as some antiseptics, such as alcohol or glutaraldehyde, will cause irreparable damage to the probe and keyboard.

For transvaginal probe use a disposable condom cover and discard the cover after each use.

Also clean the surface bed/table on which you are scanning. A disposable cover may be used to be changes after each patient.

How to Take Care of Your Machine?[7]

The most important thing to learn before you start scanning is to maintain your machine. This expensive piece of equipment requires personalized attention and care.

- Read the user manual
- Use the machine properly
- Clean the machine daily and each probe before and after use

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- Give the transducer extra attention
- Disinfection is very important
- Clean the air filters regularly
- Take precautions during transport
- Get a regular maintenance plan
- Have a backup stabiliser in order to avoid machine damage by voltage fluctuation
- Transducers are highly sensitive so avoid equipment which can generate electromagnetic waves near the machine which will cause artifacts and reduce your image quality.

REFERENCES

1. Donald I, Macvicar J, Brown TG. Investigation of abdominal masses by pulsed ultrasound. Lancet. 1958;1(7032):1188-95.
2. WFUMB symposium on safety and standardization in medical ultrasound. Issues and recommendations regarding thermal mechanisms for biological effects of ultrasound. Hornbaek, Denmark, 30 August-1 September 1991. Ultrasound Med Biol. 1992;18:731-810.
3. National Council on Radiation Protection and Measurements. Exposure criteria for medical diagnostic ultrasound: I. Criteria based on thermal mechanisms. NCP report no. 113, 1992.
4. American Institute of Ultrasound in Medicine/National Electrical Manufacturers Association. Standard for Real-time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment. Rockville, Md: The Institute; 1992.
5. Salvesen K, Lees C, Abramowicz J, et al. ISUOG statement on the safe use of Doppler in the 11 to 13+6 week fetal ultrasound examination. Ultrasound Obstet Gynecol. 2011;37:628.
6. Rodgers S, Chang C, DeBardeleben J, Horrow M. Normal and Abnormal US Findings in Early First-trimester Pregnancy: Review of the Society of Radiologists in Ultrasound 2012 Consensus Panel Recommendations. Radiographics. 2015;35(7):2135-48.
7. How to Maintain Your Ultrasound Machine – All Imaging Systems [Internet]. Allimaging.com. 2022 [cited 7 August 2022]. Available from: https://allimaging.com/how-to-maintain-your-ultrasound-machine/

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