Ultrasound in obstetrics and gynaecology

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Abstract

Ultrasound is a key first line imaging modality in obstetrics and gynaecology. It is cheap, painless, inexpensive and has a long safety record in pregnancy. Its use as a screening and diagnostic tool is dependent upon the technical skill of the operator and their ability to interpret the scan findings. This review summarizes the theoretical and practical elements of the clinical application of ultrasound in obstetrics and gynaecology.

Keywords cancer; ectopic; fetal anomaly; miscarriage; ultrasound

Introduction

Ultrasound is a key investigation used both in diagnosis and in treatment of patients in obstetrics and gynaecology. However, it is important to understand the mechanics of ultrasound and the machines used in clinical practice to maximize its effectiveness. Patient factors such as body mass index also play a role in the ability of the operator to obtain a high quality image.

How does ultrasound work?

Ultrasound uses sound frequencies above the audible range, 20 kHz. For medical applications frequencies of 1−15 kHz are used. Piezoelectric crystals in the transducer act as the source of ultrasound. When an electrical current is applied to these crystals they change shape rapidly and the vibrations as a result of this produce sound waves. As well as emitting sound waves these crystals produce an electric current when sound waves, or echoes, return to them.

A pulse of sound leaves the transducer, travels through the patient meeting different tissues along the way. Different tissues have different effects on the sound waves passing thorough them this is described as acoustic impedance. The junction between different tissues is known as the acoustic interface. At each interface a proportion of the sound beam is reflected back to the transducer as an echo. This is the pulse−echo principle underlying ultrasound.

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The electrical voltage produced in the piezoelectric crystal by this echo is stored by ultrasound machine as a single line of information. The voltage is assigned a brightness level. As multiple pulses leave the transducer and multiple echoes are received, a cross sectional image is produced, this is known as Brightness mode or B-mode.

Optimizing ultrasound images and safety

In order to obtain the highest quality image while maintaining safety, the following principles need to be considered:

Power: ultrasound is absorbed as it passes through tissues, therefore lower power is needed for women with a lower BMI. Excessive power causes image distortion through noise and affects the thermal index (TI) and mechanical index (MI). The TI estimates tissue heating and the MI estimates mechanically induced tissue damage. Both MI and TI must be maintained within safety settings and this is particularly pertinent for early pregnancy ultrasound.

Frequency: frequency measures the number of wavelengths per unit of time and is usually measured in Hertz (Hz). The ultrasonographer can alter this; a higher frequency will give better image resolution but lower penetration. Deeper structures will not be seen as well at higher frequencies.

Gain: gain alters the brightness of the image, increased gain results in brighter echoes but also increases image noise and artifact leading to a loss of contrast.

Focus: the focus denotes the narrowest part of the beam and should be directed to the area of interest to achieve the highest quality image at this point.

Harmonics: harmonics reduce background noise and can improve contrast. It is particularly useful when examining cystic structures.

Angle/Sector width: resolution is improved by scanning a smaller area: reducing the sector width increases the frame rate and resolution thus resulting in a better quality image. Increasing the sector width does not improve the image quality but allows appreciation of the scope of large structures.

Depth/Zoom: increasing the depth allows visualization of structures further away from the probe but compromises image quality. When scanning structures near the probe reducing the depth improves the image quality.

Using zoom over a small area restricts ultrasound processing to that area, this allows the maximum amount of detail to be acquired for that area.

Colour and pulsed wave Doppler: Doppler is associated with an increase in temperature and care must be taken paid to maintain the TI within safety limits. Doppler should be avoided over small areas as this increases the risk of tissue damage. Colour Doppler is useful in assessing tissue vascularity. Pulsed Doppler should not be used in early pregnancy due to the high-energy output associated with this. In early pregnancy M-mode can be used to measure the fetal heart rate.

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Assessment prior to ultrasound

The pathology likely to be identified on ultrasound can often be delineated from the patient's clinical history and a through history should be taken prior to ultrasound scan. In addition ultrasound does not replace the need for gynaecological examination and in some cases this can help with interpretation of scan findings.

Transvaginal ultrasound (TVUS) is recommended by NICE for diagnosis in early pregnancy. It is also preferred over transabdominal scan (TAUS) for the imaging of pelvic masses due to its increased sensitivity and specificity. TAUS is a useful adjunct to TVUS in the assessment of large pelvic masses, and it may also be an alternative modality in women who have never been sexually active or for those women who decline TVUS. Transrectal ultrasound (TRUS) should be considered in these cases if transabdominal views are suboptimal. TVUS and TRUS ultrasound should be performed with an empty bladder and for TAUS the bladder should be full.

An explanation should be given prior to the scan and verbal consent should be obtained. The patient's identify should be confirmed and a chaperone should be available during the scan. For TVUS and TRUS latex allergy status should also be checked.

Performing the ultrasound

The orientation of the probe should be checked prior to scan. The operator should be familiar with the settings and how to adjust these during the scan to optimize the views of the organs being examined.

The pelvic ultrasound scan should be performed in a systematic manner to examine the following structures:

Uterine position

- Identification of the bladder and cervix should take place first then the position of the uterus is assessed.

Presence of uterine anomalies

- This is assessed by sweeping through the uterus in the transverse plane from cervix to fundus.

Endometrial thickness

- The entire length of the cervical canal and uterine cavity should be examined in the sagittal plane and the endometrial thickness measured at its thickest point.

Ovarian morphology and volume

- Ovaries are usually seen lateral to the uterus and medial to the internal iliac vessels. The position of the ovaries can vary depending on the length of the infundibulopelvic ligament and the presence of adhesions.

Pouch of Douglas

- The presence of and appearance of free fluid (anechoic), blood or pus (echogenic) should be recorded.

Mobility of the pelvic organs

- Use the non-scanning hand to move the pelvic organs closer to the probe and assess the movement of organs on the ultrasound monitor to establish mobility or the presence of adhesions.

Any abnormalities

- If pathology such as an ovarian cyst is identified early in the scan it is often better to look at this at the end of the scan to avoid missing any co-existing pathology.

Gynaecological ultrasound

Uterine pathology

- Leiomyoma

Fibroids are the most common uterine tumours appearing in up to 40% of pre-menopausal women. They appear as symmetrical, well-defined, hypoechoic, and heterogeneous masses. They are often multiple and usually cause acoustic shadowing. Calcification may be present particularly in post-menopausal women. Degenerating fibroids may contain cystic areas and haemorrhage within a fibroid may appear hyperechoic.

Ultrasound can help define the location of fibroids, classifying them as subserosal, intramural or submucosal. Pedunculated and subserosal fibroids (Figure 1) may mimic the appearance of a solid ovarian tumour. In these cases it is important to identify the fibroid pedicle and the ovary separately from the fibroid. The degree of intracavity projection of submucosal fibroids can be aided by instilling saline into the uterine cavity.

- Adenomyosis

Adenomyosis is defined as the presence of endometrial glands and stroma within the myometrium leading to hypertrophy and hyperplasia of surrounding adjacent myometrium. Adenomyosis is a histological diagnosis but there are some ultrasound features which support the diagnosis of adenomyosis (Figure 2):

- Globular enlarged uterus
- Echogenic linear striations
- Myometrial cysts
- Heterogeneous myometrium
- Myometrial anteroposterior asymmetry
- Poor definition of the endometrial–myometrial junction.

Endometrial pathology

In pre-menopausal women the appearance of the endometrium varies throughout the menstrual cycle. In the proliferative phase the endometrium has a trilaminar appearance (Figure 3a). In the secretory phase it is at is thickest and is uniformly echogenic (Figure 3b).

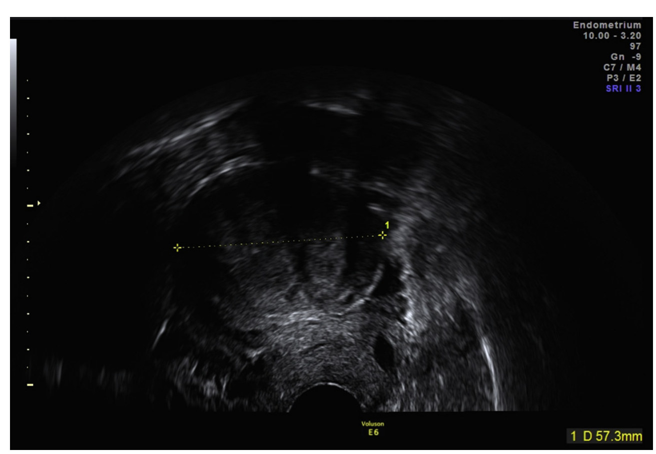

Figure 1 Subserosal fibroid.

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