Optimising 2D ultrasound to produce the best 3D images in a Gynaecological exam

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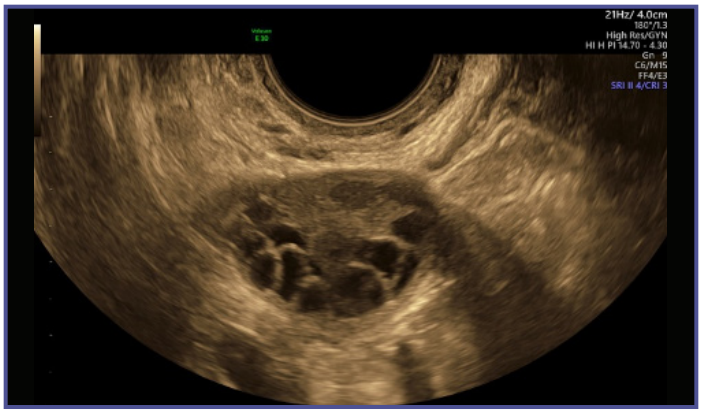
Ultrasound scanning in gynaecology has been in use since the 1980s and is now the most widely used imaging modality in the field of fertility medicine for both pre-treatment assessments and monitoring during treatment.[1,2]

The majority of fertility units continue to utilise real-time 2D ultrasound for imaging, however, 3D ultrasound can provide much better images for pre-treatment diagnosis and during treatment. 3D ultrasound has been shown to decrease time taken for scanning[3] and identify and better visualise pathology, which may not have been seen on traditional 2D scanning – as the examples below will illustrate.

We will discuss how to change ultrasound settings to optimise your images for fertility assessments. We will also show some examples of how obtaining good ultrasound images has helped diagnose uterine, ovarian and adnexal pathology.

Sector Width

The sector width refers to the width of area which is to be visualised. While it does have advantages to see more information in a single image, it does have an effect on the lateral resolution of the image. The greater the sector width the poorer the resolution of the image. Therefore, the sector width should always be reduced to include only the object of interest. This increases frame rate (which is the rate at which the image is updated on the screen), which in turn translates to a better quality image.



The images above are of the same ovary. The structures are clearer with the sector width being reduced. The frame rate is increased from 21Hz to 40Hz.

Depth & Focal Zone

Depth setting is important to ensure the structure of interest can be visualised properly. It should be optimised so the structure of interest fills the screen with a small border. Using transvaginal scanning for fertility evaluation, the majority of structures will be superficial and therefore depth should be adjusted to minimise visualising more than is necessary.

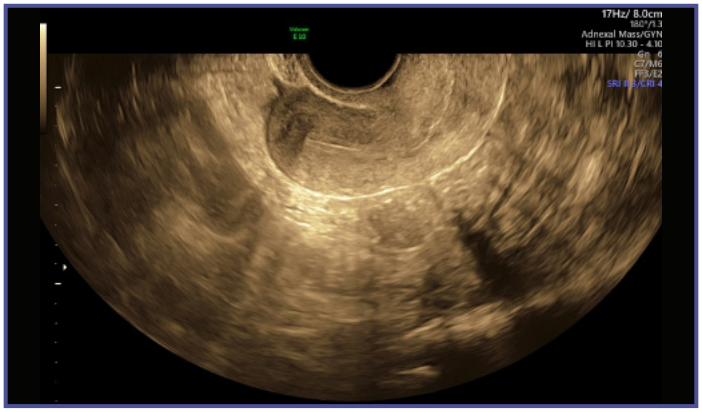


Image a. Deep depth setting with too many peripheral structures included and the uterus is small.

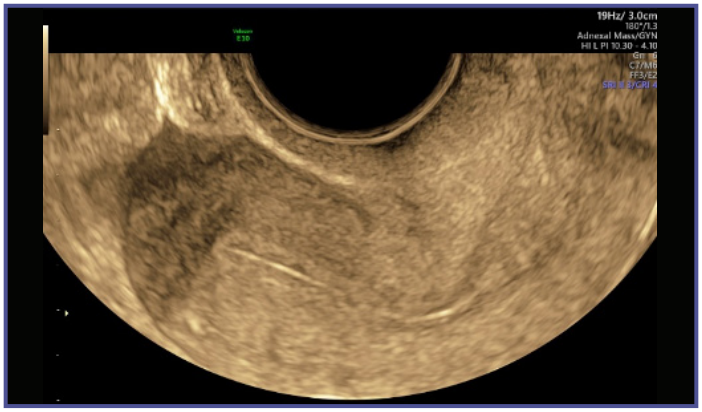


Image b. Shallow depth setting. The posterior uterine wall cannot be fully visualised.

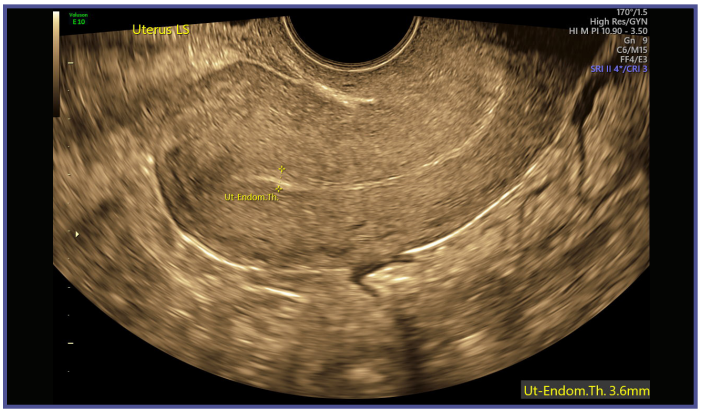


Image c. Optimised depth setting for the uterus. All margins can be clearly seen and minimal peripheral structures included.

Image d. Depth setting too deep for the ovary.

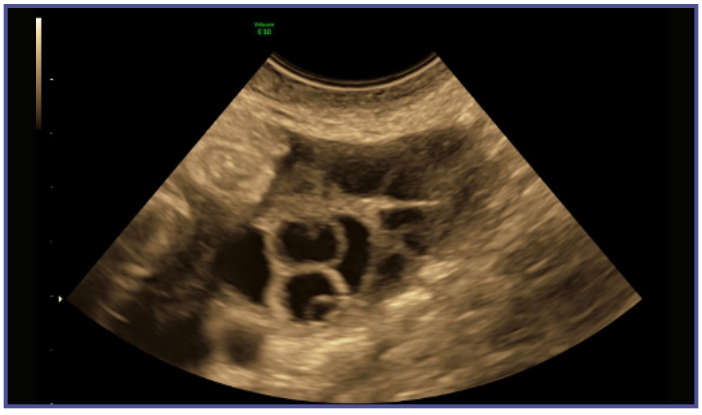


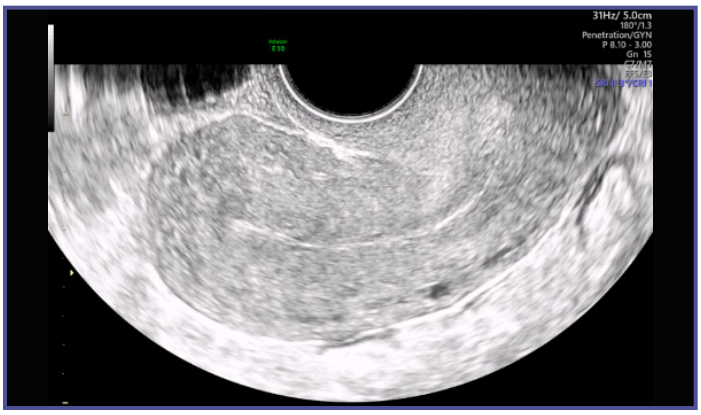
Image e. Optimal depth setting for the ovary.

Focal Zone

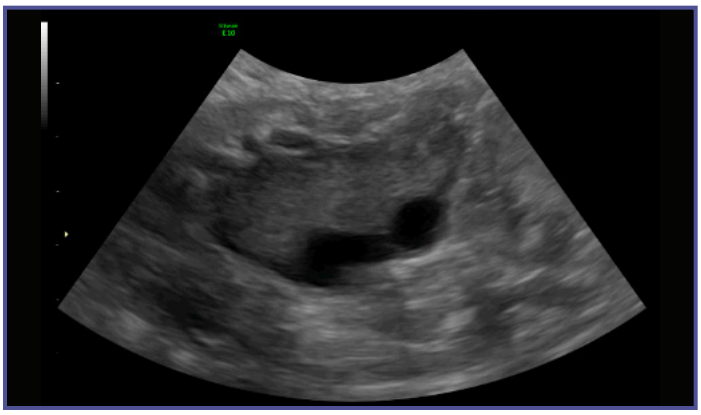
The focal zone is the place in which the ultrasound beam is at its narrowest, becoming narrower than the width of the transducer. The position of the focal point will be the level where the best resolution will be visualised. The focal point should be set at or just deeper than the structure of interest.

Gain & Contrast

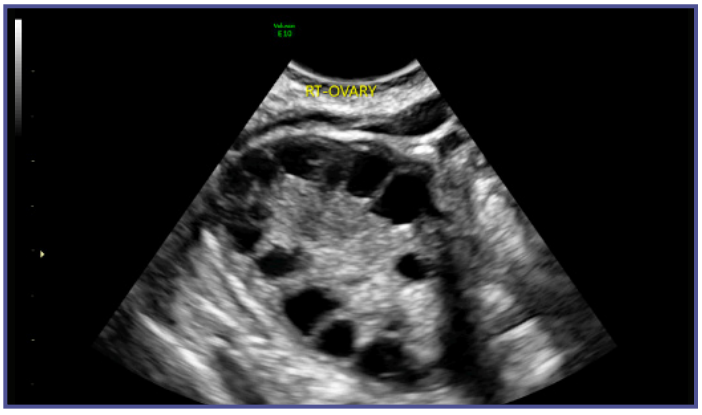
Gain alters the overall brightness of the image. Contrast alters the amount light and dark shades are different from each other. The optimum settings will depend on the structure you are imaging.



High gain which accentuates endometrial echo but also artificially gives the myometrium a coarse and too bright echotexture.



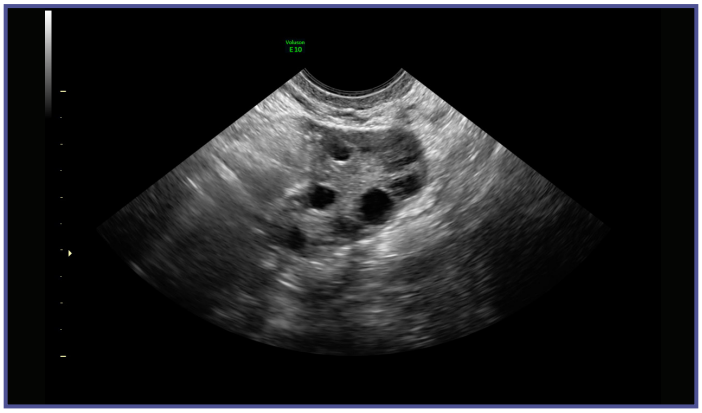
Low gain making defining the borders of follicles difficult to see.



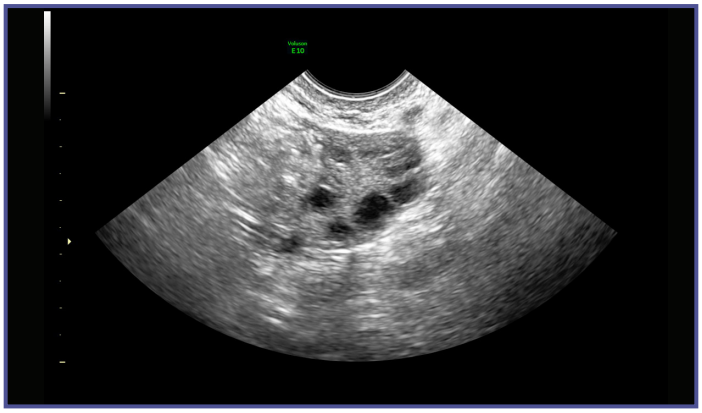
Optimal gain and high contrast, which is useful for defining antral follicles against the background of ovarian stroma.

Harmonic Imaging

Harmonic imaging leverages the non-linear propagation of ultrasound waves in tissue to increase resolution and reduce artefacts when compared to conventional imaging.

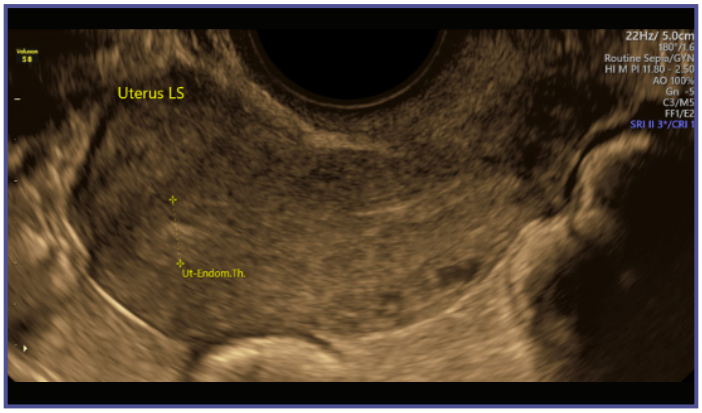


With Harmonics

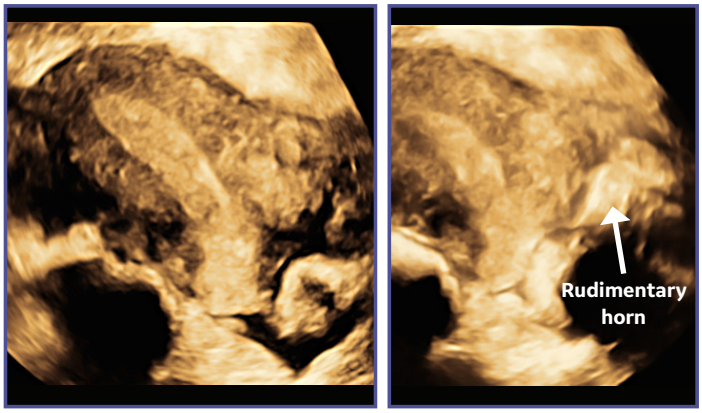


Without Harmonics

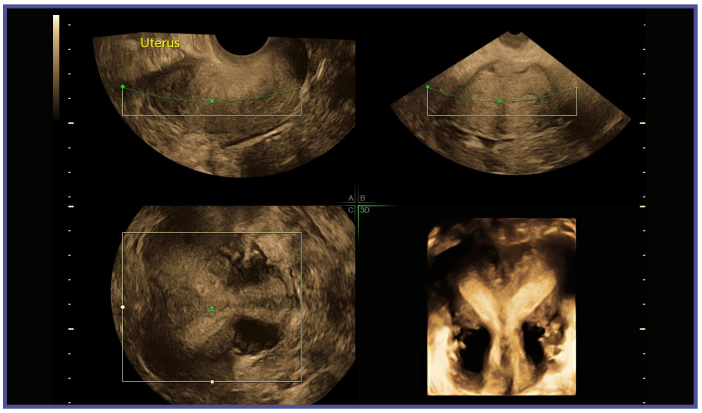
Clinical Benefits of 3D Ultrasound



Apparently normal uterus.



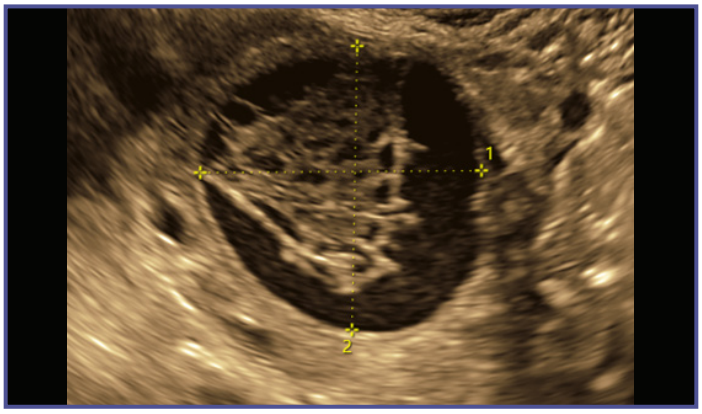
The same uterus using 3D ultrasound. Employing 3D clearly demonstrated a unicornuate uterus and also identified the rudimentary horn which was difficult to image with 2D ultrasound.



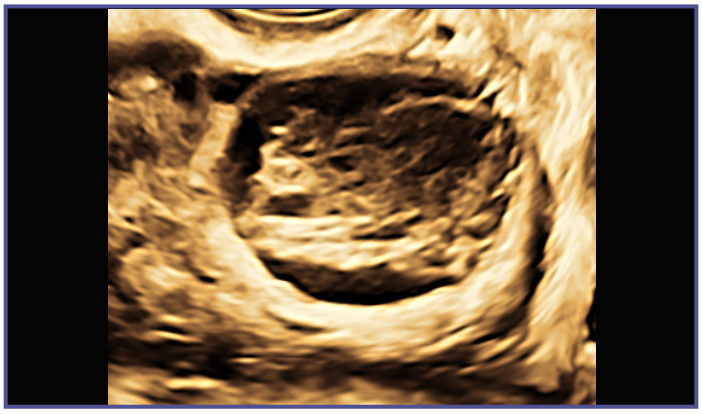
Uterine didelphys. 3D allowed confirmation of pathology without the need for invasive investigations such as a hysteroscopy.

Adnexal Pathology

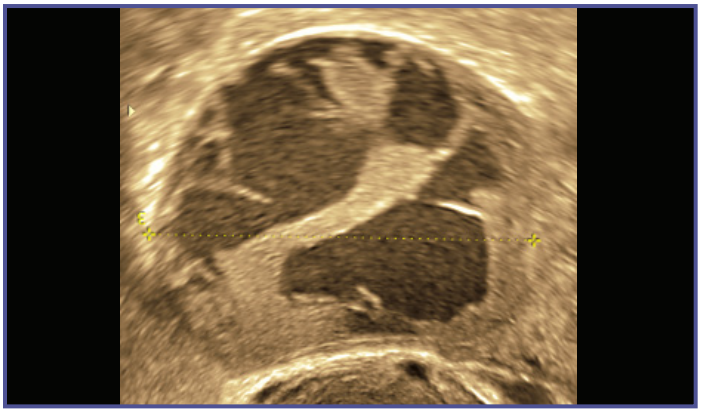
3D ultrasound can be used to distinguish different structures.



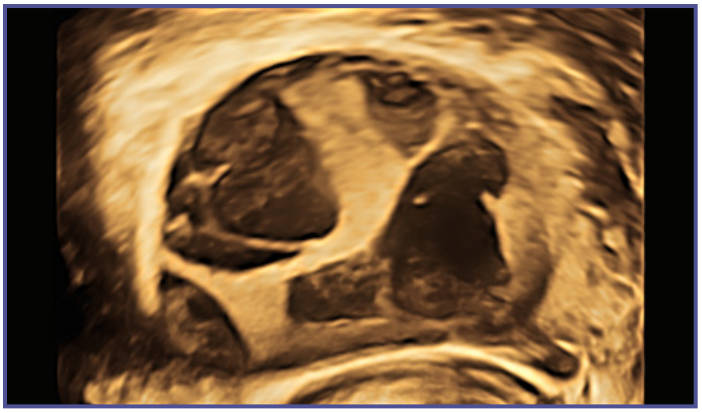
Corpus luteum with 2D imaging. This can be difficult to differentiate from a haemorrhagic cyst.



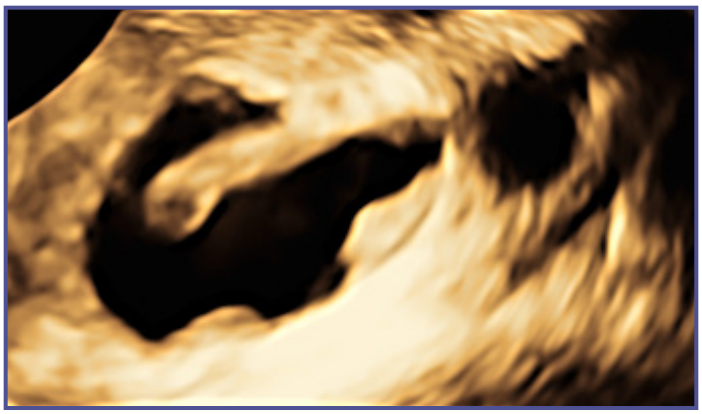
3D ultrasound of the same structure. The thick-walled nature of the corpus luteum is clearly visible with better characterisation of haemorrhagic components.



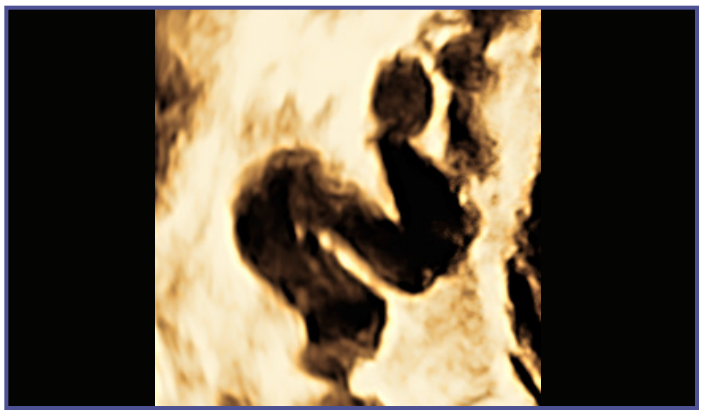
2D haemorrhagic cyst which is similar in characteristics to a haemorrhagic corpus luteum.



3D ultrasound of the haemorrhagic cyst. Its thin wall nature can be seen as well as the depth and characterisation of internal blood clot.



3D hydrosalpinx. Internal indentations can be clearly seen, despite this being a small hydrosalpinx. The use of 3D enabled this to be differentiated from adhesions and allowed better counselling of the patient.



Tortuous uterine vein. 3D imaging allowed its course to be mapped in its entirety to define its position and proximity to the surgical field.

Author Descriptions:

Nurture Fertility is an Assisted Fertility Unit based in Nottingham, England. We provide a range of fertility treatments and specialise in 3D scanning to facilitate in the care and management of our clients.

Dr. Joanne Wilkins is a Consultant Obstetrician and Gynaecologist with special interests in Assisted Reproduction, Early Pregnancy and Acute Gynaecology. She graduated from Manchester University and completed her O&G training in Nottingham. She is now a consultant working at Nurture Fertility and undertaking a PhD using 3D ultrasound and ovarian mapping for better ovarian follicular tracking.

Lynda Lacy is an ultrasonographer with over 25 years experience. She qualified with a Diploma from the College of Radiographers and later gained her Diploma of Medical Ultrasound. She has practiced in England and Australia where she gained expertise in obstetrics, gynaecological, abdominal and carotid ultrasound. Since 2006 she has been dedicated solely to ultrasonography for assisted reproduction.

Nick Raine-Fenning is a Reader of Reproductive Medicine and Surgery at the University of Nottingham and a Consultant Gynaecologist at Nottingham University Hospitals NHS Trust. He also acts as Clinical and Scientific Director of Nurture Fertility, part of The Fertility Partnership, the largest providers of IVF and assisted reproduction in the UK.

Nick is an internationally recognised expert in 3D ultrasound and gynaecological imaging. He has given numerous invited talks, plenary sessions and workshops all over the world and published over 170 peer-reviewed papers, review articles, opinions, and editorials.

Nick's main research interests are related to the application of ultrasound, which he and his team use to individualise patient care and predict outcome. Ultrasound is a key part of his IVF unit's continued and unprecedented success.

Nick has served on the Executive Boards of the British Fertility Society, the Clinical Study Group for Reproductive Medicine, the Wellbeing of Women and the International Society of Ultrasound in Obstetrics and Gynaecology.

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2. HECHT, B, HOFFMAN, D. The Use of Ultrasound in Infertility. *Clinical Obstetrics & Gynaecology*. 1989, vol 32(3), 541-549
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