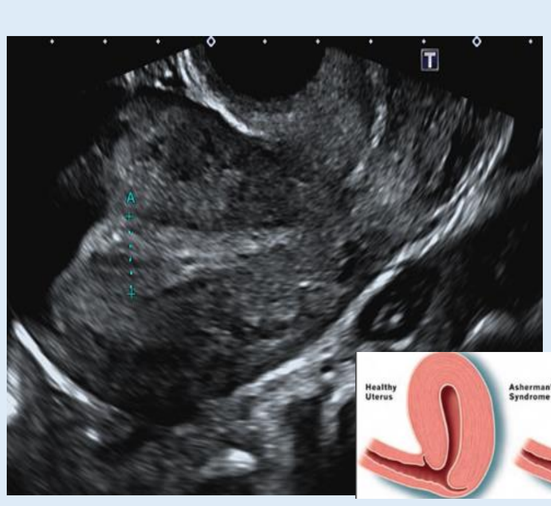
Interesting cases of the three dimensional (3D) uterus/endometrium in patient's with suspected infertility

Pamela Norbury (Team Lead) and Farrah Stephanie Elsaghir (Advanced Practitioner Sonographer)
Royal United Hospital, Bath

Royal United Hospitals Bath
NHS Foundation Trust

Introduction

NICE (2017) identifies 1 in 7 heterosexual couples are affected by infertility, furthermore, WHO (2022) estimates that globally, between 48 million couples and 186 million individuals live with infertility. It is imperative that infertility is addressed, as individuals and couples have the right to a family. Although sometimes unexplained, multiple factors can affect fertility including uterine disorders and endometrial pathology. Two-dimensional (2D) ultrasound is one of the first diagnostic tests to be requested in suspected infertility. 2D ultrasound requires the ultrasound practitioner to mentally form a 3D impression of the anatomy from a series of acquired images. The process is subjective, can be inconsistent and relies on the operator. The 3D system acquires a series of multiple images throughout the volume of interest which can be arranged in a variety of formats including: parallel slices, in a wedge, in a cone or in an arbitrary orientation (Hedrick et al, 2005). Patients included in this poster presented to the gynaecology department for a HyCoSy, all had suspected fertility issues. This poster demonstrates some of the pathology that can cause issues with fertility and demonstrates the comparison between 2D and 3D ultrasound images. Voxel-based reconstruction has allowed the original 2D image to be preserved and the 3D volume to be manipulated to ensure the most optimal image obtained. NICE (2017) recommends patients under 40 should be offered 3 NHS IVF cycles if they satisfy specific criteria, however some NHS integrated care boards only fund women under 35. Women therefore could be denied funding if pathology requiring corrective surgery is discovered late in their subfertility journey.
These images endorse the provision of 3D capability for all Gynae patients to enable earlier, more accurate diagnoses.



Asherman's Syndrome

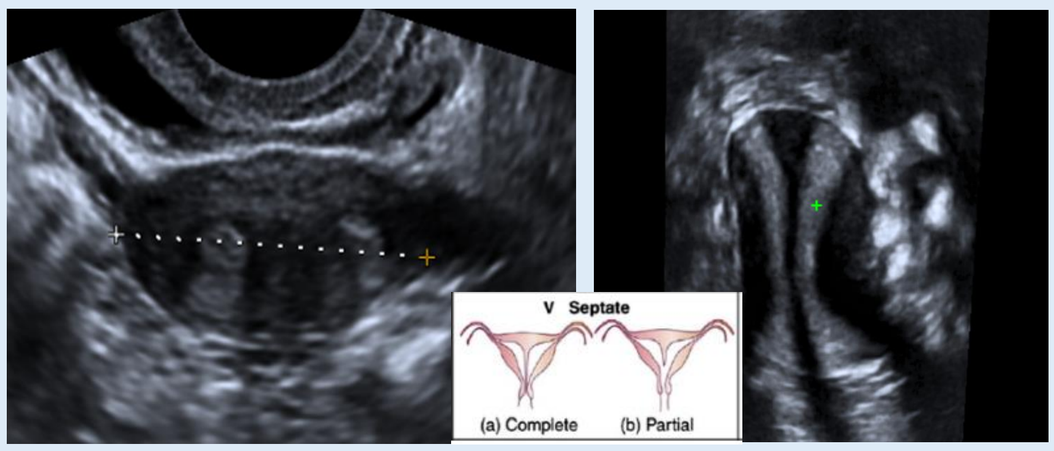
Trauma to the basal layer of the endometrium can lead to destruction of the endometrium resulting in the possibility of uterine adhesions known as Asherman's Syndrome (Ahmadi & Javam 2013). Multiple factors can increase a patient's risk of acquiring this condition including: dilation and curettage (D&C), medical abortion, after a miscarriage delivery, myomectomy, pelvic infection, intrauterine devices (IUDs) and a c-section.

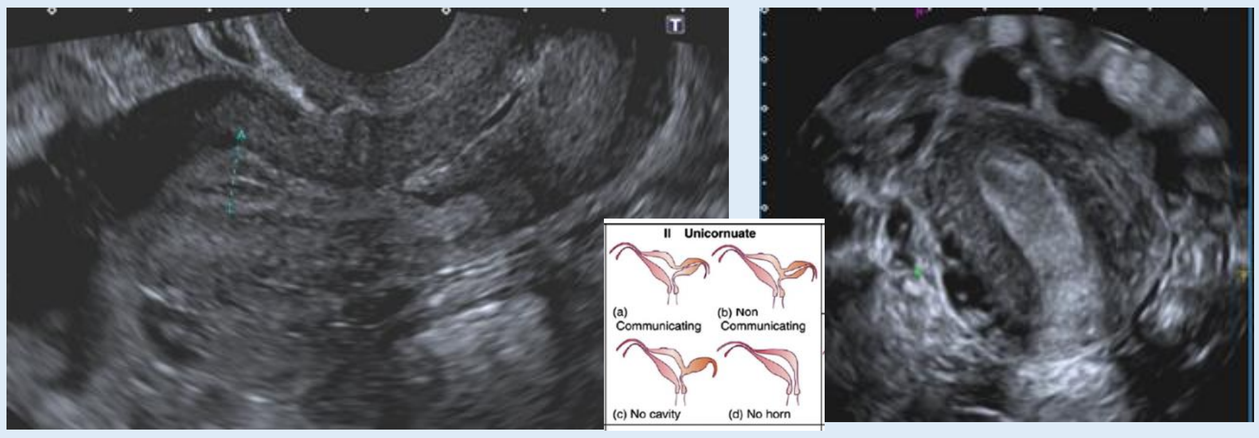
The 2D image shows a endometrium that has a normal thickness and does not appear to contain any adhesions. Prior to the HyCoSy, a 3D assessment shows multiple adhesions noted. Volume rendering has allowed the opacity and colour to be manipulated to depict the adhesion. To produce the 3D image, the volume first has to be acquired, displayed then analysed. The region of interest should be as small as possible with the angle approx. 30-40 degrees. Reduced acquisition time reduces background artefact. Determine the acquisition plane (e.g. sagittal uterus) & optimise settings. These images were produced using the 2D array transducer system where the transducer elements are arranged in a 2D array, which when fired, are combined to form a pyramidal volumetric scan. The probe can be held stationary during acquisition. Surface rendering specifically demonstrates external features adding depth to the displayed image & whilst more commonly associated with obstetrics, this case demonstrates the utility in gynaecology.

Complete Septate uterus

There are 3 developmental phases of the paramesonephric ducts & anomalies occur due to failure of any of these. Septate results from failure in septum resorption phase & accounts for more than 55 % of mullerian duct anomalies whereas bicornuate accounts for approx. 10%. & results from a failure of the fusion phase (Homer et al, 2000). Septate uterus is more common than bicornuate uterus, the anomaly is associated with poorest reproductive outcomes, and high incidence of abortion and miscarriage and now surgical interference is the preferred method for intervention. It is crucial that a diagnosis is made between a bicornunate and septate uterus due to prognosis (Dewan et al, 2014).

The 2D images shows a clear definition of myometrium within the endometrium. Further assessment by 3D ultrasound shows a clear definition of myometrium allowing a diagnosis of a complete septate uterus. The 3D multi-planar reconstructed (MPR) view represents parasagittal, transverse & the additional coronal view which is essential for distinguishing between a bicornuate, sub-septate & complete septate uterus.





Unicornuate uterus (No Horn)

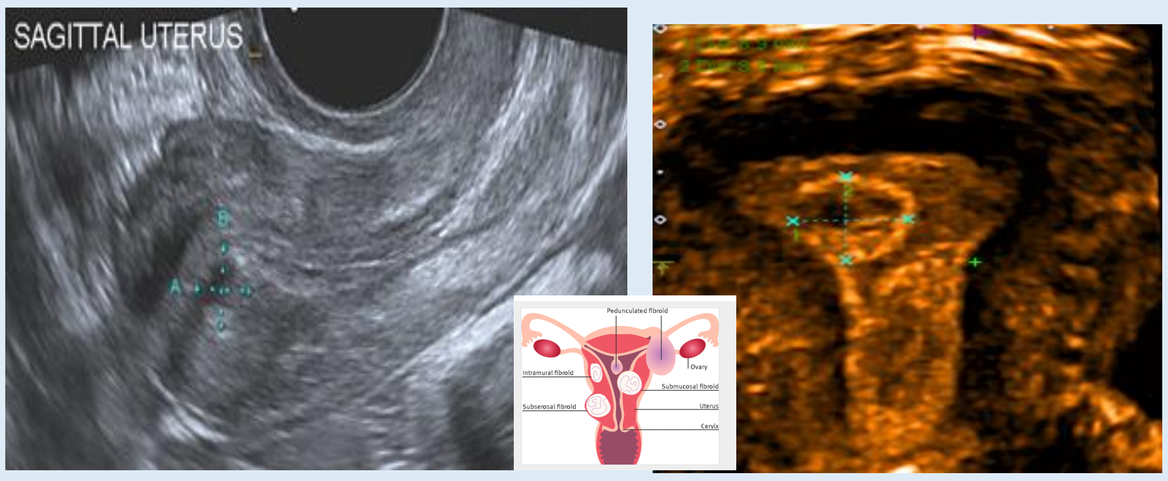
Unicornuate uterus is caused by maldevelopment of a Mullerian duct & is present in 0.1% of the unselected population but prevalence increases to 0.5% in those with infertility. It is associated with miscarriage, ectopic pregnancy, premature rupture of membranes, intrauterine growth restriction & fetal malpresentation.

If a unicornuate uterus is suspected on imaging, it must be differentiated from bicornuate uterus, septate uterus, and uterus didelphys as the need for intervention varies. Differentiation of the unicornuate uterus is difficult on 2D assessment but further diagnostic information can be obtained by 3D. MRI and three-dimensional ultrasonography are the best modalities for an accurate diagnosis (Mahany et al, 2018).

Submucosal fibroid

Uterine leiomyomas or uterine fibroids are the most common gynaecological tumours and occur in about 20-50% of women around the world, with the highest frequency in groups of black women of reproductive age (Bates, 2006). Studies show that fertility outcomes are decreased in women with submucosal fibroids & removal seems to confer benefit (Pritts et al, 2009).

The 2D image shows a fibroid posterior to the endometrium in the sagittal plane. From this assessment it is difficult to distinguish if the fibroid is in the myometrium or endometrium. The 3D assessment provides further detail, and it is apparent that the fibroid is submucosal, endometrium is noted surrounding the fibroid. Manipulation of the colour has allowed the border of the fibroid to be clearly identified. Whilst the 3D image is a MPR coronal section, the addition of tomographic/ multi-view modality allows structures such as this fibroid to be more closely interrogated by moving through the MPR slice by slice. The volume data can be used to confirm the diagnosis if a second opinion is required for research or audit

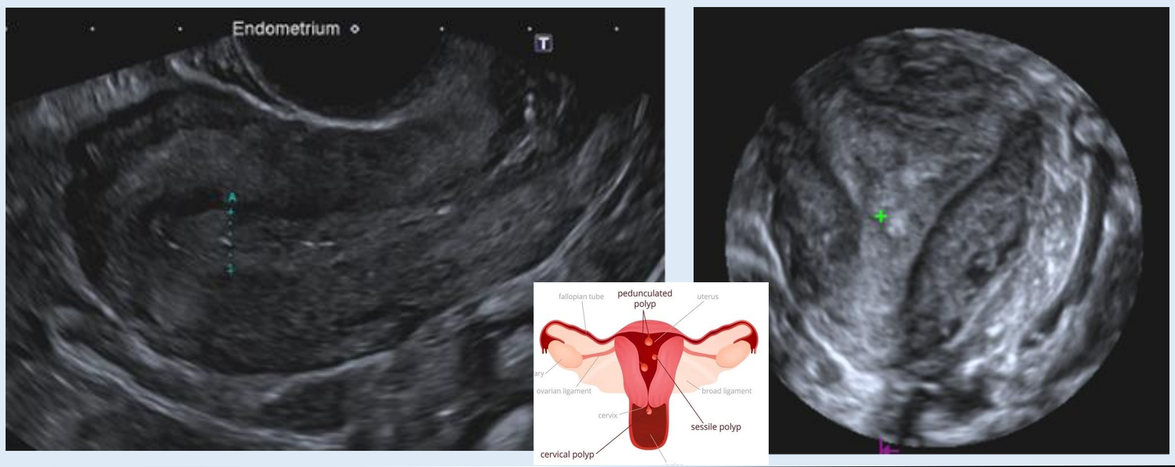


Endometrial Polyp

The difference between polyps & fibroids is their composition. Polyps are made of endometrial tissue whereas fibroids are comprised of uterine muscle & fibrous tissue. A common disorder consisting of overgrowths of the endometrial glands, stroma and blood vessels which project into the cavity affecting approx 10% of women (Bates, 2006). Polyps can present as solitary but are often multiple on histology.

Endometrial polyps are common in those with infertility with a prevalence as high as 32% however can also be similarly prevalent in normally fertile women. Mixed results have been found in those where polypectomy has been performed compared to those who have not. The studies indicate endometrial receptivity is a more complex process than simple polypectomy (Munro & Malcom, 2019).

The 2D image shows a sagittal endometrium with a normal thickness and no obvious polyps identified. Further assessment by 3D shows multiple polyps within the cavity



Conclusion

Ultrasound is one of the first tests requested in patients with suspected primary/secondary infertility. Its role in assessing the uterus and endometrium is crucial. The addition of 3D ultrasound provides improved detail and accuracy in suspected anomaly/pathology on 2D ultrasound. An ultrasound practitioner must be able to recognise pathology/anomalies on 3D assessment therefore appropriate training should be given by application specialists or from proficient senior staff. It is evident that the 3D images have both clarified pathology noted on the 2D image but also highlighted that pathology is present even if the 2D appeared normal. Volume rendering in the 3D mode has allowed images to be manipulated to further display pathology endorsing the provision of 3D capability for all Gynae patients to enable earlier, more accurate diagnoses.

References

Ahmadi, F., Javam, M. (2013). Role of 3D sonohysterography in the investigation of *uterine synechiae*/asherman's syndrome: Pictorial assay. *Journal of Medical Imaging and Radiation Oncology*, 58 (2), 199-202.
Bates, J. (2006). *Practical Gynaecology Ultrasound*. Cambridge University Press. UK
Dewan, K., Hefeda, M., Elkohly, D. (2014). Septate or bicornuate uterus: Accuracy of three-dimensional trans-vaginal ultrasonography and pelvic magnetic resonance imaging. *The Egyptian Journal of Radiology and Nuclear Medicine*, 45 (*3*), 987-995
Hedrick, W., Hykes, D., Starchman, D. (2005). *Ultrasound Physics and Instrumentation*. ElsevierMosby. USA
Homer, H, A., Li, T, C., Cooke, J. (2000). The septate uterus: a review of management and reproductive outcome. *Fertility and Sterility,* 73 *(1), 1-14*
Hoskins, P., Martin,K., Thrush, A. (2019). *Diagnostic Ultrasound Physics and Equipment*. CRC Press. USA
Munro, M, D., & Malcolm, G. (2019). Uterine polyps, adenomyosis, leiomas and endometrial receptivity. *Fertility and Sterility*, 111 (*4*), 629-640.
NICE (2017). *Fertility problems: assessment and treatment.* National Institute for Health and Care Excellence. https://www.nice.org.uk/guidance/cg156
Pritts, E., Parker, W., Olive, D. (2009). Fibroids and Infertility: an updated systematic review of the evidence. *Fertility and Sterility*, 91 (*4*), 1215-1223
WHO. (2022). *Infertility*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/infertility