Ultrasound / White paper

A practical guide to ultrasound investigation of endometriosis using the advanced imaging technology of the Aplio i-series

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Introduction

Endometriosis is a complex gynaecological disorder. Its clinical and morphological presentation can vary tremendously. This has to be reflected in our approach to ultrasound investigation of the disease. The incidence of endometriosis remains uncertain. Clinical symptoms can be relatively mild. Indeed, endometriosis is frequently detected as an incidental finding say at surgery or part of pelvic examination for other reasons. Relatively few cases, probably less than 5-10% of patients with endometriosis, involve extensive infiltrative disease process but particular focus needs to be applied to interrogation of these more debilitating forms of the disease. The ability to confirm its presence or even high probability of endometriosis at the earliest stage possible is essential in order to facilitate appropriate clinical or surgical management especially from a prognostic point of view.

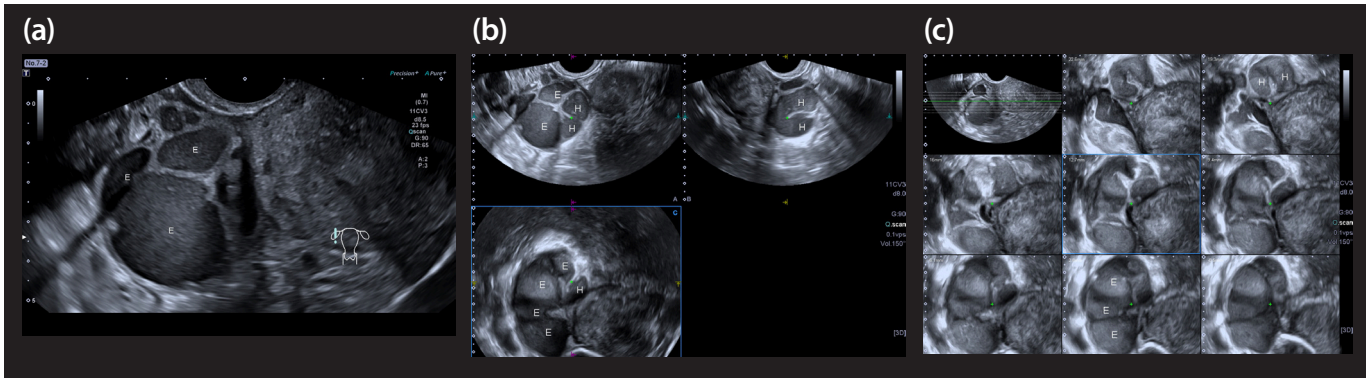

Figure 1 Multiple endometriotic cysts ("E") plus an adherent, convoluted hydrosalpinx ("H"). Examples of transvaginal greyscale imaging formats: (a) 2D (b) Multiplanar Reconstruction (c) Multi View.

Technical aspects

Ultrasound requires a comprehensive approach to identifying and evaluating all levels of endometriosis. This involves utilisation of modern imaging formats currently available as well as increased consideration given to practical scanning aspects itself.

- 3D (volumetric) transvaginal scanning (TVS) remains the principal approach to investigating complex pelvic disease processes. The ability to rapidly acquire, store and interrogate image data post-examination is shown to considerably enhance diagnostic capability and accuracy.

A range of imaging formats include Multiplanar Reconstruction (MPR), as well as Multi View (MV) tomographic mode. Volumetric "rendered" studies remain of value particularly in terms of clinical communication. Single sweep technology reduces the need for transducer movement, an important consideration in those cases presenting with more severe pain. Combined with plane tilting options, greater visual access to more distal tissues can be achieved. (Figs. 1-3) The acquisition of a simple 2D sweep (clip store) can prove of value as a replacement in the absence of 3D TVS.

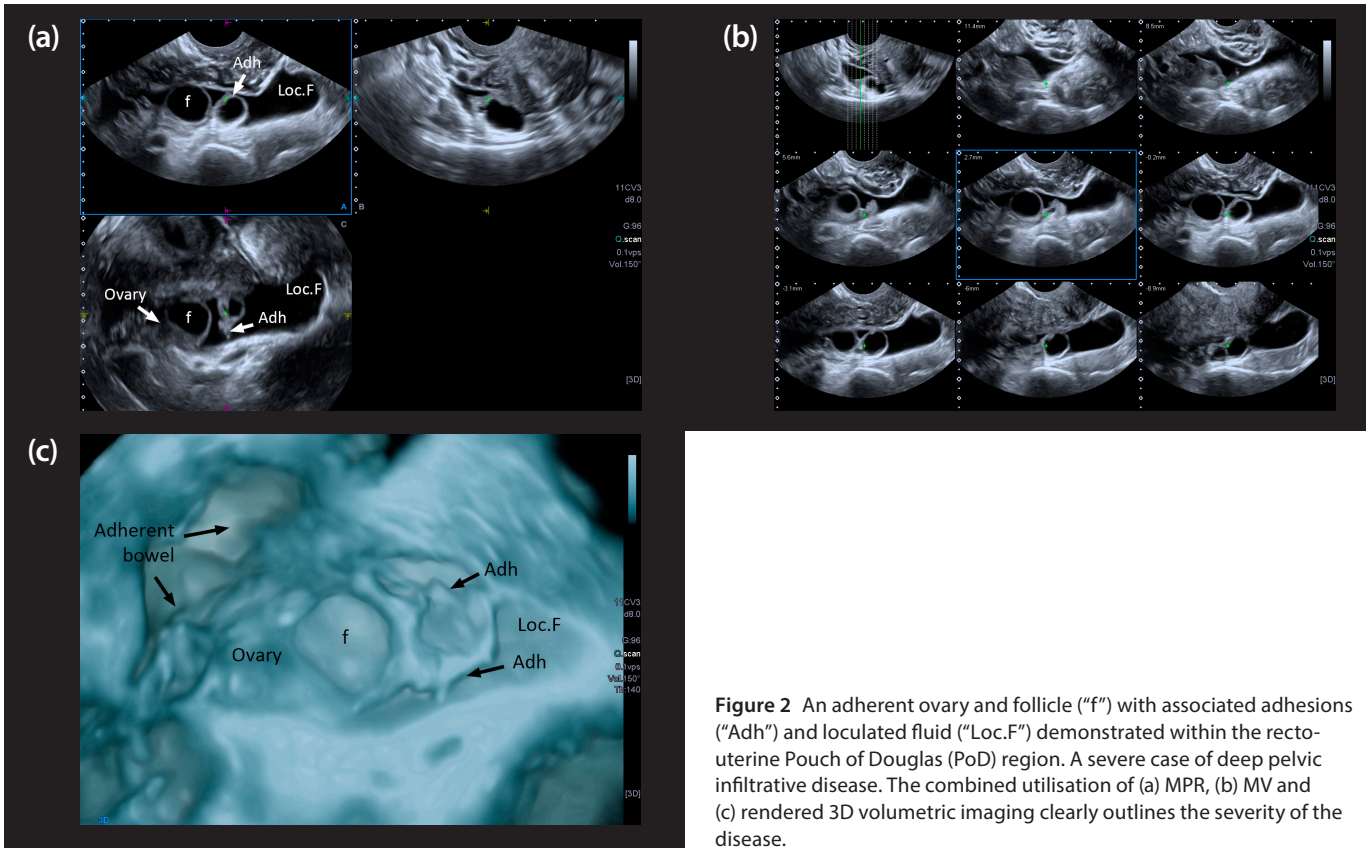

Figure 2 An adherent ovary and follicle ("f") with associated adhesions ("Adh") and loculated fluid ("Loc.F") demonstrated within the recto-uterine Pouch of Douglas (PoD) region. A severe case of deep pelvic infiltrative disease. The combined utilisation of (a) MPR, (b) MV and (c) rendered 3D volumetric imaging clearly outlines the severity of the disease.

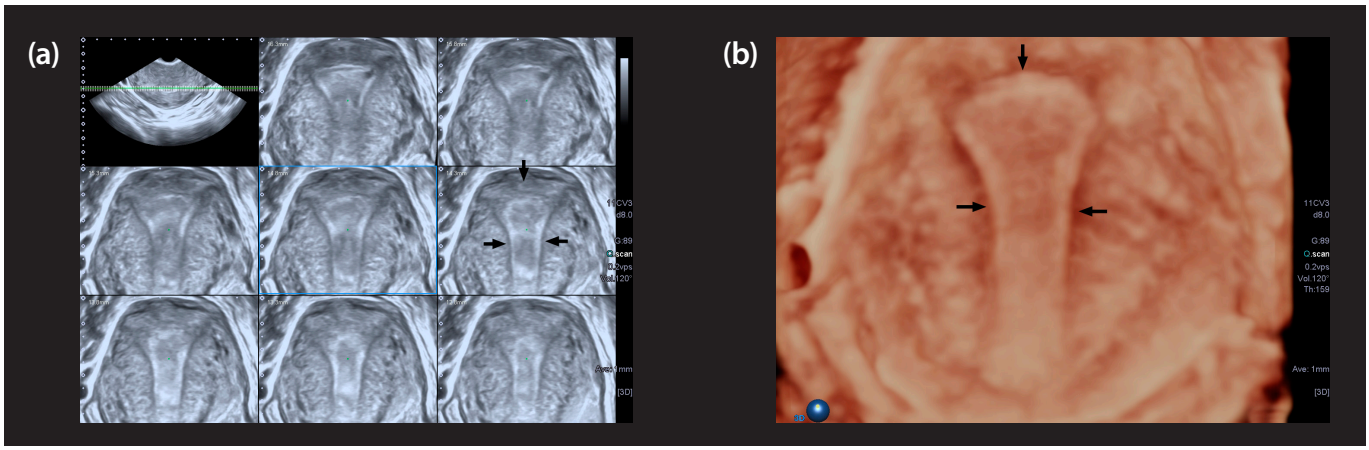

Figure 3 (a) MV and (b) volume-rendered coronal sections of the uterus providing clear delineation of an intact endometrial-myometrial interface ("arrowed") in a case of adenomyosis.

- High quality greyscale remains an essential component of all forms (2D and 3D) of TVS and transabdominal ultrasound. Endometriomas are typically recognised by the characteristic greyscale appearances. Complex gynaecological disease is not confined to pelvic structures and high definition transabdominal greyscale is crucial in the examination of more severe, extensive cases of endometriosis. These might involve other organ systems such as the bowel or urinary tract. (Figs. 4-5)

- Superb Micro-vascular Imaging (SMI) is an innovative, highly sensitive form of colour Doppler processing. It recognises low velocity blood flow changes within specific tissues associated with endometriosis (adenomyosis). It improves differentiation between endometriotic and other forms of pelvic/ovarian lesions. (Figs. 6-9)

- Gentle tissue movement, achieved through both manual manipulation and transducer probing, is used for sliding test assessment. This is particularly of value in cases of extensive, infiltrative stages of pelvic disease.

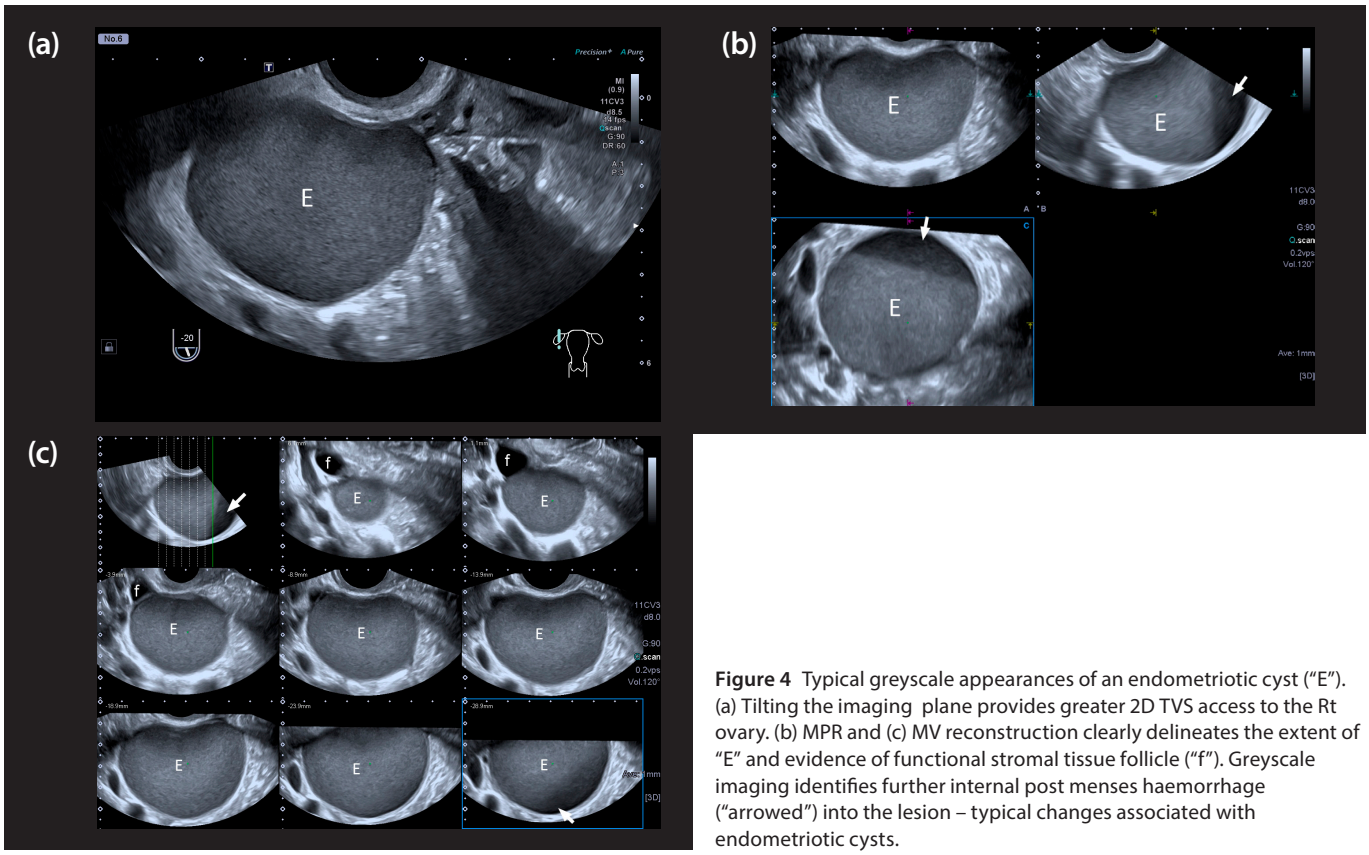

Figure 4 Typical greyscale appearances of an endometriotic cyst ("E"). (a) Tilting the imaging plane provides greater 2D TVS access to the Rt ovary. (b) MPR and (c) MV reconstruction clearly delineates the extent of "E" and evidence of functional stromal tissue follicle ("f"). Greyscale imaging identifies further internal post menses haemorrhage ("arrowed") into the lesion – typical changes associated with endometriotic cysts.

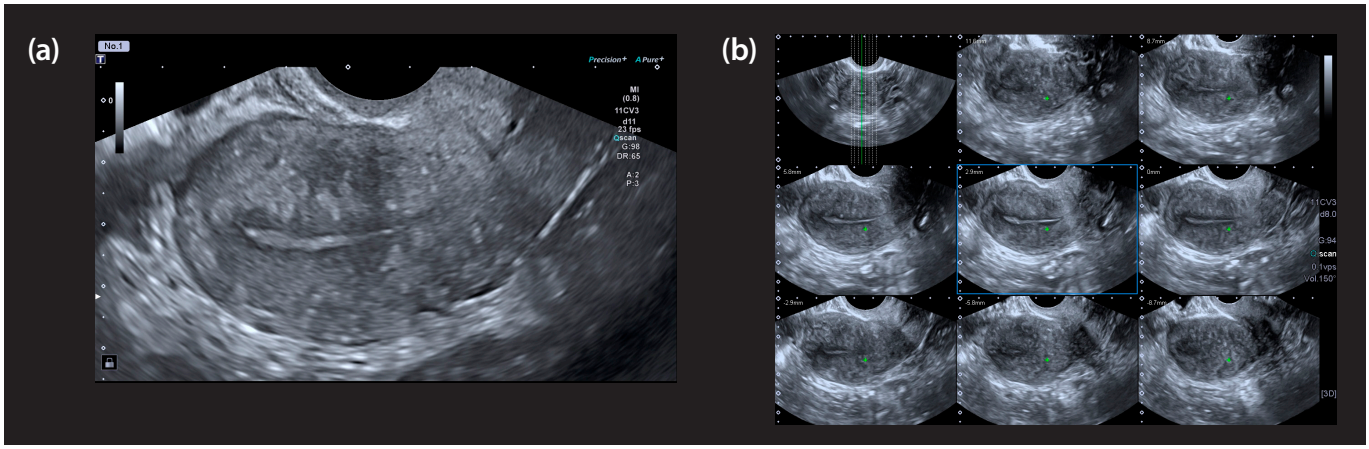

Figure 5 Diffuse myometrial changes associated with adenomyosis visualised by high quality greyscale in (a) 2D and (b) 3D MV TVS techniques.

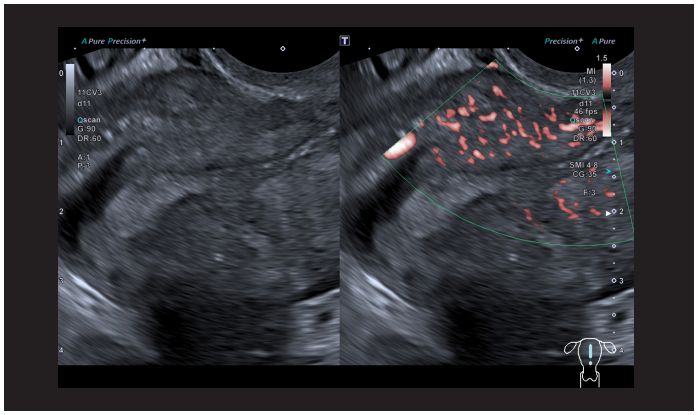

Figure 6 Combined 2D greyscale + SMI images of adenomyosis demonstrating myometrial textural changes and increased myometrial vascularity associated with hormonal (oestrogen) factors, a common feature found in cases of uterine endometriosis.

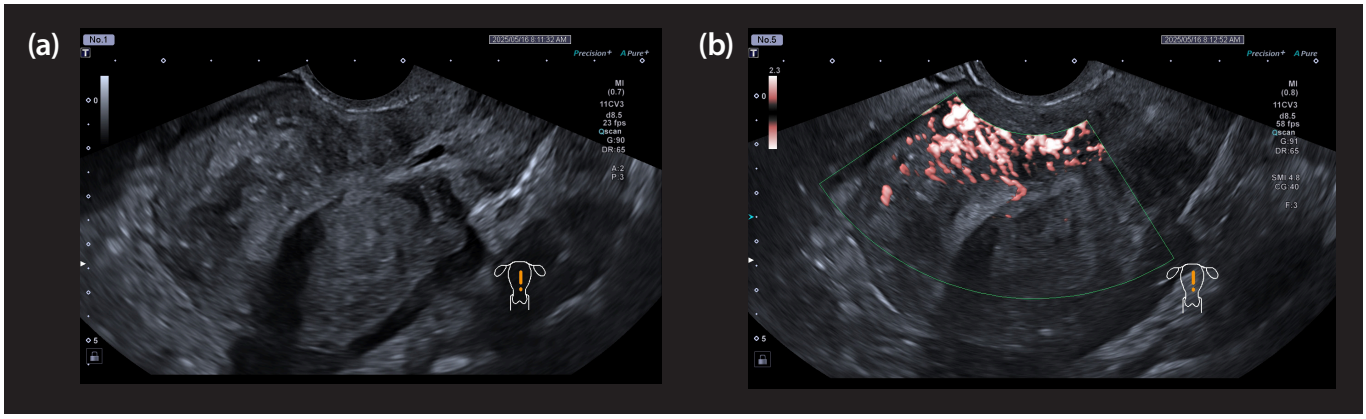

Figure 7 (a) Greyscale and (b) SMI imaging of adenomyosis emphasising co-existing, increased myometrial tissue vascularity typically indicative of the disease.

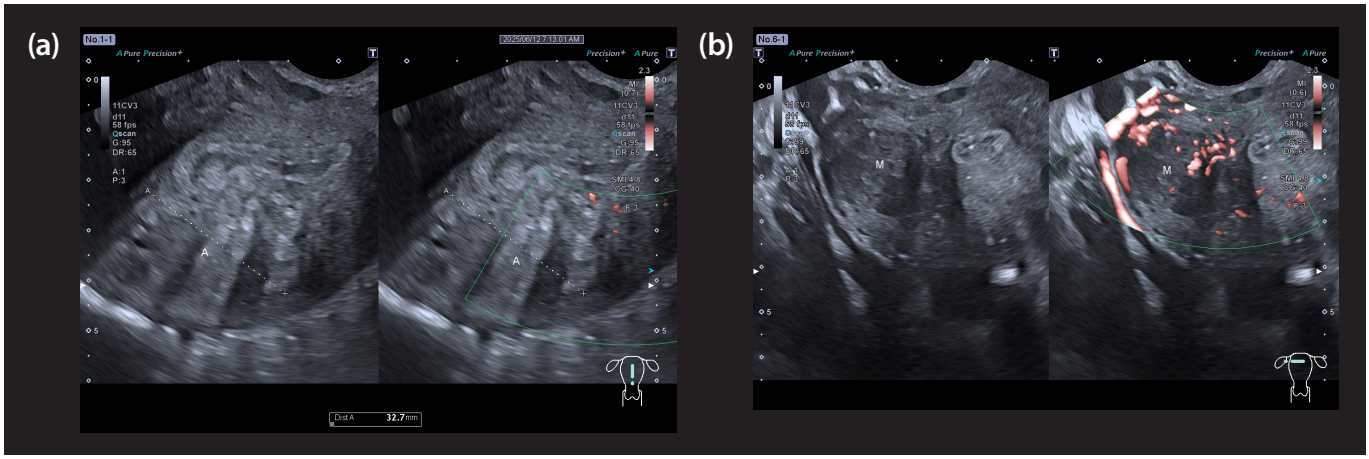

Figure 8 (a) Typical greyscale features of a relatively poorly defined, avascular adenomyoma. (b) SMI of a co-existing intramural myoma ("M") in the same case highlights the typical vascular nature of the lesion thereby differentiating it from the presence of an adenomyoma.

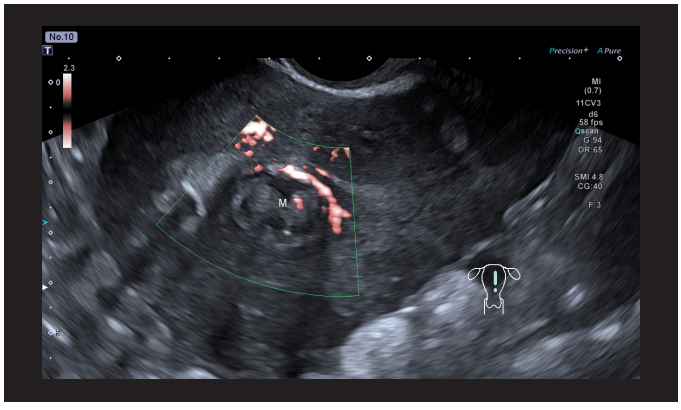

Figure 9 SMI appearances of an intramural myoma ("M") demonstrating typical peripheral and internal vascular patterns – emphasising the value of colour Doppler studies enabling differentiation between myomas and adenomyomas in particular.

Scanning protocols (1) : Uterus and adenomyosis

Technique

(1) A single TVS longitudinal sweep with an expanded sector angle, i.e. centred on the mid-sagittal section of the uterus, provides a 3D "survey" examination of uterine structures.
(2) A similar TVS transverse 3D survey sweep, i.e. centred midway between the internal os and uterine fundus.

Include

- Uterine body (myometrium + endometrium).
- Cervix to include rectouterine pouch (PoD) + vesicouterine pouch.
- External fundus and adjacent (bowel) tissues.
- Sliding sign assessment (manual and transducer probing).

Notes

- Diffuse greyscale changes within the myometrium are very often an indication of adenomyosis. Abnormal and asymmetrical thickening of the uterine wall is present in severe cases. 3D (coronal) multiplanar reconstruction readily visualises the integrity of the myometrial-endometrial interface and excludes infiltration of the disease into the endometrial cavity. 3D and SMI interrogation of associated lesions (adenomyomas) differentiate endometriotic disease from diffuse fibroid changes. (Fig. 10)
- The ability to detect subtle changes within the myometrium allows recognition of early stages of adenomyosis in symptomatic cases. High resolution greyscale demonstrates variations in textural appearances according to the stage of the menstrual cycle. SMI identifies hypervascularity within myometrial tissue

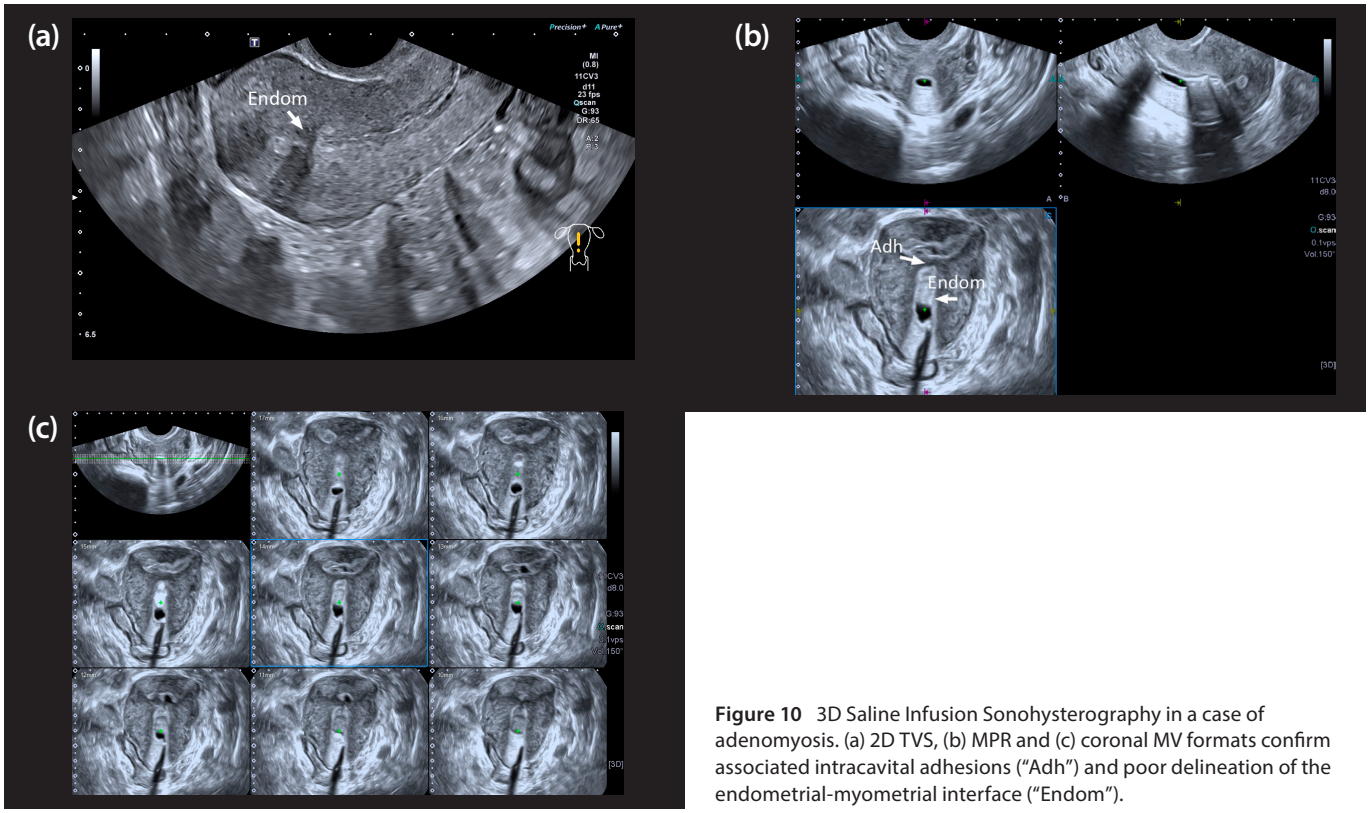

Figure 10 3D Saline Infusion Sonohysterography in a case of adenomyosis. (a) 2D TVS, (b) MPR and (c) coronal MV formats confirm associated intracavital adhesions ("Adh") and poor delineation of the endometrial-myometrial interface ("Endom").

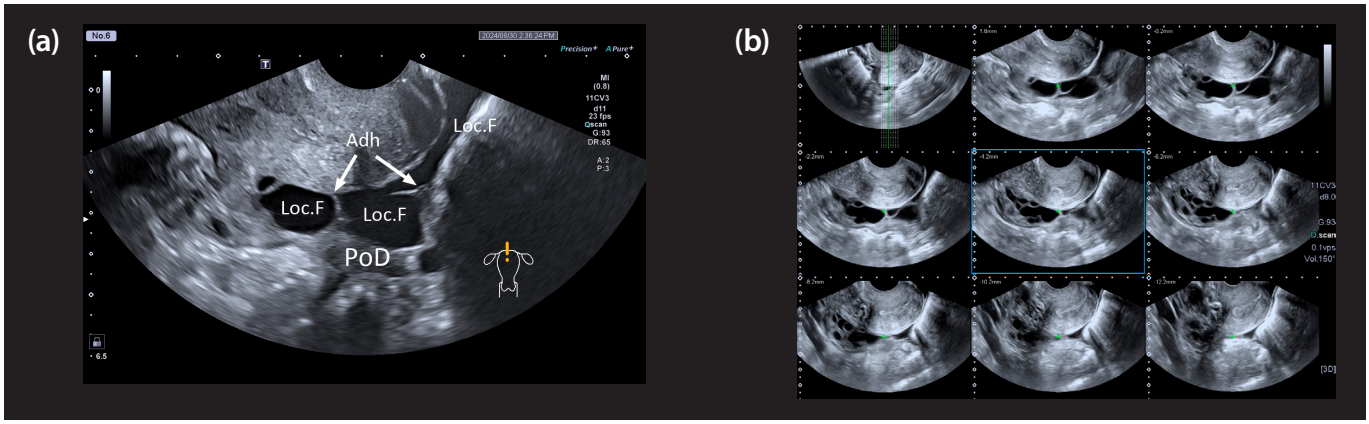

Figure 11 (a) 2D and (b) 3D MV images of extensive disease processes within the Pouch of Douglas ("PoD") region. Extensive adhesions ("Adh") and loculation fluid collections ("LocF") resulting in lack of "sliding movement" between pelvic bowel and the posterior wall of the cervix.

which might reflect hormonal (oestrogen) effects often regarded as an underlying factor in the development of endometriosis. Greyscale and SMI formats combine to aid differentiation between adenomyomas and other forms of myometrial lesions, namely myomas (fibroids).

- Longitudinal 2D scanning action focussed on the lower uterine and cervical areas enables examination of the uterine pouches. Gentle physical transducer probing (i.e. "sliding" motion) of the rectouterine pouch (PoD) gauges relative tissue movement between the posterior cervix and deep bowel. Lack of sliding sign especially when accompanied by increased pelvic discomfort during the manoeuvre, reflects the presence of localised adhesions and likelihood of deep pelvic disease processes. Similar physical assessment of the vesicouterine pouch can highlight adhesions between the uterus and the urinary bladder. (Fig. 11) "Static" plus "sliding" TVS interrogation focussed on the PoD region is crucial in the assessment of symptomatic patients.
- Manual manipulation of the uterine fundus on longitudinal 2D scanning reveals normal separation of neighbouring bowel from the uterine wall. Associated adhesions present within those areas can be excluded or confirmed. Transducer probing often with manual examination assists in confirming adherent ovaries and associated neighbouring bowel.

Scanning protocols (2): Ovarian and pelvic endometriosis

Technique

(1) Single expanded longitudinal and transverse survey scans respectively of each ovary.
(2) Localised high-resolution examination of either ovary respectively with reduced sector angle and corresponding adjustment of frame rates etc.

Include

- Ovarian anatomy – to include intracapsular and stromal features, associated pathologies, ovulatory activity and capsule appearances etc.
- Adjacent pelvic / adnexal structures, particularly local bowel.
- Sliding test assessment (manual and transducer probing).

Notes

- 3D TVS provides very detailed imaging of the ovaries and relevant anatomical and physiological information. Experience confirms its crucial role in this area of gynaecological diagnosis.

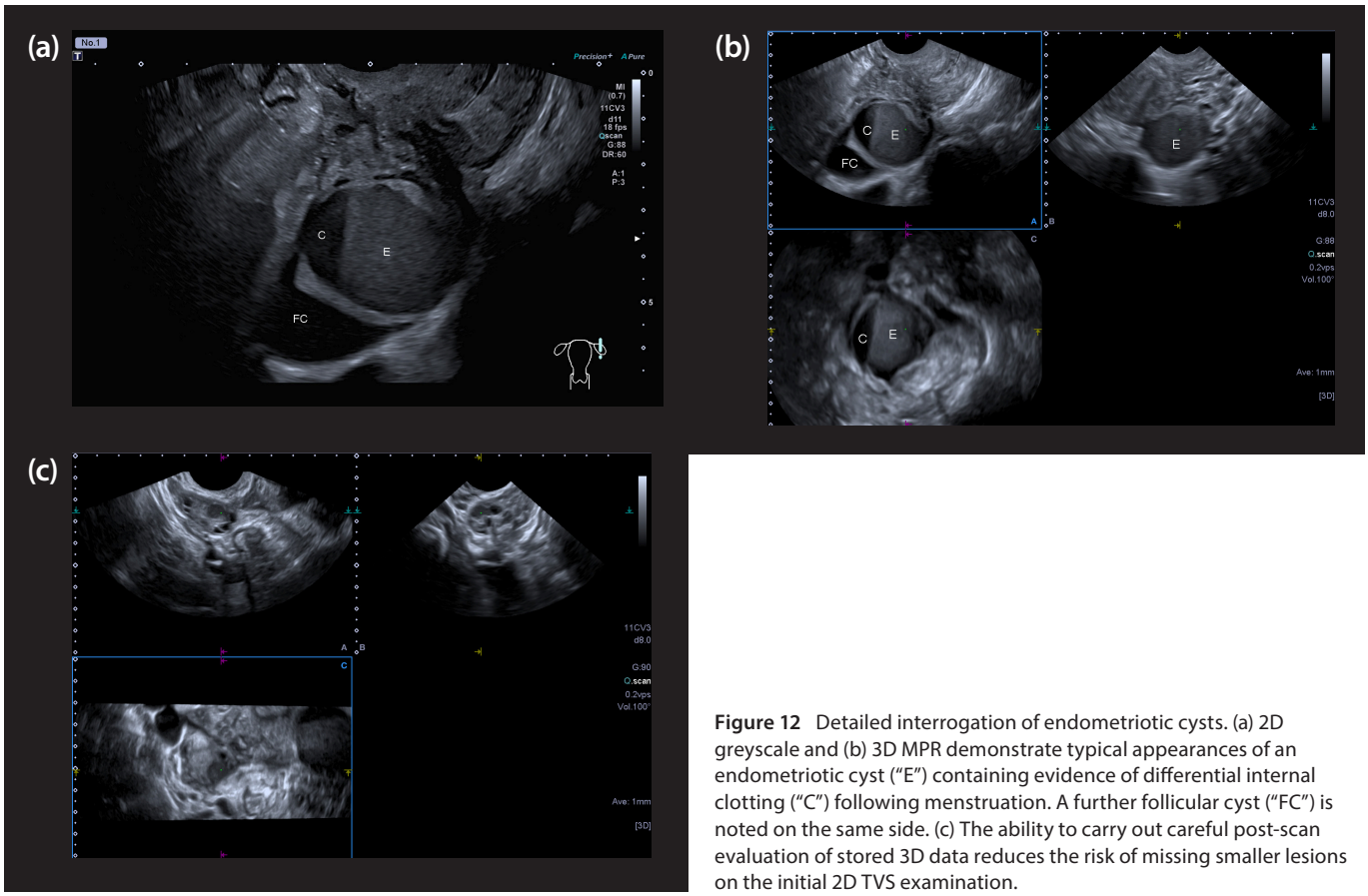

Figure 12 Detailed interrogation of endometriotic cysts. (a) 2D greyscale and (b) 3D MPR demonstrate typical appearances of an endometriotic cyst ("E") containing evidence of differential internal clotting ("C") following menstruation. A further follicular cyst ("FC") is noted on the same side. (c) The ability to carry out careful post-scan evaluation of stored 3D data reduces the risk of missing smaller lesions on the initial 2D TVS examination.

- 3D TVS remains the technique of choice as first-line diagnosis of ovarian endometriosis. MPR and MV reconstruction of acquired 3D data clearly define the size, number and nature of endometriotic lesions within the ovary. They confirm the presence of existing healthy, functional stromal tissue – a crucial factor influencing clinical management and confirming preservation of fertility status. (Fig. 12)
- The greyscale appearances of endometriotic cysts can significantly vary on comparing post-menses changes with those at peri- or post-ovulatory phases of the cycle. Recognition of these changes as well as use of SMI studies differentiates endometriomas from other types of ovarian lesions. (Fig. 13)
- A wider sector angle produces an extended field of view which provides a more complete visualization of adnexal and neighbouring structures. Combined MPR and MV reconstructions demonstrate evidence of (Fallopian) tubal involvement and / or associated pathologies particularly loculated fluid collections secondary to pelvic adhesions. Careful scanning and review of stored 3D information improves the ability to recognise the formation of pelvic nodules. (Fig. 14)

Scanning protocols (3): General abdominal

Technique

An expanded approach to ultrasound scanning is indicated according to the severity of clinical symptoms or perhaps in response to findings in more routine TVS examination as outlined above. This necessitates careful examination of the gastrointestinal and urinary tracts in particular and especially in cases presenting with extensive infiltrating forms of endometrial disease.

Notes

- Transabdominal inspection of the serosal layer of the intestine reveals abnormal tissue thickening or associated nodules. Manual assessment whilst scanning confirms normal separation of bowel loops or the presence of bowel adhesions in affected cases.
- Evidence of pelvic adhesions and / or possible involvement of the ureter(s) requires scanning of the kidneys in order to exclude hydronephrotic changes resulting from localised ureteric strictures.
- Longitudinal transabdominal scan carried out through a distended urinary bladder demonstrates bleeding within the rectovaginal region at the time of menstruation.

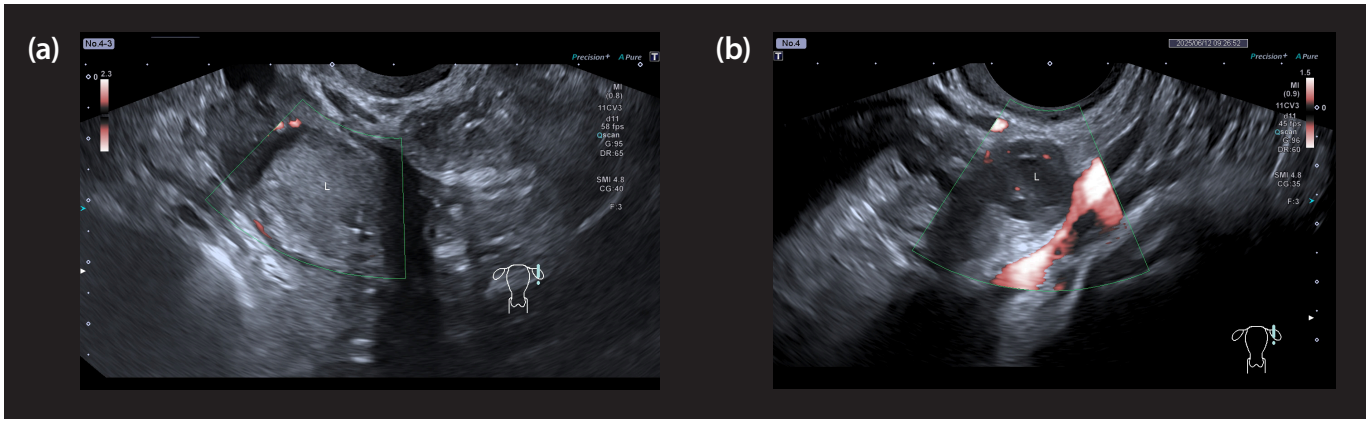

Figure 13 (a) An ovarian lesion ("L") mimics the appearances of an endometrioma. (b) A follow-up post menses scan of the same lesion confirms a collapsing corpus luteum cyst. This case shows the value of serial scanning in terms of differentiating an endometriotic lesion from other types of ovarian cysts.

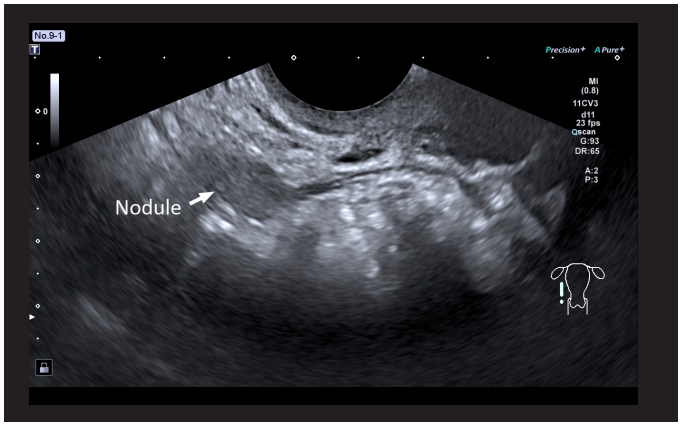

Figure 14 TVS identifies an endometriotic nodule within the region of the Rt uterosacral ligament and emphasises the need to examine pelvic tissues within the pelvic cavity generally.

Ultrasound characteristics of “Ovarian cysts”

Ovarian lesions can often mimic the greyscale ultrasound appearance of endometriosis. Considerations in terms of practical application and combined utilisation of available ultrasound imaging formats assist in differentiating other common ovarian lesions.

Typical findings include:

(Haemorrhagic) Functional Cysts

- Integral element of the reproductive / ovulatory cycle.
- Cyclical variations in size and internal greyscale appearances.
- Usually resolved following menses; post menses follow-up assessment recommended.
- Marked variation and presence of peripheral vascularity (angiogenesis) indicated by SMI.
- Associated changes in endometrial appearances.

(Mucinous) Dermoid Cysts

- No significant variation in size and greyscale appearances on a month-to-month basis or due to reproductive / menstrual activity.
- Absence of peripheral angiogenesis +/- internal evidence of vascular changes are typical findings.
- Note: similar protocols for Ovarian Fibromas

Endometriotic Cysts

- So-called “ground glass”, uniform greyscale appearances can vary around menstruation as a result of differential clotting processes internally.
- Appearances greatly influenced by hormonal changes e.g. associated with ART, HRT, oestrogen dominance etc.
- Gradual increase in size from menstrual cycle to cycle.
- Absence of peripheral angiogenesis indicted by SMI.

Summary

Clinical treatment of endometriosis primarily relies on diagnosis of the disease at the earliest possible stage of development possible. Vigilance in terms of scanning technique and “complete” utilisation of available imaging formats is paramount. The impact of advanced ultrasound application and diagnosis continues to be increasingly recognised in the selection of appropriate clinical or surgical treatment of endometriosis. A comprehensive approach to scanning technique is essential and indeed crucial in order to facilitate appropriate planning for treatment of endometriosis and involvement of relevant clinical specialists as necessary.

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