How modern ultrasound technology can improve and accelerate the challenging diagnosis of endometriosis and investigation of pelvic pain

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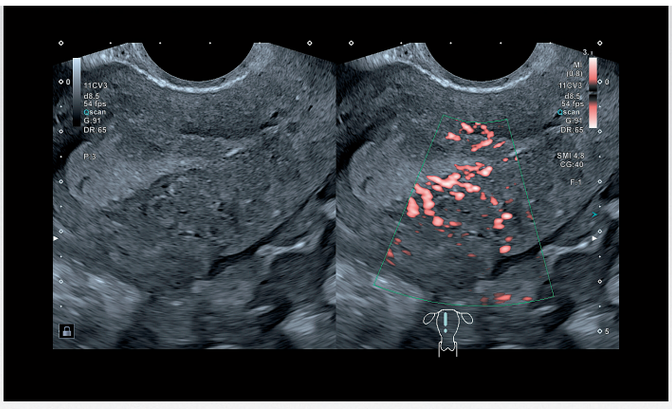
Introduction

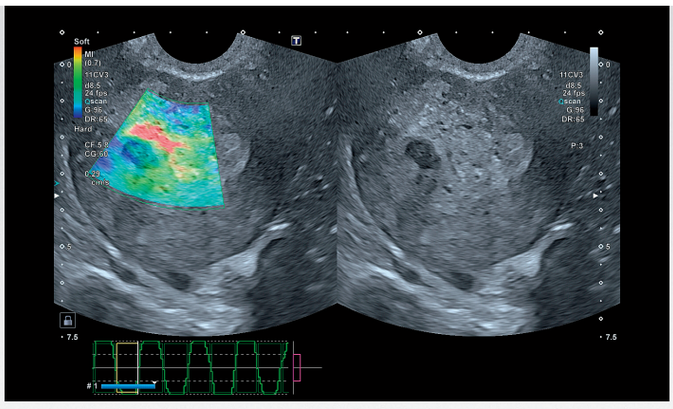
Ultrasound investigation of pelvic pain is a complex area of gynaecology. It presents both diagnostic and clinical challenges not always realised. Modern ultrasound imaging focusses both on identifying as well as excluding gynaecological causes. Pelvic pain can be associated with urinary tract, bowel and musculoskeletal disorders. Ultrasound examination therefore requires an acceptable level of scanning competence and vigilance as well as access to a range of imaging modalities.

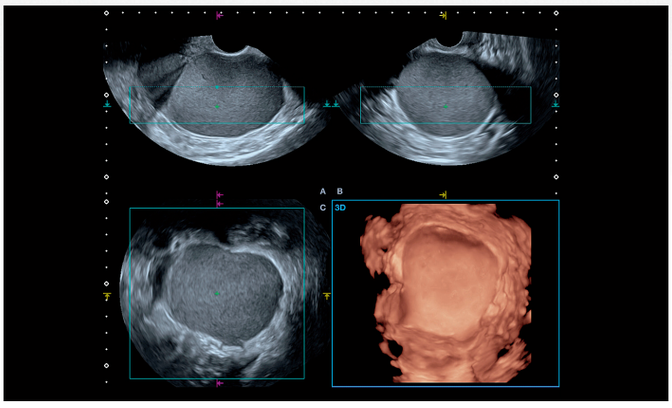
The value of ultrasound investigation in this context is gauged not only by diagnostic accuracy but crucially by the clinical information it provides to allow appropriate treatment options to be considered.

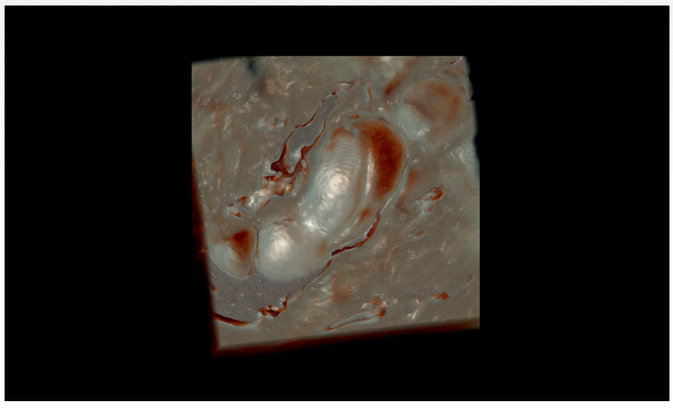
State of the art ultrasound technology offers a comprehensive approach to assessment of chronic and acute pelvic pain. It follows that gynaecological causes might involve uterine issues or adnexal pathologies. However studies over several decades at CDS suggest a significant number of cases present with symptoms emanating from functional (hormonal) disorders often with co-existing presence of uterine or pelvic endometriosis.

The aetiology and natural history as well as true incidence of endometriosis remains uncertain. Previous studies report the diagnosis of endometriosis in as many as 50–60 % of women being evaluated for pelvic pain. Endometriosis is quoted as affecting up to 10 % of women of reproductive age although identifying adenomyosis by scan remains a more recent concept and is therefore perhaps not taken into account.









The disease can occur in adolescence. It can also develop as a result of exogenous hormonal therapy particularly in post-menopausal patients.

Clinical perspective

When a clinician has a patient and the diagnosis of endometriosis is suspected, presentation to the clinician can be in several ways.

The diagnosis of endometriosis may have already been made and so the focus is then on whether there has been recurrence of disease. Knowledge of pre-existing surgery is important in several ways. It informs the clinician as to the possible severity of disease and also possible location of recurrent disease. The dialogue between clinician and ultrasonographer should in these circumstances be a two-way process and the clinician should pass on all clinical details, as this ultimately will guide the imaging technique. Dialogue cannot be over-emphasised.

Many patients will present with symptoms suggestive of endometriosis but the diagnosis has not yet been made. These symptoms may be varied and they may range from painful periods, painful intercourse or even concerns about fertility. When the symptoms are focused, the clinician is often interested in certain anatomical areas. For example, in deep dyspareunia the clinician will be wanting information about tethering/adhesions/mobility of ovaries, the presence of endometriomas or nodularity and thickening within the Pouch of Douglas. An indication of ovarian mobility is important especially when dealing with endometriomas at surgery. Many gynaecologists will perform surgery for endometriosis but only a few in specialist centres will treat severe stage IV disease and deep infiltrating endometriosis (DIE). There is thus a filtering system in treating patients and imaging helps enormously in triaging the patient to the right place /surgeon in order to give the best possible care.

Technical aspects

Modern ultrasound systems should provide access to a choice of scanning applications and a range of imaging formats. A flexible approach to routine pelvic scanning is shown to maximise its diagnostic effectiveness essential for selection of appropriate clinical management. This particularly applies to the ultrasound investigation of endometriosis and other causes of pelvic pain.

Transvaginal scanning (TVS) is fully recognised as the principal imaging modality for examination of the female pelvic organs and assessment of gynaecological disorders. High-quality TVS greyscale capability is essential. The issue of differential diagnosis in confirming the nature of ovarian lesions or the ability to recognise subtle textural changes associated with adenomyosis for example emphasise the importance of identifying very fine greyscale changes within pelvic tissues.

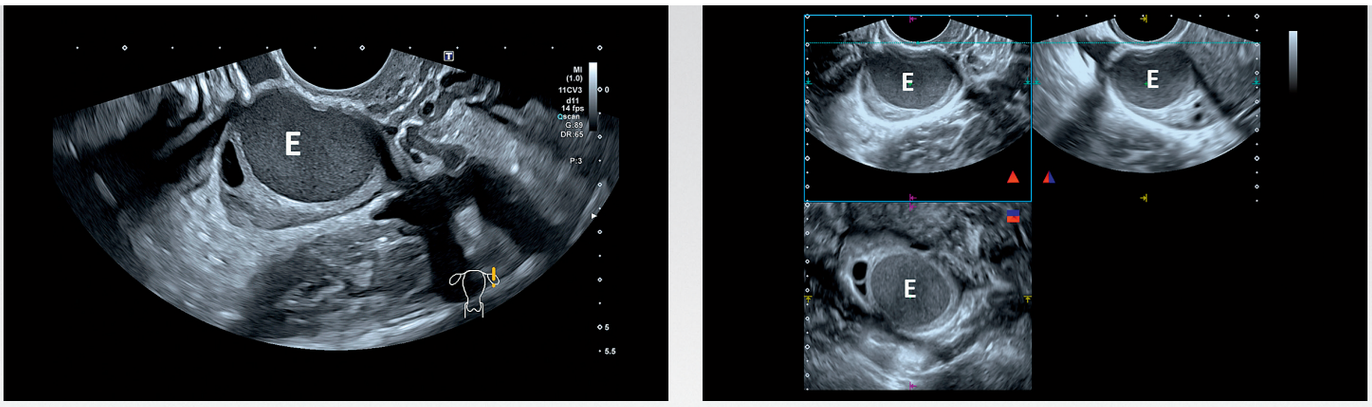


Fig. 1a and 1b: 2D [a] + 3D multiplanar images [b] demonstrating the characteristic appearances of an endometriotic cyst (E). 3D acquisition clearly shows the presence of preserved healthy ovarian tissue.

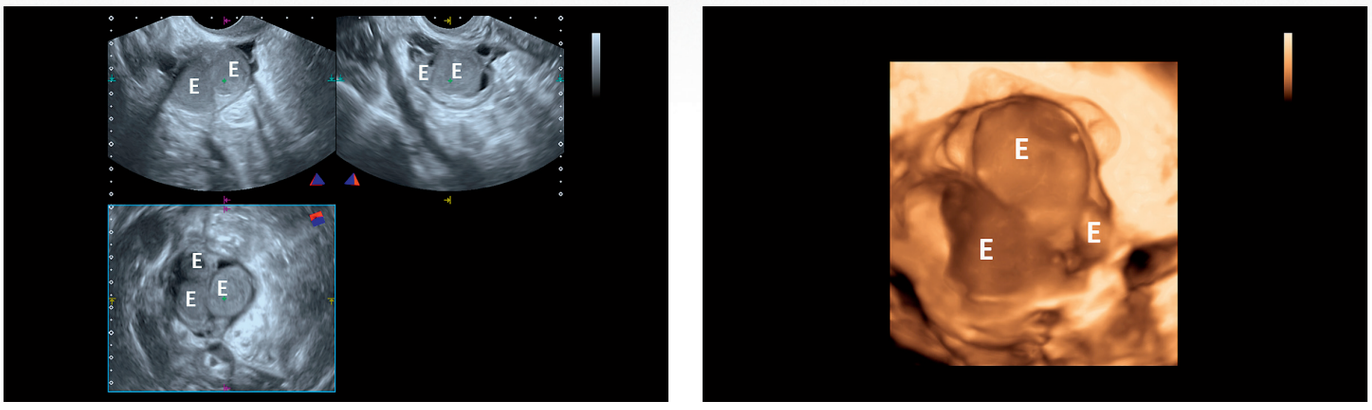


Fig. 2a and 2b: 3D multiplanar [a] and rendered [b] images clearly delineating the presence of multiple endometriotic cysts (E).

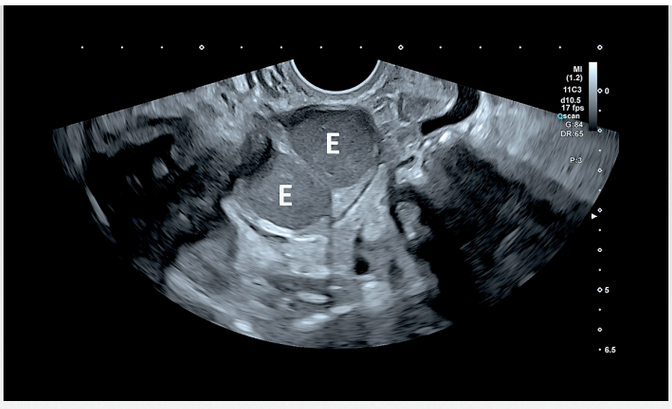
The value of both transabdominal (TAS) and transrectal (TRS) imaging can complement or provide a necessary alternative to TVS. The wider field of view and increased ultrasound beam penetration provided by TAS improve delineation of large uterine or ovarian masses. The cause of pelvic pain and the development of endometriosis itself often originate from the deep pelvic region. TRS offers more detailed evaluation of associated changes and overcomes some of the technical problems encountered in these cases. It provides greater access to adherent ovaries within the deep pelvis.

3D TVS has had a major impact in key areas of general gynaecology and reproductive medicine. It greatly enhances ultrasound evaluation of ovarian morphology, uterine anatomy and related anomalies. In addition, it provides greater visual separation of pelvic structures and tissues and proves to be of significant diagnostic value in the assessment of complex disease.

Coronal section of the uterus generated by 3D TVS clearly delineates the endometrial – myometrial interface important in the assessment of adenomyosis. The need for uniformity in terms of registration and spatial resolution as well as contrast (greyscale) resolution in all anatomical planes is essential for accurate reconstruction of 3D data. Post-processing functions and creation of rendered image formats introduce the concept of post-scan evaluation and reporting. This is shown to be especially beneficial in terms of clinical communication and pre-surgical planning. Advanced virtual 3D TVS (Fly Thru) provides the technical basis for "ultrasound hysteroscopy" as part of saline sonohysterography (SIS) procedure.
The sensitivity and image resolution attributed to modern TVS colour Doppler imaging modalities continue to improve. "Superb Micro-vascular Imaging" (SMI) has provided a greater awareness of vascular changes demonstrated within the pelvic tissues and specific organs.

These are shown to reflect normal physiological (hormonal) changes as well as those caused by gynaecological disease processes. SMI has confirmed a definite impression associating pain with hyperaemic changes within the pelvic tissue. It identifies peripheral angiogenesis associated with hormonally active ovarian cysts which remain the most common cause of pelvic pain and accompanying menstrual disorders. SMI introduces the concept of "functional ultrasound" within the pelvis and appears to demonstrate the relationship between ovarian (hormonal) factors and pelvic pain, especially so in the presence of adenomyosis and pelvic endometriosis.

Realtime Elastography (RTE) is a more recently introduced ultrasound modality in the investigation of gynaecological disease. Localised variation in the compressibility of myometrial tissue is caused by diffuse processes such as adenomyomas. It follows that RTE can be extremely useful in



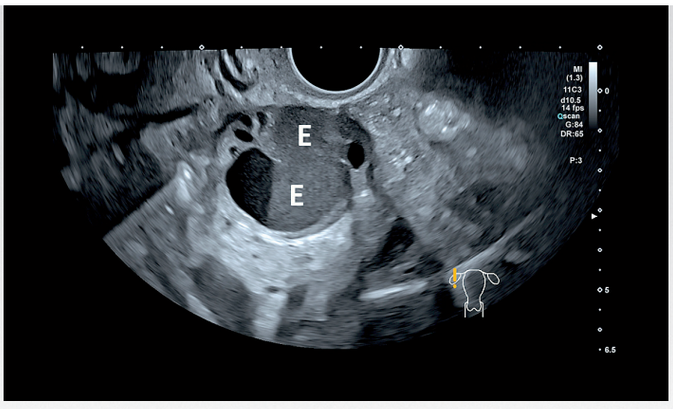


Fig. 3a and 3b: Serial 2D imaging of the same endometriotic cyst (E) showing changes in ultrasound appearances at pre-menses [a], menses [b] and post-menses stages.

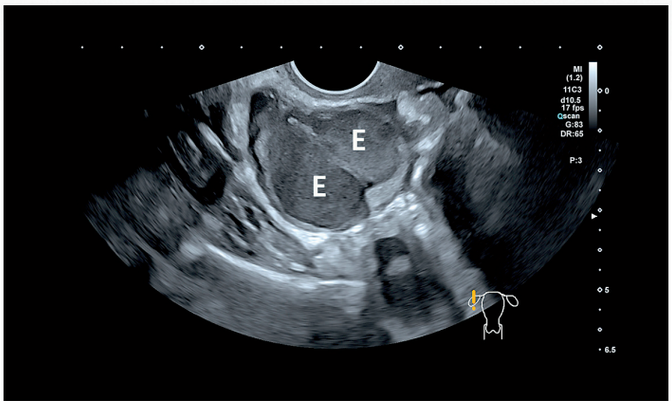


Fig. 3c: It emphasises the value of follow-up interrogation in confirming the presence of an endometrioma compared to other types of haemorrhagic or mucinous lesions.

differentiating between adenomyomas and uterine fibroids. To date a manual compression approach has been adopted rather than shear-wave technology. Gentle prodding of the uterus is in itself of diagnostic value if it appears to cause patient discomfort on examination of specific anatomical areas within the pelvis.

Aspects of scanning practice

The practical approach to TVS requires consideration in terms of patient tolerance. Routine probe movements can be the cause of significant patient discomfort especially in cases of severe, extensive endometriosis as well as acute inflammatory changes. The availability of wider scan sector angles, automatic sector displacement facility and especially 3D acquisition of ultrasound data greatly reduce the need for and extent of TVS probe manipulation. Conversely, (gentle) prodding of specific anatomical regions such as the rectovaginal and uterosacral areas with the TVS probe might well be of diagnostic value. Focal pain experienced by the patient in this respect can often be an indication of endometriosis present within the deep pelvis.

Endometriosis: ovarian endometriomas and pelvic nodules

The characteristic ultrasound appearances of clot-filled ovarian endometriomas are widely reported. Typically they present with a relative homogenous low-level echo pattern. [1] [2] but this can vary. Internal bleeding into the lesion at the onset of the menstrual period can certainly change the ultrasound features seen.[3] Different staging of internal clotting results in irregular appearances and can even give the impression of loculations. These tend to resolve and normal, uniform appearances are restored later in the ovulatory cycle. Greyscale textural changes either side of menses, the usual avascular nature in ultrasound terms and the growth of the lesion from cycle to cycle differentiate endometriotic cysts from structures such as haemorrhagic luteal cysts or mucinous teratomas of the ovary. 3D TVS of the ovary has a crucial role to play in assessment of endometriomas.

Manipulation of the stored data, multiview (tomographic) imaging and access to rendered 3D functions are of considerable value. Lesions are very clearly delineated and their numbers confirmed.[2] The ability to gauge the presence and extent of preserved functional ovarian tissue[1] is a crucial factor in considering surgical management of large endometriomas. Endometriomas tend to be asymptomatic in nature unless relatively large. Associated, often acute pain can nevertheless occur as a result of cyst rupture[4] or torsion.[5] The presence of nodules elsewhere within the pelvis is more likely to be a source of localised pain. The presence of bowel gas within the pelvis can provide a major obstacle in identifying extra-ovarian nodules or endometriotic tissue. TRS offers clearer imaging of deep pelvic pathology [6a + b] and often proves to cause less discomfort for the patient in cases of severe, extensive endometriosis. TAS can also be better suited for interrogation of those lesions involving pelvic bowel. [6c]

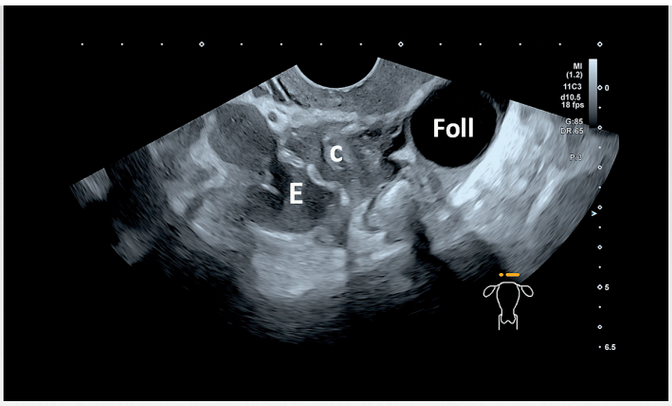


Fig. 4: Remnants of a ruptured endometriotic cyst (E) with associated resolving pelvic clot (c) and the presence of a peri-ovulatory follicle (Foll) on the opposite ovary.

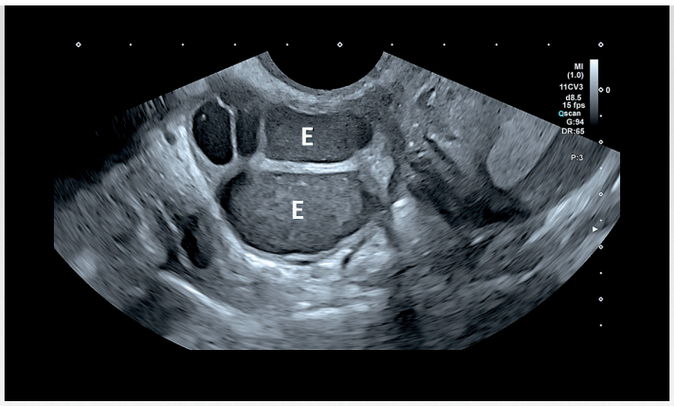


Fig. 5a: Torsion of an endometriotic cyst (E). 2D appearances [a] suggest two separate lesions.

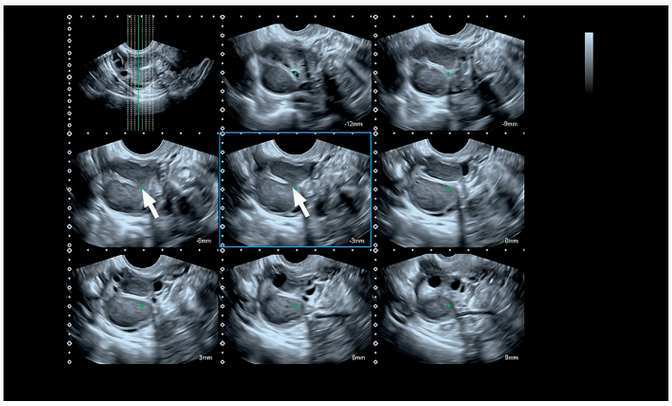


Fig. 5b: Multisectional images [b] however demonstrate continuity (arrowed) between the two apparent lesions.

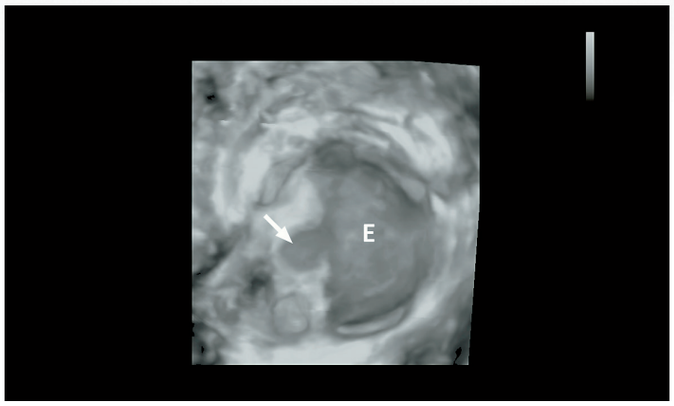
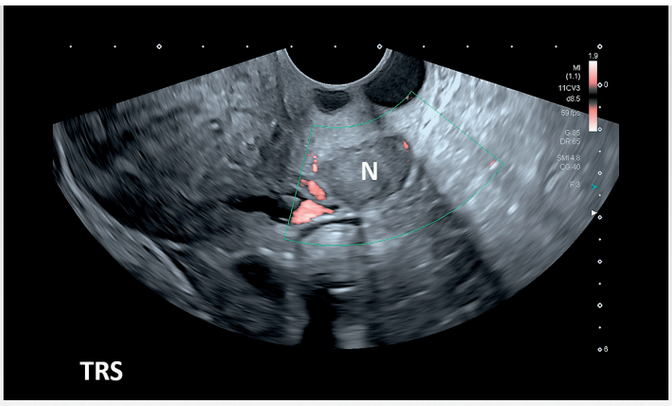


Fig. 5c: A rendered image [c] shows distortion (arrowed) within the wall of the single lesion associated with torsion.

Endometriosis: deep pelvic endometriosis

Ultrasound evaluation of the deep pelvis, particularly visualisation of the rectovaginal and uterosacral regions can be difficult. It remains poorly accessible technically and can prove extremely painful for patients presenting with deep infiltrating disease. Ultrasound procedures involving pre-examination bowel preparation might be carried out in specialised units.

MRI remains the technique of choice in terms of non-surgical diagnostic imaging. However, greater consideration given to the approach to "standard" pelvic scanning can provide useful clinical information. A basic scoring system rating the degree of localised pain experienced by the patient on interrogation of relevant pelvic anatomy might reflect the presence of endometriosis as such. The occurrence of bleeding within the rectovaginal area which occurs at menstruation but resolves within the first week of the ovulatory cycle is demonstrated by TAS.[7c][8] 3D TVS interrogation of the deep pelvic structures is able in some cases to confirm the presence of rectovaginal adhesions. The so-called sliding mechanism showing relative movement of bowel along the posterior cervical/lower uterine wall has been described.



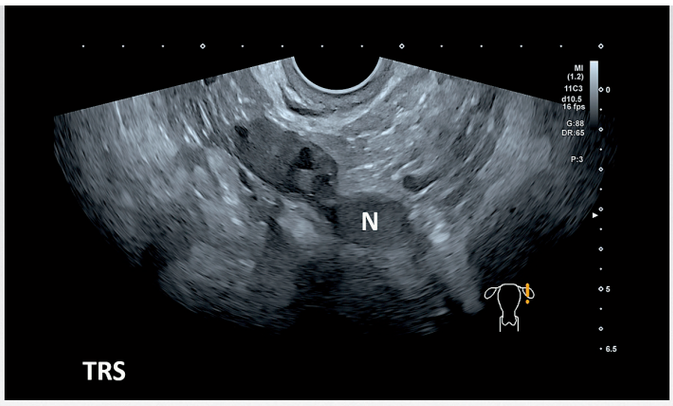


Fig. 6a and b: Images confirming the need for a flexible scanning approach to ultrasound investigation of endometriosis. Transrectal scanning (TRS) clearly demonstrates endometriotic nodules (N) in [a] and [b].

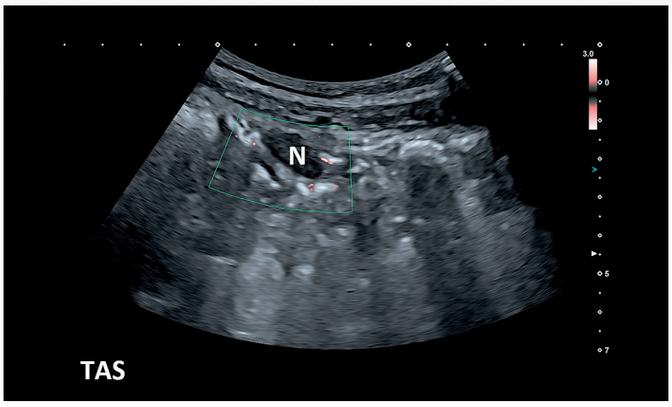


Fig. 6c: Transabdominal scanning (TAS) shows the presence of a nodule (N) associated with pelvic bowel [c].

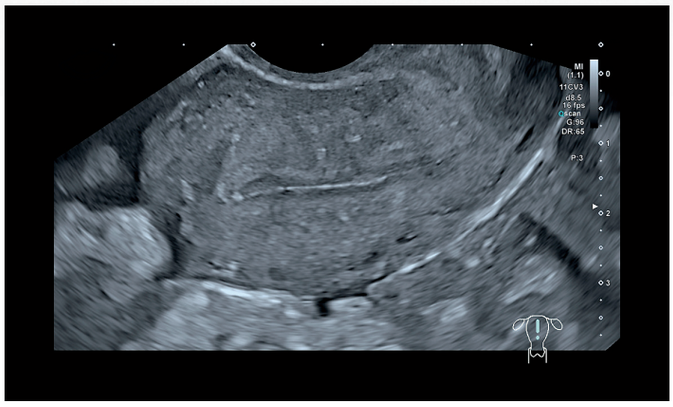


Fig. 7a: Adenomyosis and deep pelvic endometriosis. [a] shows the "speckled" appearances of the myometrium suggestive of adenomyosis.

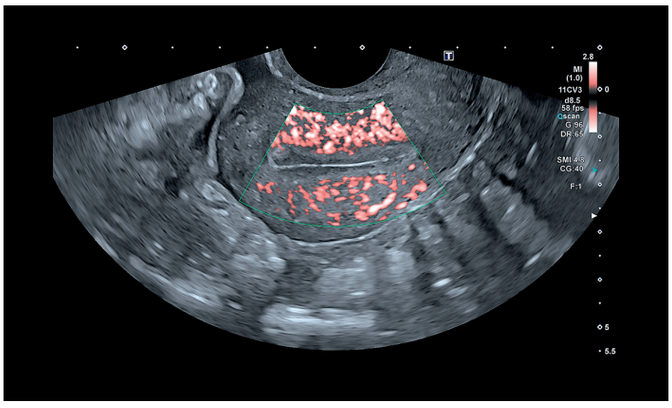


Fig. 7b: [b] SMI demonstrates increased myometrial vascularity typically found in cases of suspected adenomyosis and probably reflects associated hormonal ("oestrogen") factors.

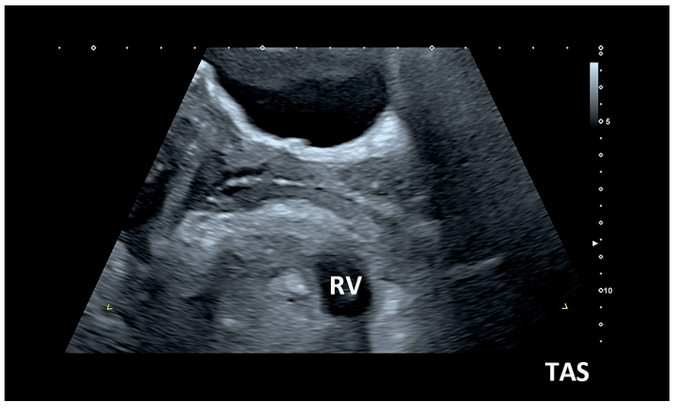


Fig. 7c: [c] Transabdominal scanning outlines bleeding within the rectovaginal area (RV) immediately following menstruation strongly suggestive of deep pelvic endometriosis.

Experience confirms this is not always reliable mainly due to patient pain caused by the technique.

The above elements can nevertheless serve as useful factors indicating the need for laparoscopic investigation in the management of pelvic pain.

They give rise to the suspicion of pelvic endometriosis in the absence of identifying ovarian endometriomas or obvious pelvic nodules.

Endometriosis: adenomyosis

More recent, ongoing improvements in TVS imaging have had a considerable impact in the diagnosis of adenomyosis. Adenomyosis is defined as being invasion of the myometrium by endometrial tissue. It remains a common cause of pelvic pain. Clinical symptoms include menorrhagia, dysmenorrhea and dyspareunia. In addition it is regarded as a major factor influencing the ability to conceive or maintain early pregnancy development.

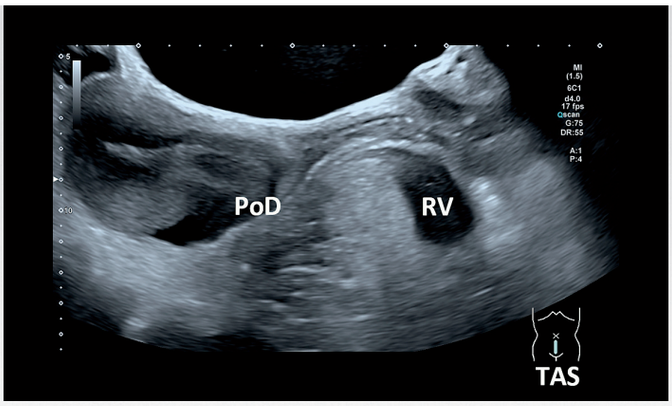


Fig. 8: Transabdominal scanning at the time of menstruation showing obvious shedding of the endometrium. Menstrual clot is present within the Pouch of Douglas (PoD). In addition associated bleeding can be seen within the rectovaginal region (RV). The case suggests a novel approach to identifying the likely presence of deep pelvic endometriosis as a result of standard TAS at the time of menstruation.

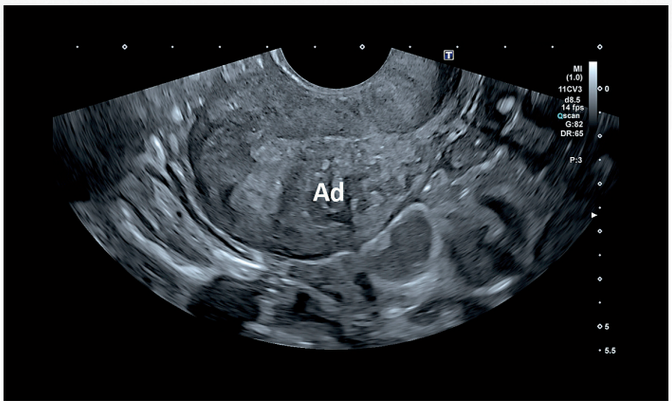


Fig. 9a: Irregular greyscale appearances [a] and myometrial vascularity [b] in a severe case of adenomyosis (Ad).

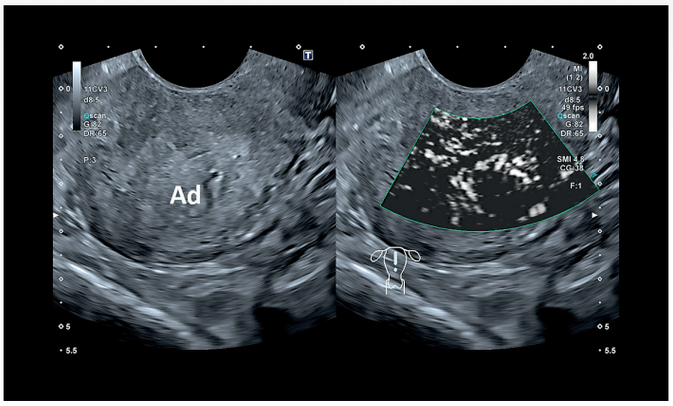


Fig. 9b: Highly sensitive monochrome SMI highlights the vascular changes present in many of those cases.

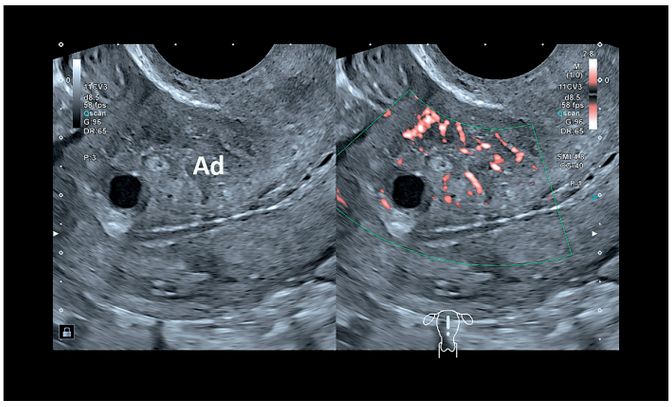


Fig. 10: Irregular myometrial greyscale textural and SMI vascular changes as well as asymmetrical thickening of the uterine wall in a severe case of adenomyosis (Ad).

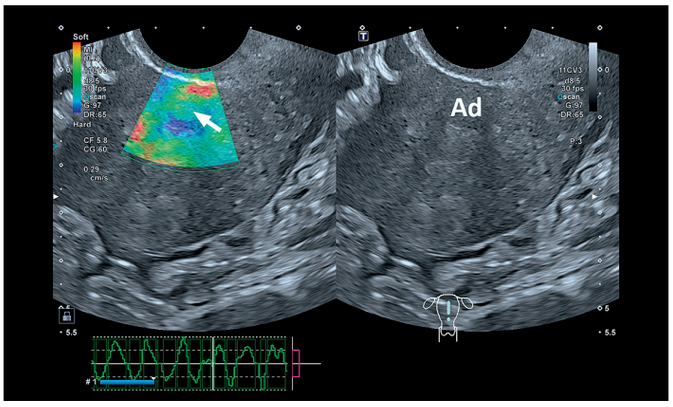


Fig. 11: Compression real-time elastography identifies tissue changes (arrow) associated with a small adenomyoma (Ad).

The presence of ectopic endometrial glands and stroma are located somewhat haphazardly usually deep within the myometrium. Extensive adenomyosis typically presents with asymmetrical thickening of the uterine wall. It might appear ultrasonically as relatively diffuse changes distributed throughout the myometrium or in the form of a discreet but often poorly-defined intramyometrial tumour or adenomyoma.[9][10] RTE has the potential to recognise affected myometrial tissue and is of particular value in differentiating between uterine myomas and adenomyosis.[11][12] 3D TVS provides more detailed assessment of irregularities within the greyscale tissue patterns of the myometrium. Coronal anatomical reconstruction of 3D data clearly outlines the uniformity of the cavity wall and highlights loss of the myometrial-endometrial interface in more severe cases.[13] Saline infusion sonohysterography (SIS) incorporating advanced virtual 3D ("Fly Thru") technology or "ultrasound hysteroscopy" is very effective in evaluating the

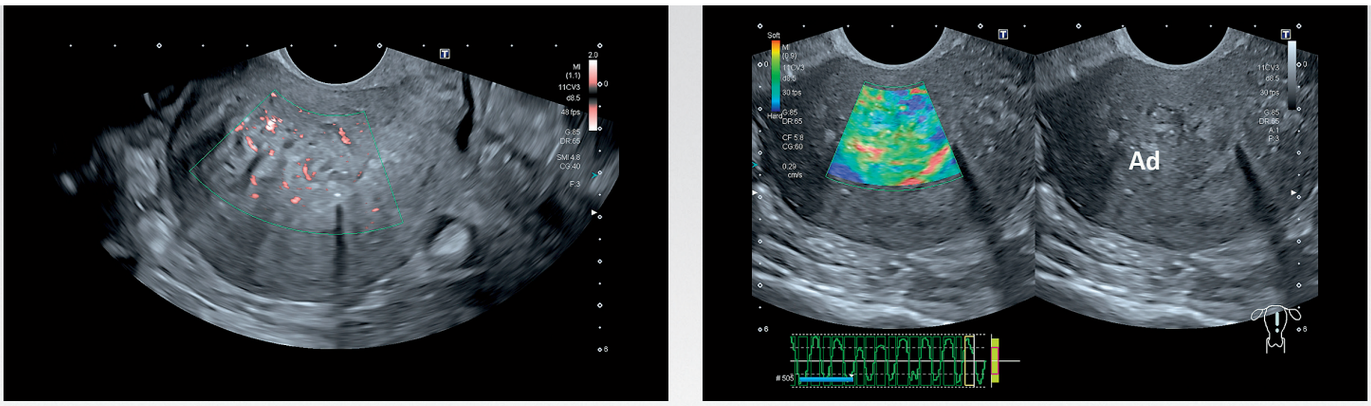


Fig. 12a and b: Irregular greyscale appearances plus SMI [a] and real-time elastography [b] highlight myometrial changes in a severe case of adenomyosis (Ad).

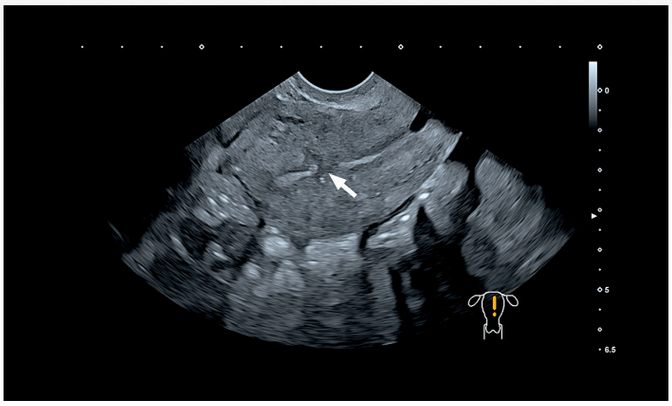


Fig. 13a: 2D greyscale [a] and 3D rendered [b] imaging of the effect of extensive adenomyosis on the endometrial cavity (arrow).

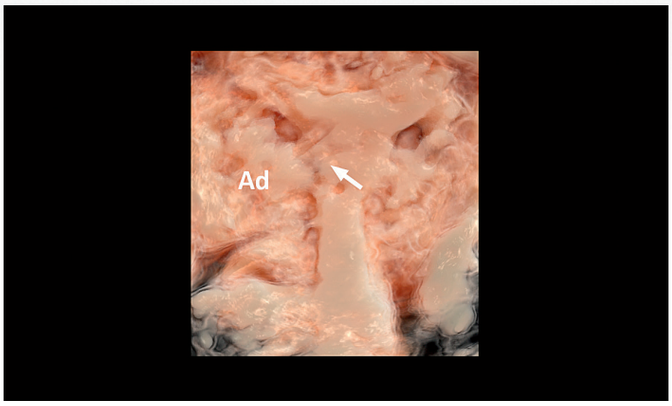


Fig. 13b: The rendered image [b] identifies "endometrial-like" tissue (Ad) changes within the myometrium associated with severe adenomyosis as well as loss of the myometrial-endometrial interface.

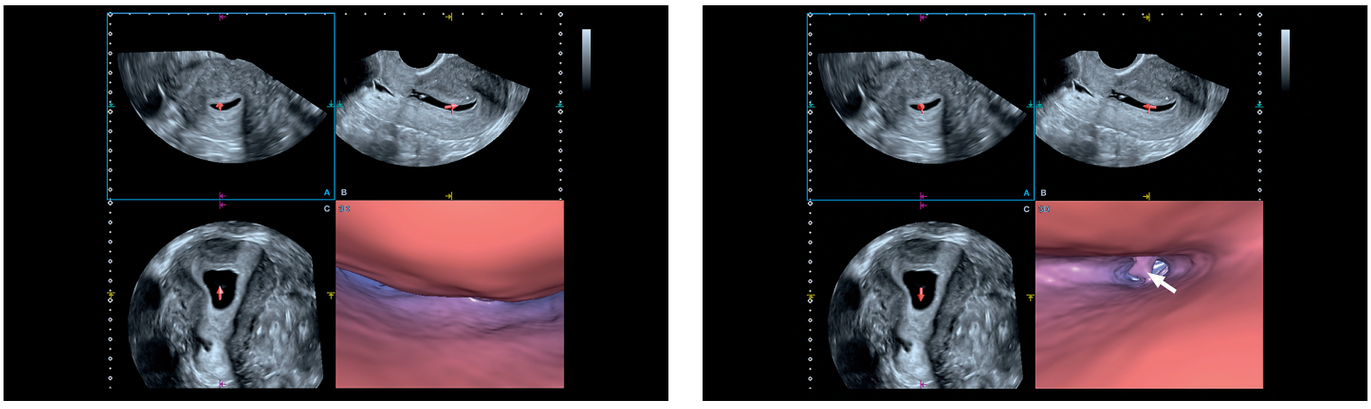


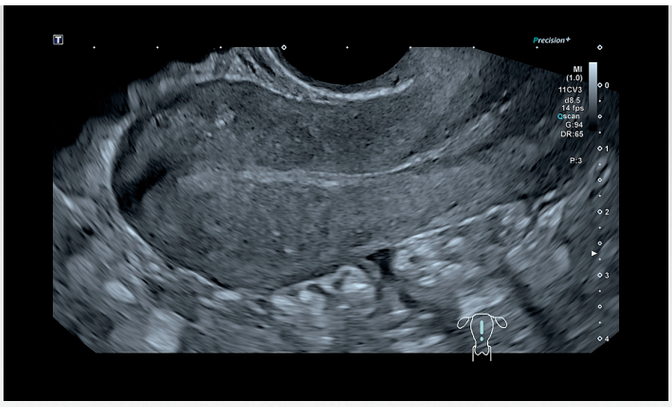
Fig. 14a and b: Advanced Fly Thru 3D virtual imaging shows indentation of the anterior uterine cavity wall by extensive adenomyosis [a] and the presence of an associated localised adhesion (arrow) within the lower cavity [b].

healthiness of the endometrial cavity and visualising any abnormal features which might be related to the presence of adenomyosis.[14] Improvements to greyscale capability readily highlight the presence of the disease certainly in more severe cases. Modern high-performance TVS systems are nevertheless able to recognise subtle greyscale changes within the myometrial tissue, specifically around the time of menstruation, which are seen to change in appearance as the ovulatory cycle progresses. This identifies the likely presence of the condition at an extremely early stage of the disease process.[15] Although the precise aetiology of endometriosis remains unclear, it is accepted that angiogenesis represents a crucial step in the pathogenesis of endometriosis. Improved colour Doppler sensitivity provided by SMI clearly demonstrates increased vascularity within myometrial tissue in confirmed cases of adenomyosis. [9][10]Diagnostic and clinical impressions confirm the relationship between hyperaemic changes within the pelvic organs and hormonal (oestrogen) factors. Studies suggest the co-existence of oestrogen-sensitive lesions, such as myomas, as well as tissue changes, such as endometrial proliferation frequently with the formation of polyps in up to 80 % of cases of suspected adenomyosis. SMI used in conjunction with 2D and 3D greyscale TVS and RTE is a useful imaging component in confirming the likely presence of uterine endometriosis. The availability of 2D and 3D vascular indices also demonstrate changes in vascular patterns on comparing normal myometrial tissue with localised areas of adenomyosis.

Pelvic pain: vascular influences

The increasing sensitivity of modern colour Doppler (CDI) systems and the improved image definition they produce have greatly extended the role and diagnostic influence of blood flow studies in key areas of gynaecological ultrasound.

SMI identifies microvascularisation processes within the myometrium and endometrium. Both are extremely sensitive to the ovarian steroids. Ongoing studies utilising TVS-SMI technology strongly suggests a direct relationship between oestrogen factors and myometrial tissue vascularity. An observational study carried out over several years involved approximately 2,500 consecutive patients presenting with a history of acute or chronic pelvic pain. Retrospective analysis of findings revealed a significant overlap between increased myometrial vascularity, the presence of pelvic endometriosis and suspicion of adenomyosis within the group. In particular, it emphasised the value of SMI in identifying likely functional (hormonal) aspects as the major cause of pelvic pain, very often accompanied by abnormal uterine bleeding and menstrual disorders such as dysmenorrhea, menorrhagia etc. Frequently ultrasound findings confirmed the co-existence of active functional cysts.



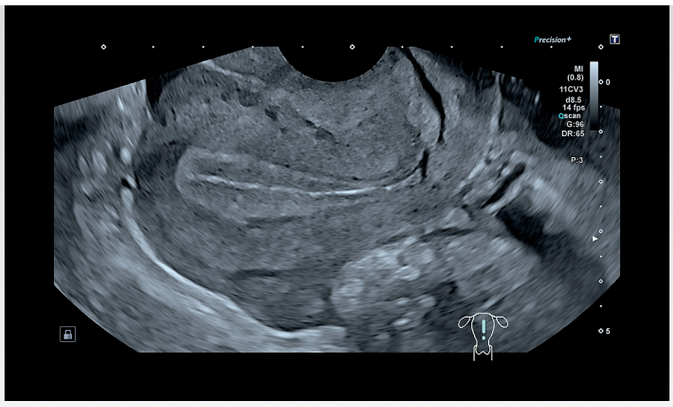


Fig. 15a and b: High quality greyscale imaging demonstrates subtle changes in myometrial appearances in a suspected case of adenomyosis between the menstrual [a] and peri-ovulatory [b] phases of the cycle within the same patient. It might offer the potential to identify the disease at a very early stage of development.

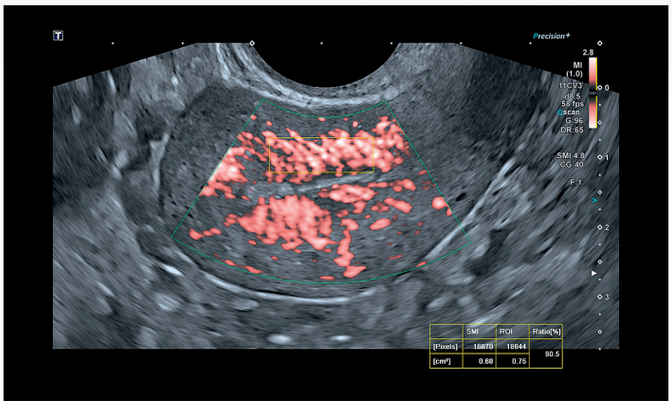


Fig. 16: SMI demonstration of increased myometrial vascularity secondary to hormonal (oestrogen) factors. The availability of "vascular indices" (see chart in lower Rt. hand corner) allows a degree of quantification in evaluating vascular changes within tissues due to infection, pathology or hormonal influences.

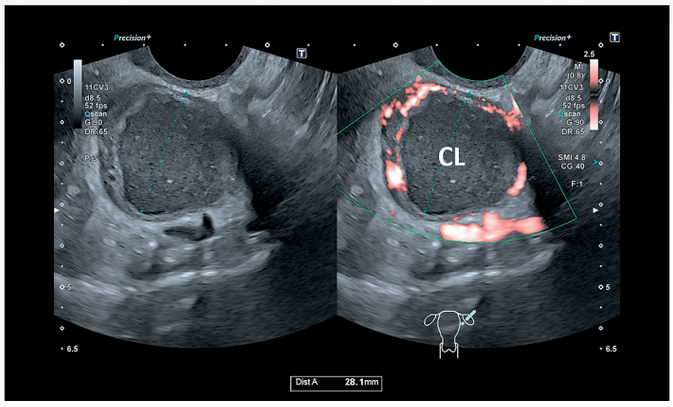


Fig. 17: Characteristic greyscale appearances of a haemorrhagic corpus luteum (CL). SMI clearly highlights peripheral angiogenesis around the lesion therefore confirming its nature.

CDI is somewhat limited by the subjective nature of interpreting the ultrasound findings. 2D or 3D vascular indices prove increasingly useful in gauging tissue blood flow patterns within the myometrium.[16] Early impressions suggested a relatively uniform spread of values produced by hormonal factors or pelvic infections. Variation commonly occurred in localised areas within the myometrium where greyscale appearances were suggestive of adenomyosis.

Pelvic pain: ovarian factors

Functional cysts are by far the most common cause of pelvic pain. They can develop as part of natural or stimulated ovulatory cycles, result from other extra-ovarian influences such as hormone replacement therapy and can occur at any stage from adolescence to the menopause. SMI outlines the characteristic peripheral angiogenesis usually present and excludes evidence of internal neovascularity with confidence.

They are very often haemorrhagic in nature and their ultrasound features can vary tremendously and mimic other types of ovarian neoplasms. Their rapid growth pattern and subsequent collapse, confirmed by follow-up (post menses) scanning, plus SMI appearances differentiate them from other forms of ovarian lesions.[17][18][19] Although totally benign in nature, collapse of the lesion can result in significant fluid spill and bleeding into the pelvic cavity.[20] This can cause severe, acute symptoms. The presence of extensive pelvic fluid/clot as such very often causes a bowel reaction resulting in bloatedness and general pelvic discomfort. Hormonal (oestrogen) activity emanating from these lesions can have a wide-ranging effect. It results in excessive proliferation of the endometrium and often unpleasant menstrual symptoms. It promotes the growth of uterine fibroids and development of endometrial polyps. In addition it frequently results in increased breast sensitivity and prominent (glandular) tissue changes.

The vast majority of pathological lesions of the ovary are in fact asymptomatic. Increased size might be a contributory factor in cases of chronic pain. Acute symptoms would usually be the result of rupture of the lesion or ovarian torsion.[4][20][22] Continued utilisation of high-performance greyscale capability, improved Doppler sensitivity of SMI and modern 3D TVS facilities increase diagnostic effectiveness in assessing the nature of ovarian lesions as well as diagnostic confidence in differentiating between benign and malignant disease. They remain essential components in distinguishing between functional cysts, endometriomas and ovarian teratomas in particular. Pelvic discomfort and bloatedness arising from the presence of ovarian carcinomas tend to be chronic in nature and symptoms usually appear at a much later stage of growth. Bloatedness as such is more likely to result from functional changes as described previously and not from pelvic malignancy!

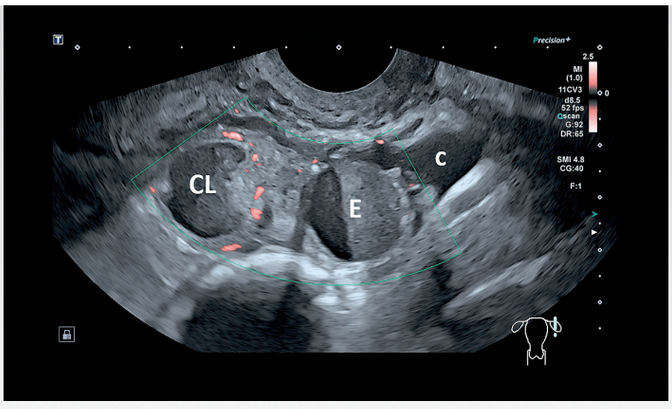


Fig. 18: Similar 2D greyscale appearances of a corpus luteum (CL) and endometrioma (E) around the menstrual phase. Peripheral vascularity outlined by greyscale changes within the endometrioma are the result of differential internal bleeding / clotting associated with the onset of the menstrual phase. The above features allow accurate differentiation between the two types of ovarian lesions. Clot (c) within the pelvic cavity was likely to be bleeding from the CL cyst.

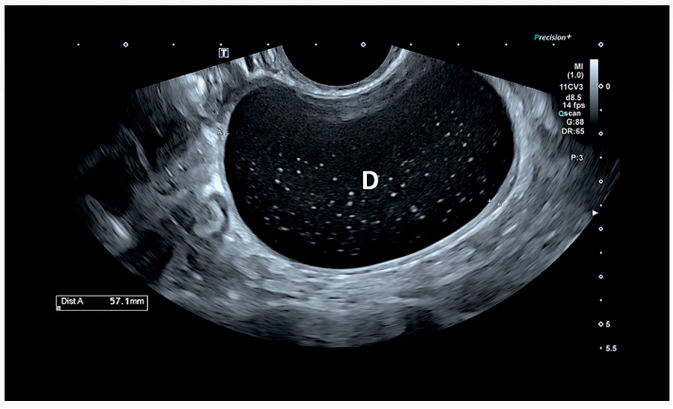
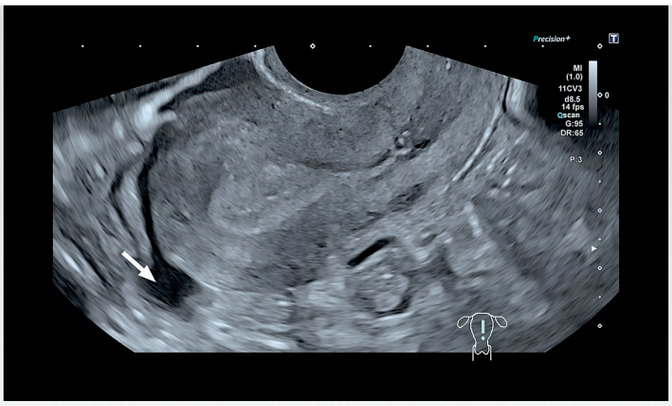


Fig. 19: 2D image of mucinous dermoid cyst (D) mimicking the ultrasound appearances of a possible endometrioma. Absence in terms of growth, greyscale appearances and vascularity over the course of a few ovulatory cycles differentiates the lesion from endometriotic or functional cysts.

A single case of ovarian malignancy (2.3 cm mucinous cystadenoma) identified in the study quoted was an incidental finding. This case confirmed the diagnostic value of SMI in terms of recognising "high risk" changes as such as an early stage of development.

Pelvic pain: uterine factors

Functional (hormonal) elements as highlighted by SMI appear to be a very common cause of pain arising from the uterus. SMI visualises what are essentially inflammatory changes within the myometrium and which can result from e.g. pelvic infection[23] or, as in many cases, associated with suspected adenomyosis. The combined use of 3D TVS, RTE and SMI provides accuracy in differentiating between uterine myomas and adenomyosis. Symptoms associated with myomas tend to reflect an increased size and/or their vascular nature. 3D TVS is very established in identifying anatomical malformations of the uterus.



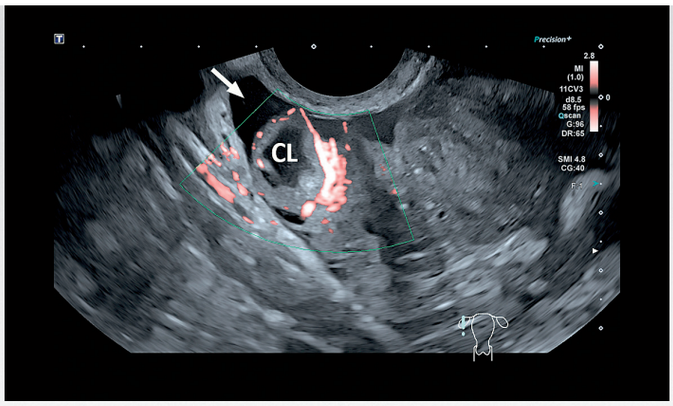


Fig. 20a and b: Pelvic discomfort, bloatedness etc. caused by increased pelvic fluid / clot (arrow) [a], [b] and [c] associated with a very active luteal cyst (CL) as shown by SMI [b]. Note the increased peri-ovulatory endometrial thickening [a]. Ovarian activity and hormonal factors remain the most common cause of pelvic pain +/- abnormal uterine bleeding.

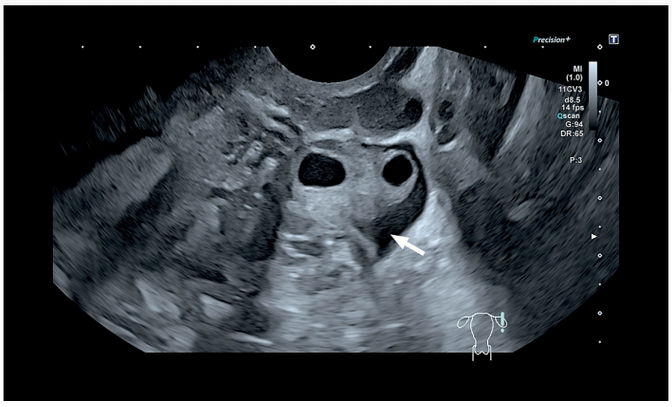


Fig. 20c: Ovarian activity and hormonal factors remain the most common cause of pelvic pain +/- abnormal uterine bleeding.

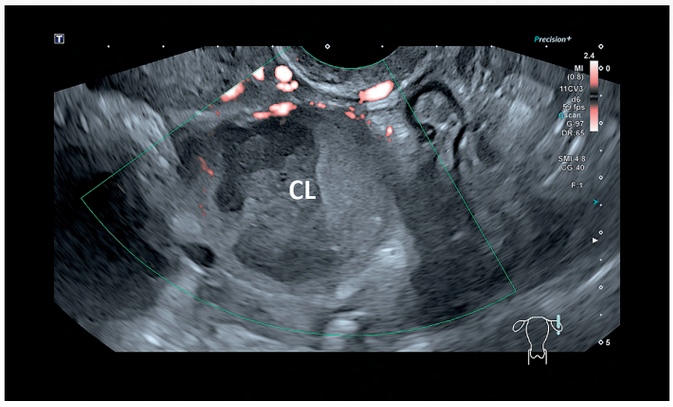


Fig. 21: A partially-collapsed, poorly-active, clot-filled corpora luteal cyst (CL) with subcapsular haemorrhage within the ovary as well as resolving para-ovarian blood. The most common ovarian lesion found in cases of acute pelvic pain.

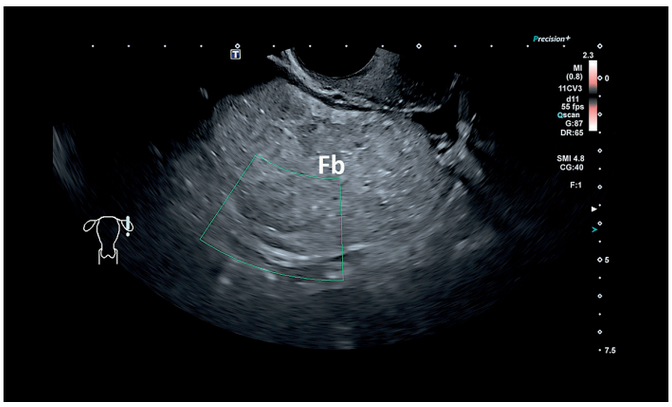


Fig. 22: Torsion of an ovarian fibroma (Fb). Note total absence of blood flow within the ovarian tissue.

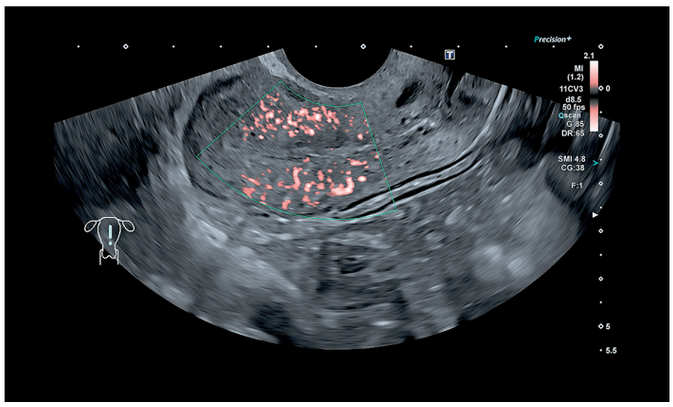


Fig. 23: SMI demonstrates increased myometrial vascularity in a case of pelvic infection.

They are unlikely to result in pelvic discomfort in the absence of any co-existing complication. These might include the formation of intracavital adhesions or congenital strictures within the lower reproductive tract, both causes of obstruction to normal menstrual flow. The extent of the accumulation of blood within the uterine cavity as well as formation of haematometria and subsequent haematosalpinx are clearly delineated and gauged by 3D TVS technology.[24] The utilisation of advanced 3D virtual imaging ("Fly Thru") as an integral part of SIS procedure is shown to produce exceptional visual clarity in examining the integrity of the uterine cavity.

It is shown to provide an alternative, less invasive technique to clinical hysteroscopy as the initial step for detailed evaluation of the endometrial cavity and confirming associated anomalies linked to pelvic pain. Large uterine myomas are the source of chronic discomfort as they increase in size and impinge on other organs.

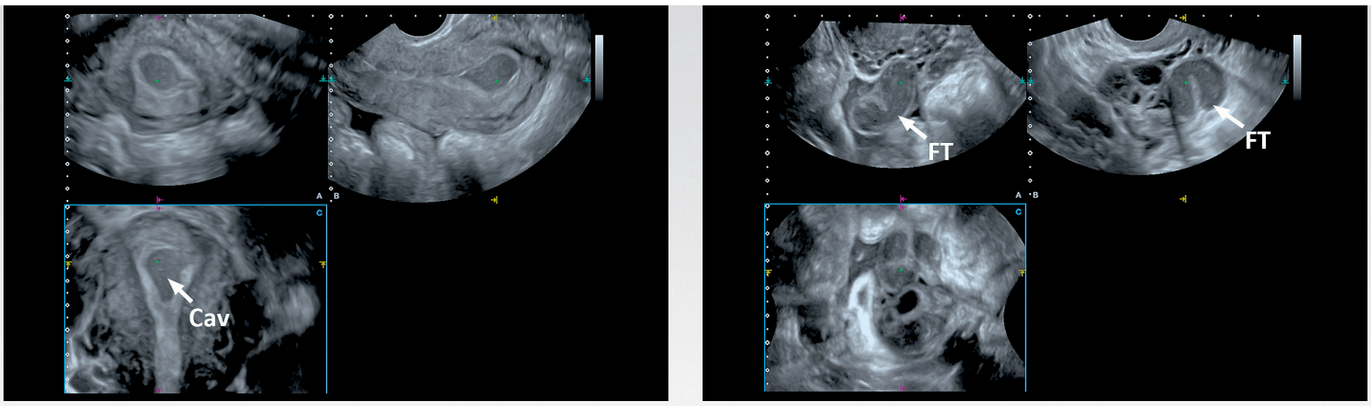


Fig. 24a and b: Multiplanar 3D section demonstrating haematometra (Cav) in [a] and haematosalpinx within a convoluted Fallopian tube (FT) in [b].

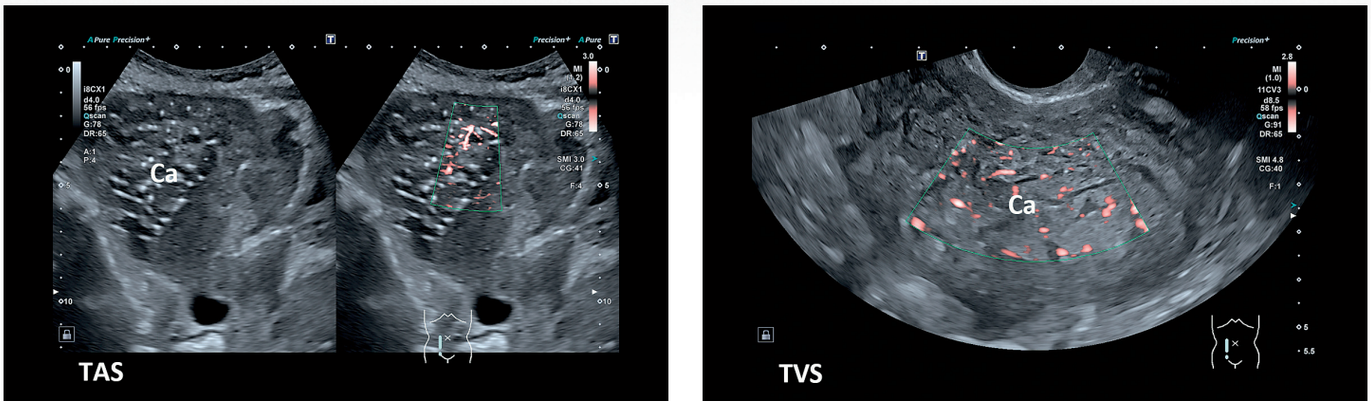


Fig. 25a and b: A case of chronic pelvic pain. "Bizarre" greyscale transabdominal appearances [a] and transvaginal SMI blood flow studies [b] confirmed diffuse, vascular changes found to be associated with uterine sarcoma (Ca).

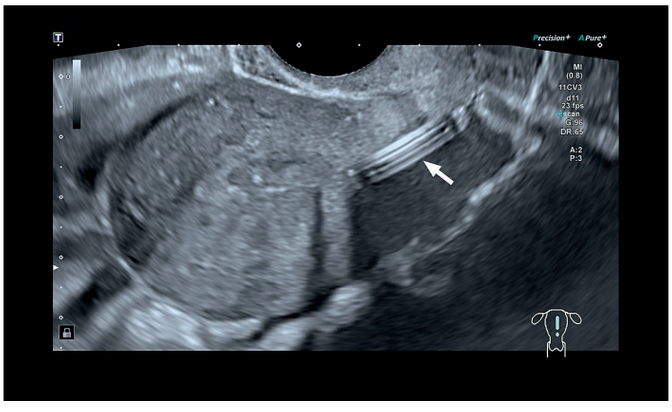


Fig. 26: 2D image of a Mirena IUS (arrow) lodged within the cervical canal / lower uterine cavity.

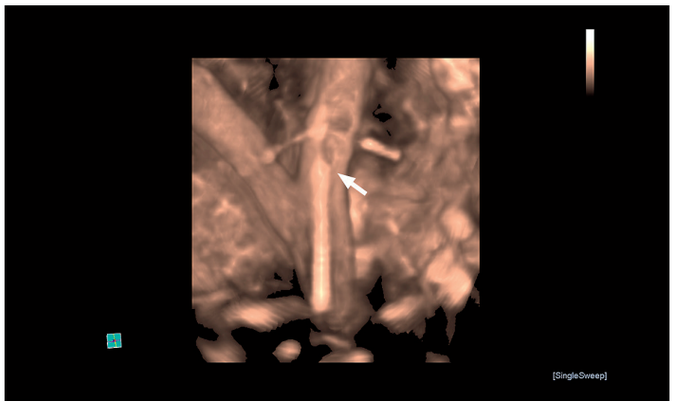


Fig. 27: Rendered 3D coronal section of an IUD (arrow) misplaced within a bicornuate uterus. Note translocation of the arms of the device into the myometrial tissue on both sides of the Lt. cavity.

More acute symptoms relate to tumour vascularity. Subserosal (pedunculated) pelvic lesions are a more common cause of symptoms and present the risk of torsion. SMI and RTE differentiate between myomas and adenomyomas. SMI remains the principal tool for identifying uterine sarcomas[25] or likelihood of malignant changes within the other types of myometrial tumours. 3D TVS clearly delineates the capsule of most fibroids and demonstrates loss of visual outline in cases of adenomyomas and sarcomas. Malpositioning and/or translocation of IUDs[26] are readily confirmed by 3D multiplanar imaging particularly as a result of the coronal anatomical plane created.[27] Other forms of intra-uterine trauma causing painful symptoms include complications arising from surgical procedures particularly involving cannulation of the cervix. Cannulation under ultrasound control significantly reduces the occurrence of these issues and proves clinically advantageous in the insertion of IUDs.

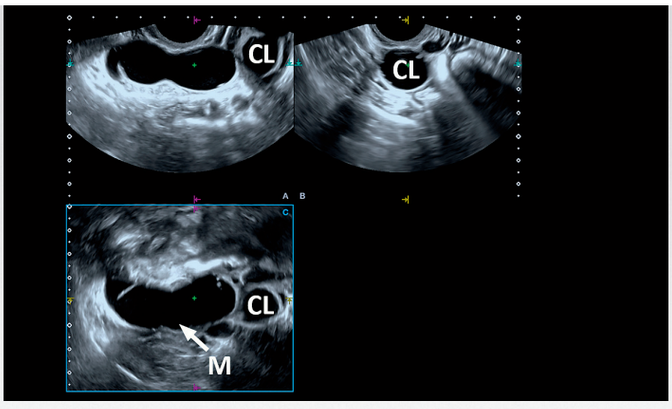
Again 3D TVS remains the choice of technique for imaging the presence and extent of damage to the uterus.

Pelvic pain: complex issues

The complexity of pelvic pathology in cases of both acute and chronic pelvic pain can present considerable problems in terms of interpreting scan findings. Access to 3D multisectional and rendered image processes and the ability to manipulate anatomical planes are paramount in this respect.[28]

Widespread formation of adhesions and/or localised fluid collections are obvious case examples. These can involve several organs or pelvic structures. Causes might be pelvic infection or extensive pelvic endometriosis. Omnidirectional interrogation of the area of interest enhances visual impression of the extent and nature of disease processes.

In addition, 3D TVS involves less movement of the ultrasound probe. Scanning of diffuse pelvic disease as such can be an exceptionally painful experience for the patient. Acquisition of ultrasound data and diagnostic information achieved with absence of probe movement has considerable benefit for the patient in this respect. CDI remains a considerable asset in confirming the spread of disease through the pelvic cavity generally. Experience shows the usefulness of SMI in confirming the presence of vascular features such as secondary (malignant) lesions or reactive lymph nodes randomly sited within the pelvis. SMI proves very reliable in identifying high risk as opposed to benign tissue changes in focal pelvic lesions responsible for localised pain.[29] The importance of 2D and 3D evaluation and follow-up assessment of free fluid collecting within the pelvic cavity should not be discarded if associated with pelvic pain. This particularly applies to cases where full utilisation of imaging modalities fails to



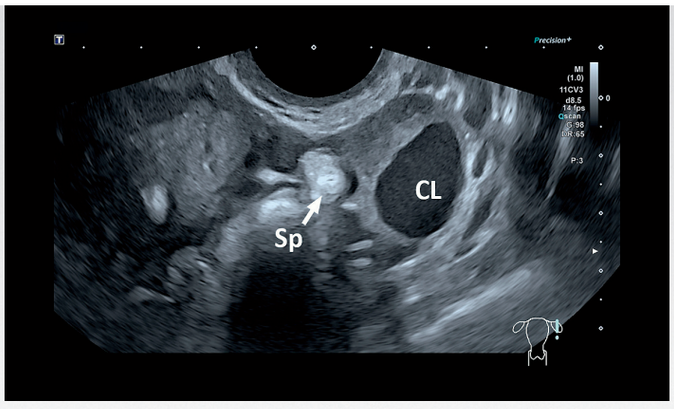


Fig. 28a and b: A case of chronic Lt. pelvic pain – the presence of a possible hydrosalpinx or pyosalpinx was queried elsewhere. 3D multiplanar images confirmed a convoluted, tubular mass (M) within the Lt. adnexal region in [a]. A Lt. ovarian corpora luteal cyst (CL) is noted. A hysterosonosalpingography using SonoVue contrast medium confirmed normal tubal spill (Sp) on the Lt. side.

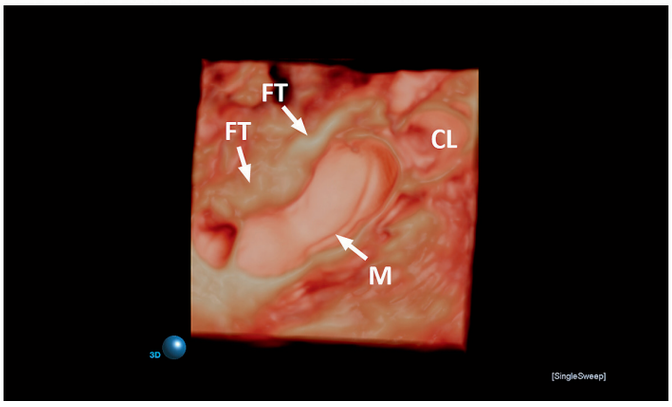


Fig. 28c: The rendered 3D image [c] demonstrated the patient's Fallopian tube (FT) separate from the tubal mass (M). Diagnosis – convoluted mesonephric cyst attached to the broad ligament on the Lt. side.

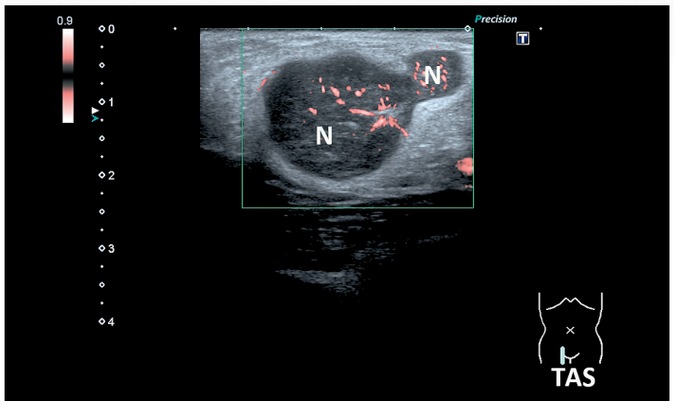


Fig. 29: Transabdominal ultrasound utilising SMI confirmed reactive inguinal nodes (N) in the case of Rt. lower pelvic pain.

identify an obvious cause and has excluded functional (hormonal) issues.[30] Concern regarding malignancy elsewhere within the body and the formation of ascitic fluid cannot be ignored. It also explains the need for an appropriate level of scanning competence and adequate system performance in general abdominal ultrasound even in the field of gynaecology. The most common cause by far of pain in early pregnancy is the presence of active, very often haemorrhagic, corpora luteal cysts. Nevertheless co-existing pathology remains the clinical issue in a number of cases.[31]

Pelvic pain: complementary imaging techniques

MRI is increasingly employed to complement ultrasound examination. It is able to outline the pelvic organs with considerable image clarity displayed in easily interpreted anatomical sections. In addition, it is very effective in identifying the spread of diffuse disease through the pelvic tissues.

The expanded field of view generated is in itself an advantage compared to the relatively restricted ultrasound sector produced by TVS. Its clinical impact in gynaecology continues to grow particularly regarding the spread of malignancy or endometriosis for example. However, comparison studies between MRI and ultrasound rarely reflect access to the full range of ultrasound imaging modalities currently available. There remain areas where ultrasound outscores MRI in terms of defining the nature of pelvic lesions. Ultrasound remains the first-line imaging technology in the investigation of pelvic pain.

The exciting development of "Smart Fusion" integrates realtime ultrasound with CT or MRI. Its diagnostic and therapeutic benefits to date primarily involve general abdominal imaging, particularly biopsying of localised structures or body tissues. The usefulness of Smart Fusion in gynaecology and the management of pelvic pain remains largely unexplored.

Summary

Canon Medical Systems Aplio series provides the extended imaging platform expected of current generation ultrasound systems. There is no doubt that a comprehensive approach to pelvic ultrasound maximises the clinical impact required of modern systems in the investigation of pelvic pain and especially endometriosis. It has led to a variety of recent technical and imaging innovations as outlined. There is an abundance of relevant clinical reference papers available but too numerous to list. A review of publications made available through ISUOG, RCOG and ESHRE covering aspects of endometriosis is recommended. This paper has touched on current practice in this respect. In addition, it provides areas of work in the field which would be regarded along the lines of "concept of principle". The clinical impact of modern ultrasound technology continues to increase in major areas of gynaecology but particularly in the diagnosis and assessment of endometriosis and causes of pelvic pain generally.

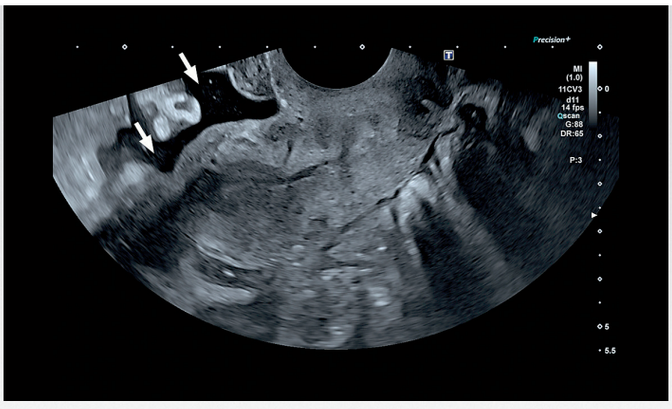


Fig. 30: Vigilance! Serial transvaginal scans showed the presence of free pelvic fluid (arrow) with no obvious change in volume in a case of chronic pelvic pain. No adverse features could otherwise be identified by ultrasound or laparoscopy. Biopsy of a normal-looking appendix revealed appendiceal adenocarcinoma with pseudomyxoma peritonei confirmed following further investigation.

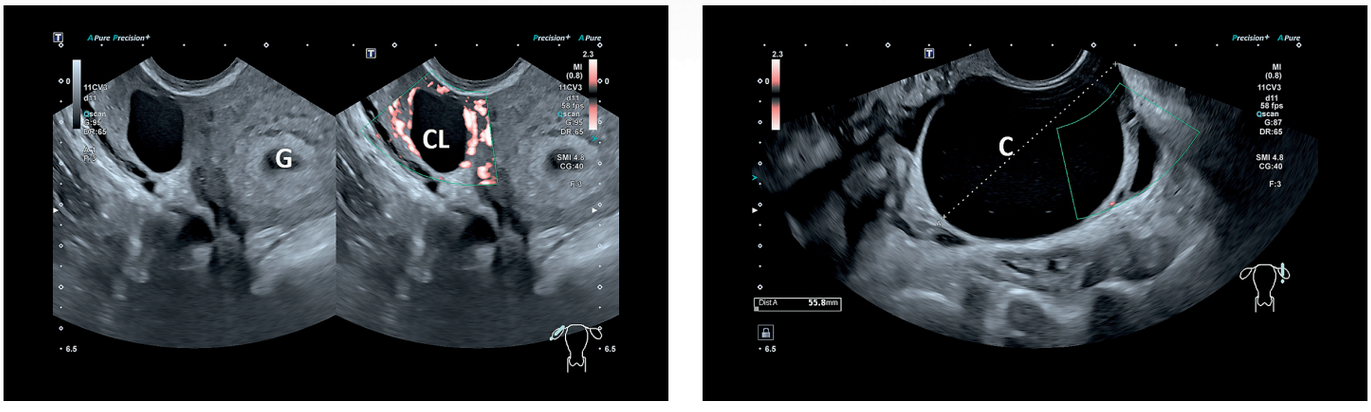


Fig. 31: A case of Lt. pelvic pain in early pregnancy. A large simple ovarian cyst (C) was confirmed on the Lt. side [b] – SMI excluded associated "high risk" (vascular) changes. SMI demonstrated an active corpus luteum (CL) on the Rt. ovary [a]. An intrauterine pregnancy sac (G) was demonstrated [a].

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