The clinical application of transperineal ultrasound in urogynaecology

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Abstract

Key content

- Transperineal ultrasound allows reproducible imaging of pelvic floor conditions that aids in the thorough assessment required to diagnose and treat urogynaecological conditions.
- Views that can be obtained include two-dimensional (2D) sagittal views of the bladder neck, urethra and pelvic floor; 2D coronal views of the anal canal; and three-dimensional (3D) or four-dimensional (4D) views of the genital hiatus and anal canal.
- This allows assessment of the post-void residual volumes, detrusor wall thickness and dynamic assessment of the urethral morphology.
- Ultrasonographic assessment enables accurate information about maternal birth trauma to be ascertained, including levator ani muscle avulsion and obstetric anal sphincter injury.
- Transperineal ultrasound can be used to identify and assess previously implanted vaginal mesh and midurethral slings.

Learning objectives

- To understand the role of ultrasound in clinical urogynaecology practice, including the assessment of slings and meshes.
- To know the ultrasound probes, techniques and views used to image the pelvic floor and anal sphincters by transperineal ultrasound.
- To describe assessment of the lower urinary tract, pelvic organ prolapse and obstetric anal sphincter injury using ultrasound.

Ethical issues

- Thorough assessment of the pelvic floor is mandatory against the background of technological advances in the investigation of pelvic floor dysfunction.
- As a common and major complication of childbirth, maternal birth trauma must be assessed fully to support primary and secondary prevention.

- Thorough assessment must underlie the use of mesh implants, and dealing with sling and mesh complications is enhanced by imaging.

1 Introduction

Urogynaecology covers a spectrum of disorders of the pelvic floor, bladder and anal function. Surgical correction of one defect may result in de novo development of another dysfunction, or prolapse of another compartment.[1, 2] Despite much progress in this subspecialty field, objective evaluation prior to surgery remains difficult. Ultrasound offers a cost-effective, accessible and reproducible assessment tool for various pelvic floor conditions.

Various standardised techniques and views in pelvic floor imaging have been described, with different techniques available for assessing aspects of the pelvic floor depending on operator preference. The use of ultrasound imaging aids diagnosis and treatment decision-making in lower urinary tract disorders, pelvic organ prolapse (POP), defecatory disorders and obstetric anal sphincter injury (OASI). Over the past two decades, several specialised units have pioneered and standardised the use of ultrasound in urogynaecology. High outputs of research are produced investigating the clinical application of ultrasound in the assessment of urogynaecological conditions. The methods involved have been standardised in a collaboration between six international societies[3] and taught through an International Urogynaecology Association (IUGA) online course 'Pelvic Floor Ultrasound,'[4] Training is structured into seven modules, each comprising online learning and submission of images to a preceptor for assessment and feedback.

While the quality of transperineal ultrasound (TPUS) depends on patient factors, such as tissue hydration and the presence of scar tissue, the quality of the machine and the skill and experience of the operator remain key. There is, however, evidence of good interobserver reproducibility for most findings on TPUS.[5]

2 Ultrasound views, settings and methodology

The principal views of the pelvic floor are two-dimensional (2D) transperineal sagittal and coronal planes, three-dimensional (3D) or four-dimensional (4D) transperineal rendering of the levator ani muscle (LAM), and 2D or 3D endovaginal imaging of the anterior and posterior compartments. The anal canal and sphincters can be imaged by 3D or 4D transperineal rendering, endovaginal and endoanal ultrasound. Commonly used views, required probes and associated settings and landmarks are summarised in Table 1 and illustrated in Figure 1.

Table 1. Transperineal ultrasound views and settings

View	Probe	Setting	Landmarks
2D midsagittal transperineal	Curvilinear phased array	B-mode 2D 3.5–6 MHz ≥70° field of vision (FOV)	Pubic symphysis Urethra Bladder neck Rectal ampulla Anorectal angle
3D/4D transperineal, midsagittal acquisition for levator ani muscle complex	Curvilinear 4D phased array	4–8 MHz ≥70° angles of acquisition and FOV	Pubic symphysis Urethra Vagina Levator ani muscle Anal canal
3D/4D transperineal, coronal acquisition for anal canal	Curvilinear 4D phased array	4–8 MHz 70° angle of acquisition, 60° FOV	Anal mucosa Internal anal sphincter External anal sphincter Puborectalis muscle

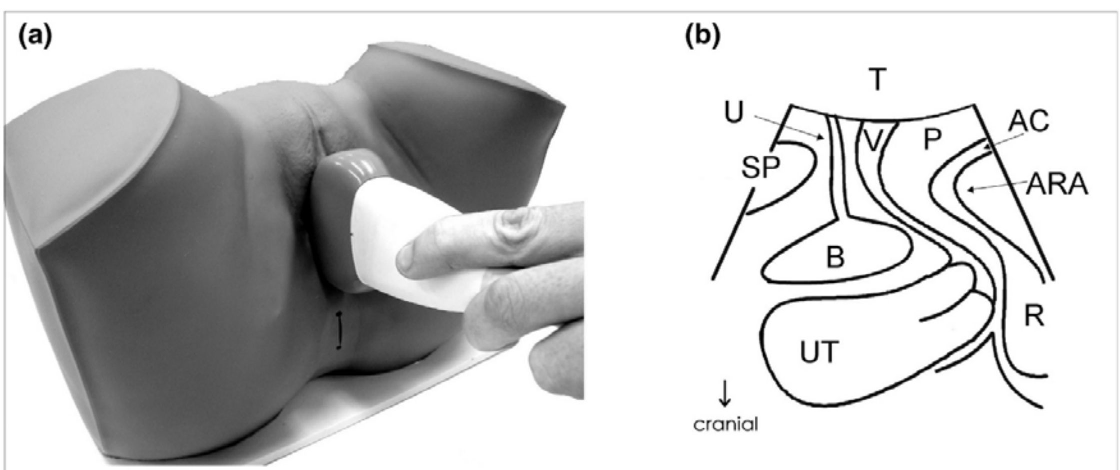

Figure 1. Transducer placement (left) and field of vision (right) for transperineal ultrasound, midsagittal plane. Modified from Dietz, 2010,[7] with permission from Elsevier.

2.1 2D transperineal views

A TPUS examination of the pelvic floor should start with a 2D assessment. TPUS requires, in its most basic form, a B-mode 2D ultrasound machine, a cine-loop function and a 3.5 to 6-MHz curved array transducer. The patient is asked to empty their bladder just before the examination. The transducer is prepared by applying gel to the curved array and then covering the transducer with a glove, condom or other probe cover. Additional gel is applied on top of this, ensuring no air bubbles have been caught between the covering and transducer, as these will cause acoustic artefacts. The scan is best performed in the dorsal lithotomy position, with the hips abducted and flexed. By bringing the heels of the patient close to the buttocks, pelvic tilt can be improved. This will aid in probe placement and subsequent imaging.[6]

The labia are parted and the transducer is placed relatively firmly against the perineum. A midsagittal view is obtained, with the gain and focal zones adjusted to the region of interest, at a depth of 2–5 cm, aiming to view the bladder neck and the inferoposterior margin of the pubic symphysis (Figure 1).[7] Bladder volume and detrusor wall thickness (DWT) can be measured. Next, a dynamic assessment should be done. Split-screen images allow evaluation of the pelvic floor at rest on the left, and during maximum Valsalva on the right. Organ descent is documented against a horizontal line placed through the inferior symphyseal margin (Figure 2).[3] This is performed during maximal Valsalva of at least 6 seconds.

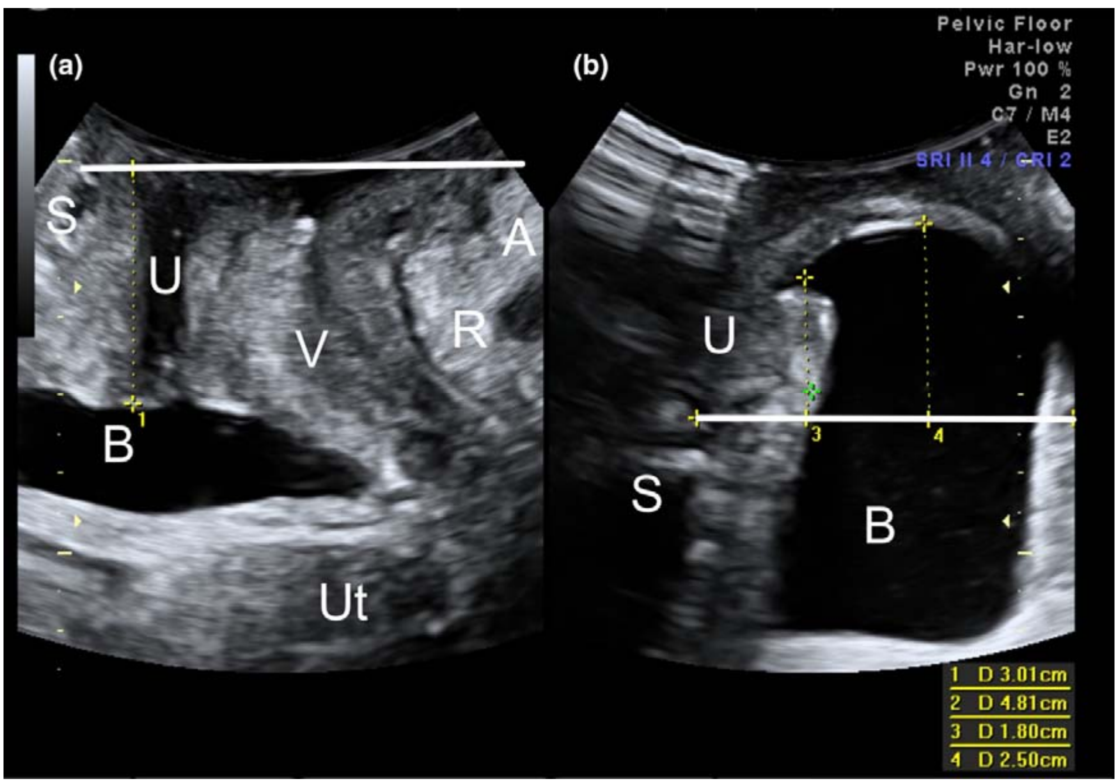

Figure 2. Transperineal midsagittal view of the pelvic floor at rest (a) and measurement of pelvic organ descent (b) below the pubic symphysis on maximal Valsalva. S = pubic symphysis, U = urethra, B = bladder, V = vagina, A = anal canal, BN = bladder neck, R = rectum, Ut = uterus. The horizontal reference line is placed through the inferoposterior symphyseal margin.

Image quality can be optimised by adjusting focal zones, harmonic settings and/or by using speckle reduction algorithms. The standard view allows identification of the following structures from ventral to dorsal: the symphysis, urethra and bladder neck, the vaginal walls, cervix/uterus, the rectum and anal canal and the puborectalis muscle.[8]

Coronal views can be obtained by rotating the probe through 90 degrees in a clockwise direction. By inclining the probe dorsally, the anal canal and sphincter complex can be seen (Figure 3).[9] For improved image quality, a single focal zone should be set to 1–2 cm depth and high harmonics utilised. The external and internal sphincters are seen as a bull's eye pattern. Usually minimal pressure should be applied, as compression of the anal sphincter can be seen to flatten the sphincter.[10] Tissue discrimination is often improved by a pelvic floor muscle contraction.

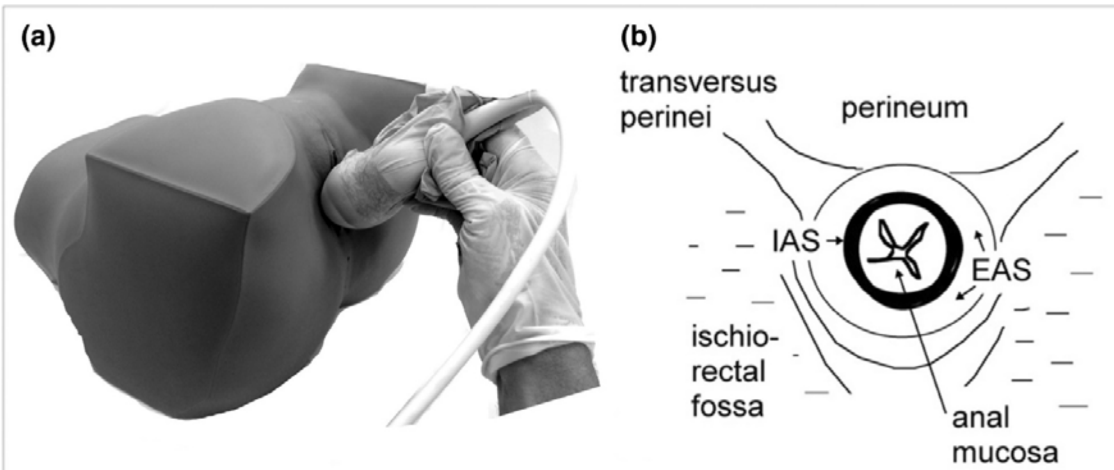

Figure 3. Transducer placement for imaging of the anal canal. The best tissue discrimination is reached by keeping the transducer surface 0.5–1.5 cm from the ventral contour of the EAS, which also allows imaging of the perineum. EAS = external anal sphincter, IAS = internal anal sphincter. Modified from Fleischer et al., 2018,[9] with permission from McGraw Hill.

2.2 3D and 4D transperineal views

Three-dimensional TPUS can be performed with transabdominal probes utilised for obstetric imaging. An electronic curved-array of 4–8 MHz with fast oscillating mechanical sector technology allows at least a 70 degree field of vision and acquisition angles. Multiple sequential volume datasets are stored during a manoeuvre, such as a pelvic floor contraction or a Valsalva manoeuvre. Such volume data will include the entire levator hiatus, which can be captured at rest, maximal pelvic floor muscle contraction and maximal Valsalva and analysed immediately on the machine in any arbitrarily defined plane or stored for later postprocessing using specialised proprietary software. Four-dimensional imaging allows real-time capture of volume data and enables a dynamic functional anatomical assessment of the pelvic floor.[10]

Modern technologies such as volume contrast imaging (VCI) and speckle reduction imaging (SRI) employ rendering algorithms to improve tissue discrimination. Multislice or tomographic imaging (TUI) enables simultaneous observation of the effect of contraction and Valsalva at different levels, as well as the documentation of findings in multiple slices. The plane of reference for assessment of the levator ani is the plane of minimal dimensions, with steps of 2.5 mm recorded from 5 mm below to 15 mm above, as previously described.[11] Such imaging for levator integrity is usually performed on pelvic floor muscle contraction. Figure 4 shows the steps required to obtain a tomographic representation of the pelvic floor.

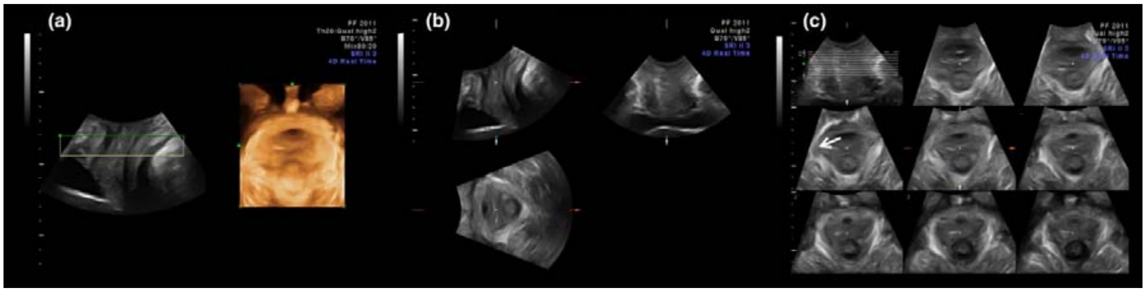

Figure 4. Tomographic imaging of the levator ani. (a) Pelvic floor muscle contraction observed on the midsagittal plane (left) and rendered volume (right). (b) identification of the plane of minimal hiatal dimensions in the C plane (bottom left). (c) Construction of a set of axial plane slices at 2.5-mm interslice interval, with the plane of minimal dimensions (central image in panel c) as reference plane. There is a minor right-sided partial abnormality (arrow) which falls well short of a full avulsion.

2.3 3D and 4D transperineal views of the anal sphincter complex

To assess the anal sphincter complex, the transducer is placed transversely and tilted more vertically (Figure 3), keeping a 1-cm distance between the transducer and the external anal sphincter (EAS), making sure that transducer pressure does not distort the circular shape of the anal sphincter. Additional gel may be required if the perineum is deficient. Tomographic or multislice imaging is used, with volumes acquired at a 60-degree aperture and a 70-degree acquisition angle. The fascial plane between the EAS and LAM is identified in the orthogonal planes, with the midsagittal plane placed in the B plane. The interslice interval is adjusted so that the set of slices extends to above the EAS cranially, and to below the IAS caudally; see Figure 5. Defects are measured by determining the defect angles in slices 2–7.[10]

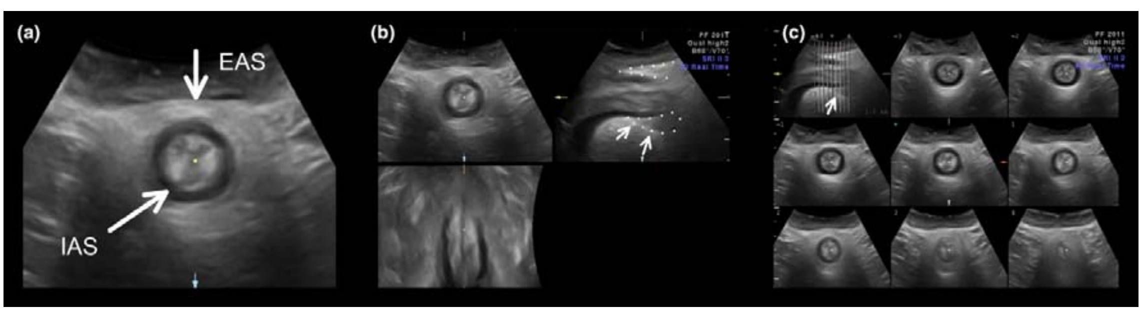

Figure 5. Tomographic imaging of the anal sphincters. (a) Coronal plane showing the doughnut shape of the anal canal at the level of the EAS. (b) Orthogonal planes on pelvic floor muscle contraction, allowing identification of the fascial plane between the external anal sphincter (EAS) and levator ani (arrows). (c) Set of coronal plane tomographic slices at individualised interslice interval, from above the EAS (top central image in panel (c) to below the interior anal sphincter (IAS) in the bottom right image.

3 Ultrasound in the assessment of urinary disorders

The physiology of continence and voiding are complex functions. Ultrasound adds objective and reliable information to consider in conjunction with the clinical history, examination and urodynamic studies.

3.1 Measuring post-void residual volumes

Post-void residual volume (PVR) is a useful measurement when evaluating stress urinary incontinence (SUI), storage symptoms and insensible urine loss. Residual volumes can be estimated either by catheter drainage of the bladder or by ultrasound measurement. Ultrasound measurement is less invasive, more acceptable to patients and has been shown to give reliable estimates.[12]

PVR can be measured by TPUS (Figure 6) or by the abdominal route. Most ultrasound machines have built-in software to calculate PVR from maximum length, width and depth measurements when using the abdominal approach. When calculating the PVR from a transperineal view, the following formula can be used:

$$PVR = X \times Y \times 5.6$$

Where X and Y are the two maximal perpendicular measurements in centimetres of bladder size in the sagittal view.[13] This gives an estimation of the volume in millilitres.

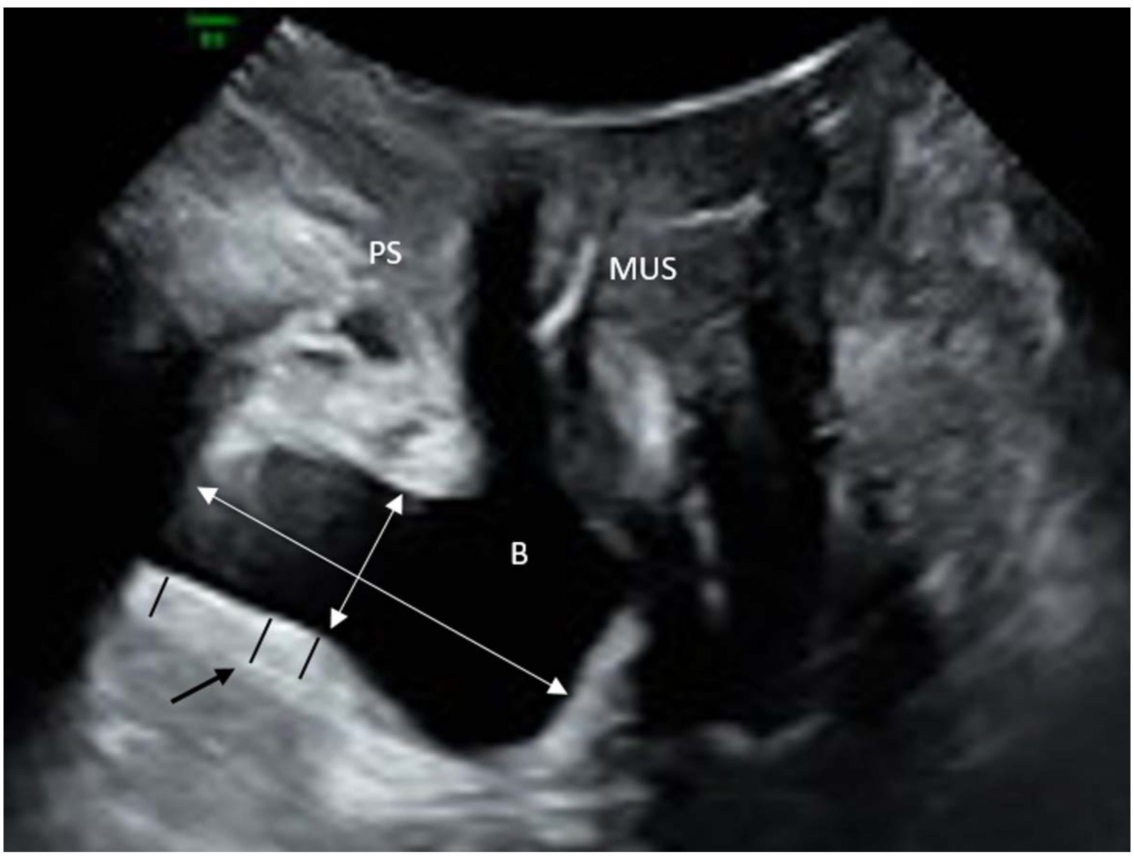

Figure 6. Midsagittal transperineal ultrasound illustrating a midurethral sling, and measurement of post-void residual and bladder wall thickness (black arrow). PS = pubic symphysis, MUS = midurethral sling, B = bladder.

Large PVR measurements are indicative of poor voiding function, either because of poor detrusor function or obstruction. When considering the use of Botulinum toxin A injection for overactive bladder (OAB), PVR of more than 100 mL, while not validated as predictive of subsequent urinary retention, would caution against such use.[14] While preoperative postvoid residual urine is not predictive of urinary retention after midurethral sling (MUS) placement, it should prompt further investigation before sling placement.[15]

3.2 Measuring detrusor wall thickness

The DWT can be measured by the transperineal or transvaginal approach. This is ideally done with the bladder empty, or with a residual volume of less than 50 mL.[16] An increase in DWT may be associated with several bladder pathologies. Detrusor hypertrophy may be the result of bladder outlet obstruction.[17] At the same time as assessing DWT, a survey can be made of the bladder wall, as this may reveal other bladder wall pathology such as tumours or ureterocoele and may indicate the need for cystoscopy.

Although a thick bladder wall supports the diagnosis of OAB, thickening can be patchy and measurements thus difficult to reproduce. The poor interobserver reproducibility of DWT[18] mean it is unlikely to be of significant clinical value. Indeed, there is poor correlation between bladder wall thickness and urodynamic detrusor overactivity.[19]

3.3 Assessing urethral length, mobility and funnelling

The mobility of the urethra can be quantified by measuring bladder neck displacement (BND) and urethral rotation during Valsalva (Figure 7). The retrovesical angle (RVA) between the urethra and the trigonal plane of the bladder can be measured at rest and on Valsalva. For BND, the inferoposterior aspect of the pubis is used as the reference point. The bladder neck is then identified and its position determined on the X and Y axes at rest and on straining. This allows accurate measurement of bladder neck position and movement. A full bladder can reduce mobility and mask prolapse. Normal values of between 10 and 25 mm are suggested for BND, and values in excess of 25 mm are likely to be significant.[20]

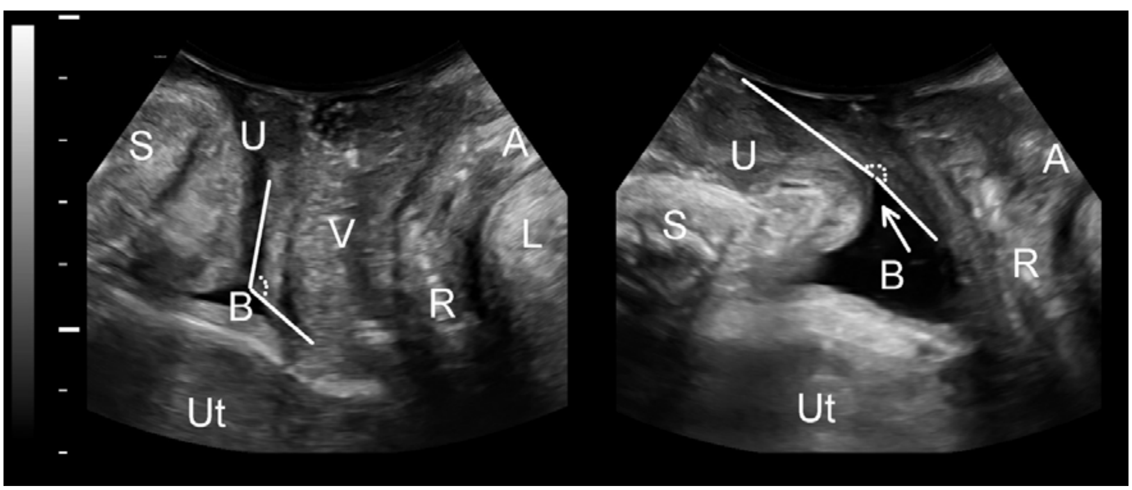

Figure 7. The bladder neck at rest and on Valsalva in a patient with urodynamic stress incontinence. The appearances are typical for stress urinary incontinence (SUI) in that there is opening of the retrovesical angle, funnelling of the bladder neck (arrow) and marked urethral rotation, together with over 3 cm of bladder neck descent. S = pubic symphysis, B = bladder, U = urethra, V = vagina, Ut = uterus, R = rectum, A = anal canal.

Measurement of the retrovesical angle differentiates between cystocoele, where RVA is less than 140 degrees, and cystourethrocoele where the RVA is 140 degrees or more. Cystourethrocoele is associated with a high flow rate and SUI.[21] Where there is a cystocoele with an intact RVA, patients often present with prolapse and voiding dysfunction rather than SUI,[21] while the combination of BND of 30 mm, urethral rotation of 45 degrees or more and funnelling of the proximal urethra is a strong predictor of SUI.[22] TPUS findings that support the diagnosis of intrinsic sphincter deficiency (ISD) are decreased urethral volume, marked funnelling on Valsalva and lack of urethral mobility in the presence of SUI.[23, 24]

3.4 Assessment of midurethral slings

Ultrasound can confirm the presence – and often the type – of a MUS and allows visualisation of its position and movement pattern; see Figures 8 and 9. On midsagittal views, the distance from the tape to the pubic symphysis can be measured as the sling–pubis gap (SPG), a measure of sling tightness.[25] The impact of Valsalva on tape position relative to the pubic symphysis and shape (as curling) can be observed. The shape can be quantified by measuring the angle formed by the cranial and caudal aspects of the tape, or be assessed subjectively as flat or curved.

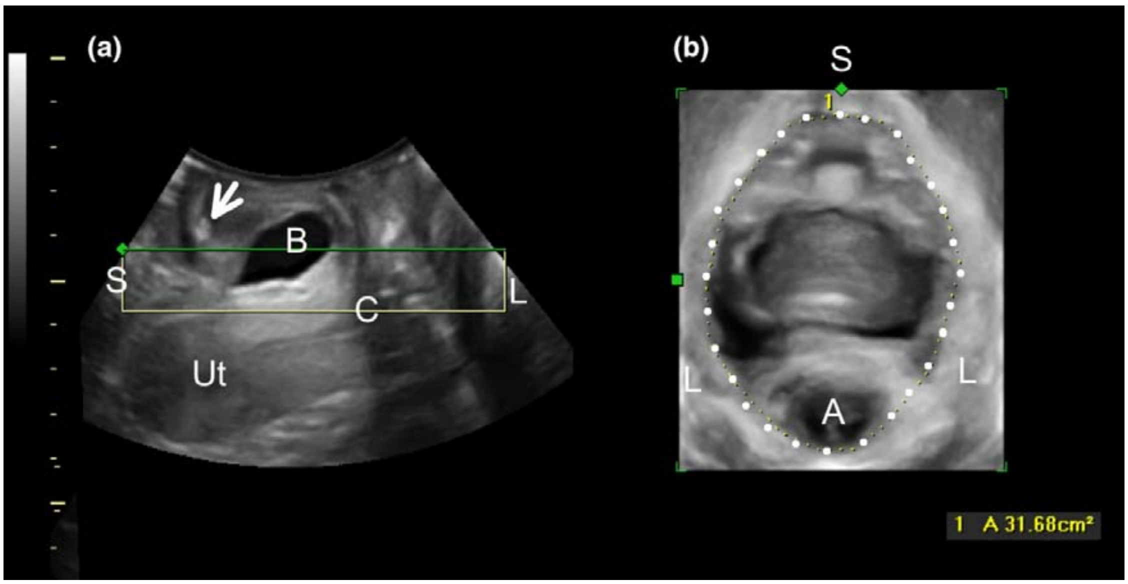

Figure 8. 4D transperineal image in the midsagittal plane (a) and a rendered volume showing the axial plane in (b). S = pubic symphysis, B = bladder, Ut = corpus uteri, C = cervix, V = vagina, A = anal canal, L = levator ani. There is a midurethral sling (arrow), a cystocoele and stage I prolapse of an anteverted uterus, and moderate ballooning of 31.68 cm^2 (dotted area in (b)).

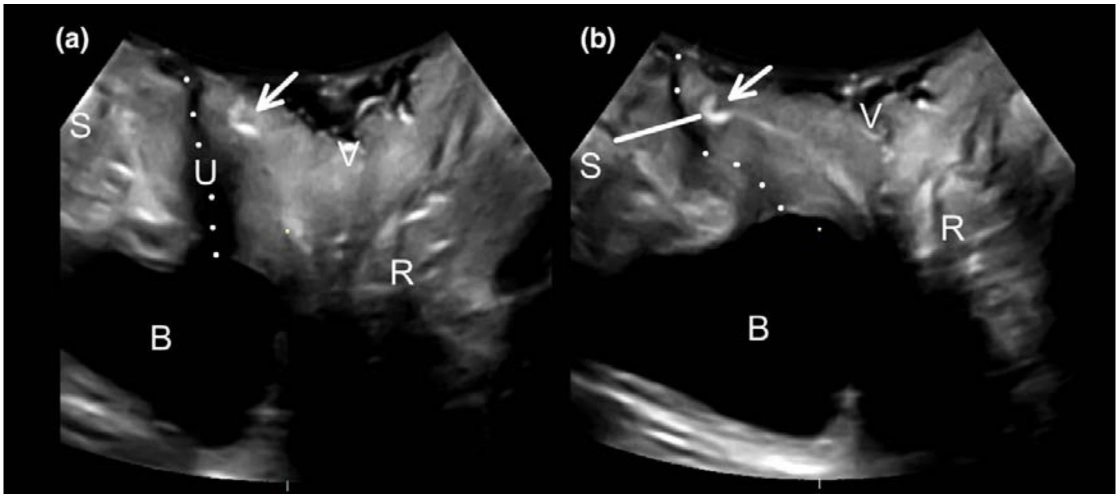

Figure 9. Suburethral sling (TVT) at rest (a) and Valsalva (b). The urethra is indicated by a dotted line; the sling by arrows. The oblique line in (b) illustrates the sling–pubis gap, which is 14 mm – somewhat on the loose side, but often sufficient in the case of retropubic slings. S = pubic symphysis, B = bladder, U = urethra, V = vagina, R = rectal ampulla. There is a gaping introitus filled with gel, but no significant prolapse

TPUS can also be valuable in the assessment of MUS failure or complications. Subjective cure and the position of the tape relative to the length of the urethra do not seem to be strongly associated,[26] but a position at or cranial to the bladder neck is clearly suboptimal. Prior identification of mesh positioning is helpful in planning surgery if mesh must be removed. At times, obstruction is plainly evident and other complications may also be suspected on the basis of imaging findings.[27]

4 Ultrasonographic assessment of pelvic organ prolapse and birth trauma

Pelvic organ prolapse (POP) is a herniation of one or more pelvic organs up to or beyond the vaginal introitus. It may present with the sensation and/or visualisation of a lump outside the vagina, in addition to other symptoms. These symptoms have a considerable adverse impact on social and professional activities of daily living, including sexual intimacy and body image.[28] In view of high recurrence rates after primary surgery, ultrasound examination can yield clinically useful information to aid understanding of POP.

4.1 Evaluation of pelvic organ prolapse

The site-specific pelvic organ prolapse quantification (POP-Q) system measures six points relative to the reference plane of the hymen. In addition, the genital hiatus (Gh), perineal body (Pb) and total vaginal length are measured, and all points recorded in a grid system.[29] The coordinates, as well as Gh and Pb, are measured on maximal Valsalva. Although this standardised clinical staging system has been adopted widely, it does not yield information on anything but vaginal and perineal surface anatomy.

During assessment of POP by 4D imaging, downwards descent of the prolapsed organ is visualised, allowing differentiation between typical cystocoele and cystourethrocoele, as well as rectocoele from enterocoele and rectal intussusception. The degree of descent is quantified against a horizontal reference line placed through the inferoposterior symphyseal margin. Other structures that mimic POP (e.g., periurethral cysts, urethral diverticulum and rectal intussusception) can be identified.[30] Figure 2 shows a stage 3 cystourethrocoele; Figure 4 shows a stage 2 cystocoele and stage 1 uterine prolapse. Prolapse imaging by TPUS has been reviewed comprehensively elsewhere.[31]

TPUS findings have been compared to clinical POP-Q staging in staging prolapse and predicting symptoms of prolapse. While there are strong correlations,[32] neither clinical examination not imaging alone are sufficient for a comprehensive assessment. Imaging can distinguish forms of prolapse that are very difficult to distinguish clinically, especially in the posterior compartment.[33, 34] Where TPUS has been compared to MRI in assessment of the levator hiatus area, pelvic floor muscle contraction and LAM avulsion, there was strong correlation, although MRI was more sensitive at diagnosing LAM avulsion.[35]

4.2 Imaging of prolapse mesh

Like MUSs, synthetic prolapse meshes are highly echogenic and visible as curvilinear structures in the anterior and posterior vaginal wall (Figure 10). Imaging can confirm the presence of a synthetic implant, or clear up misunderstandings regarding the type of surgery performed in the past. Imaging facilitates the recognition and management of certain complications, and of prolapse recurrence in the presence of mesh. It helps with patient counselling and the planning of surgical reintervention, as it gives the surgeon an indication of mesh location relative to pelvic organs. Where reoperation for symptomatic recurrence of POP is contemplated, imaging can help clarify the relation of the prolapse to the implanted mesh. In certain cases, the mesh may then be used in the repair, as in anterior recurrence of cystocoele, where the caudal mesh edge can be reattached to the trigone.[36]

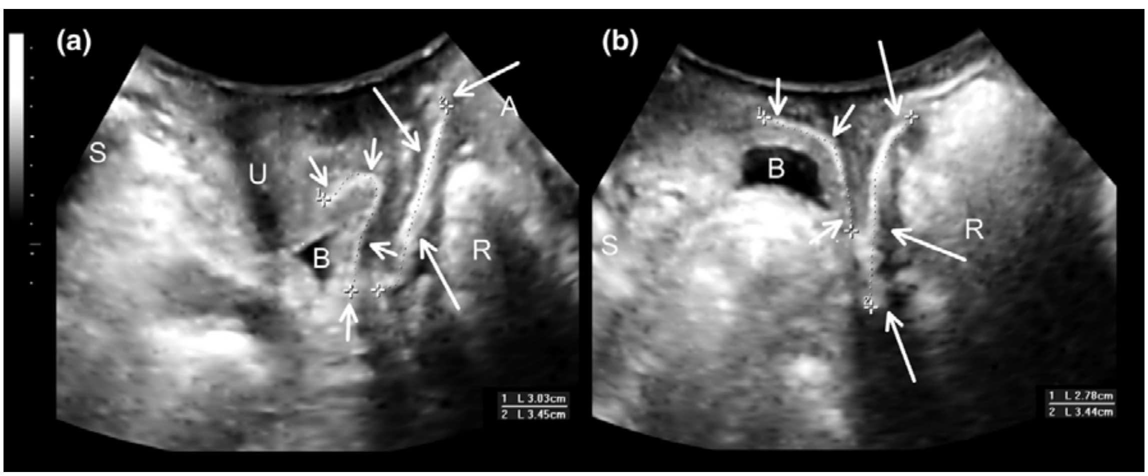

Figure 10. Typical anterior (short arrows) and posterior compartment (long arrows) prolapse meshes at rest (a) and on Valsalva (b). There is a mild three compartment prolapse recurrence. S = pubic symphysis, B = bladder, U = urethra, R = rectal ampulla, A = anal canal.

Commenting on ‘contraction’ or ‘shrinkage’ should be avoided unless findings at two different time points prove a change over time. Sling or mesh exposure or extrusion into vagina, urethra, bladder or anorectum may be suspected on imaging, but can rarely be unequivocally diagnosed. In patients with mesh complications, imaging is essential to determine whether an implant is an asset or a liability before removal is contemplated. As always, the first principle should be to avoid making matters worse. Figure 10 shows typical anterior and posterior compartment meshes on Valsalva.

4.3 Defecatory disorders

Prolapse of the posterior vaginal wall is associated with symptoms of obstructed defecation. TPUS can be useful for identifying a rectocoele, a disorder caused by a defect of the rectovaginal septum.[37] When compared with proctography as gold standard, TPUS was less accurate in determining anorectal angle and diagnosing the size and grade of rectocoele, but had strong positive predictive value for the presence of rectocoele and was better tolerated than proctography.[38]

On Valsalva, a defect of the rectovaginal septum results in a herniation of the anterior rectum into the vagina. An abnormally mobile perineum can also be visualised, as well as excessive distensibility of the rectovaginal septum, which is the hallmark of descending perineum syndrome. Imaging also allows differentiation between a rectocoele, an enterocoele and rectal intussusception, which enables more precise surgical planning (Figure 11).[39]

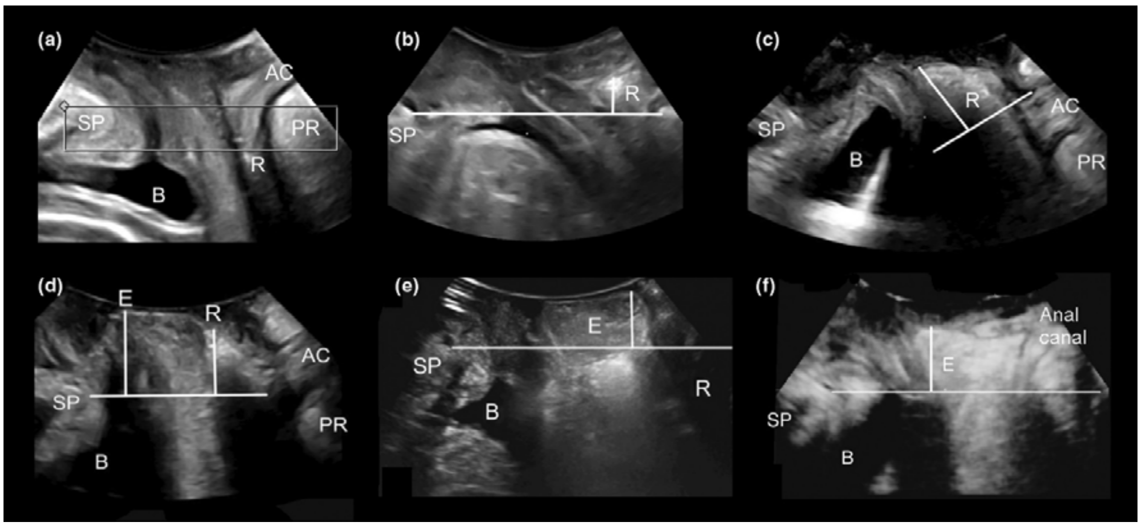

Figure 11. Transperineal imaging of the posterior vaginal compartment. Normal anatomy on Valsalva is shown in (a). Five different anatomical abnormalities of the posterior compartment giving rise to a clinical 'rectocoele' are shown in (b) (perineal hypermobility), (c) (true rectocoele), (d) (recto-enterocoele), (e) (isolated enterocoele) and (f) (rectal intussusception). Organ descent is measured relative to a horizontal reference line placed through the inferoposterior symphyseal margin. Rectocoele depth is measured against the anterior aspect of the interior anal sphincter (IAS) (c). S = pubic symphysis, B = bladder, U = urethra, V = vagina, R = rectal ampulla, AC = anal canal, E = enterocoele.

4.4 Evaluation of levator ani muscle integrity

Maternal birth trauma, in the form of levator ani muscle (LAM) avulsion, occurs in 10–36% of women during vaginal childbirth.[40] Forceps is the primary modifiable risk factor, with odds ratios of 4–5 for avulsion relative to Ventouse.[41] The use of rotational forceps appears to be particularly traumatic. Clinical consequences of this injury include an enlarged levator hiatus, decrease in pelvic floor muscle strength and the development of both anterior and central compartment prolapse and recurrence of POP after reconstructive surgery.[42]

LAM avulsion is regarded as the main causative factor explaining the epidemiological association between vaginal childbirth and the development of POP. Static and dynamic manoeuvres during ultrasound acquisition allow a more complete assessment of the functional morphology of the entire pelvic floor and supersede the diagnostic value of magnetic resonance imaging (MRI), which is limited by cost, availability, suboptimal resolutions and lack of efficient patient manoeuvres.[31] LAM integrity is assessed by tomographic imaging, as described above. A diagnosis of LAM avulsion is made by observing a defect in the insertion of the LAM in the three central slices of a tomographic set of axial plane images. In equivocal cases, a levator urethra gap of greater than 25 mm can clarify findings (Figure 12). Since diagnosis of this defect by palpation has poor agreement with both transperineal and endovaginal ultrasound,[43] diagnosis using tomographic imaging is currently the gold standard.

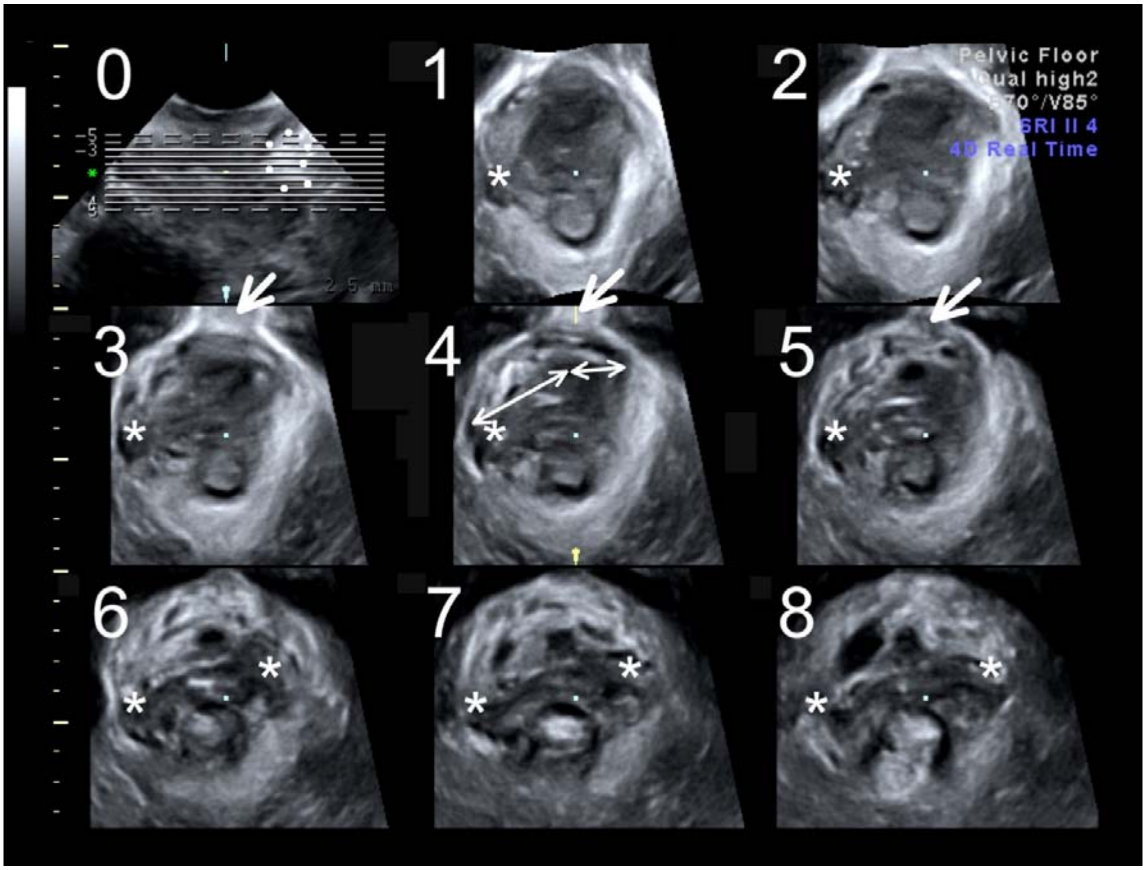

Figure 12.Tomographic ultrasound imaging in the C plane in a patient with three-compartment prolapse. There is a right-sided full avulsion (left had side of panels 1–8) and a left-sided partial avulsion affecting mainly the iliococcygeus (right hand side of panels 6–8). The defects are indicated by (*). The arrows show the pubic symphysis (open in 3, closing in 4 and invisible because of acoustic shadowing in 5). The avulsion is also visible in the coronal reference panel (0) where the intact puborectalis is marked by dots. There is no muscle visible on the contralateral side in panel 0. The levator–urethra gap is indicated by double-sided arrows in panel 4.

4.5 Evaluation of the levator hiatus

Overstretching of the LAM fibres during crowning of the fetal head at the first delivery results in considerable microtrauma, altering the distensibility and thus levator hiatal dimensions. In addition, some women show a congenitally overdistensible hiatus. Hiatal area matters because the hiatus is the largest potential hernia portal in the human body. A hiatal area to over 25 cm^2 is referred to as 'ballooning', based on normative data obtained in nulliparous women[44] and receiver operator characteristics analysis of hiatal area in symptomatic women.[45] An enlarged hiatus is likely to increase forces acting on the support structures of pelvic organs and has been shown to be strongly associated with POP symptoms[36, 37] and prolapse recurrence.[42] For this reason, the combination of avulsion and ballooning can provide an estimate of recurrence risk and a rational basis for mesh use, where this is still an option.[31] Figure 13 shows severe ballooning of the hiatus (≥ 40 cm^2) in a patient with recurrent prolapse after mesh surgery.

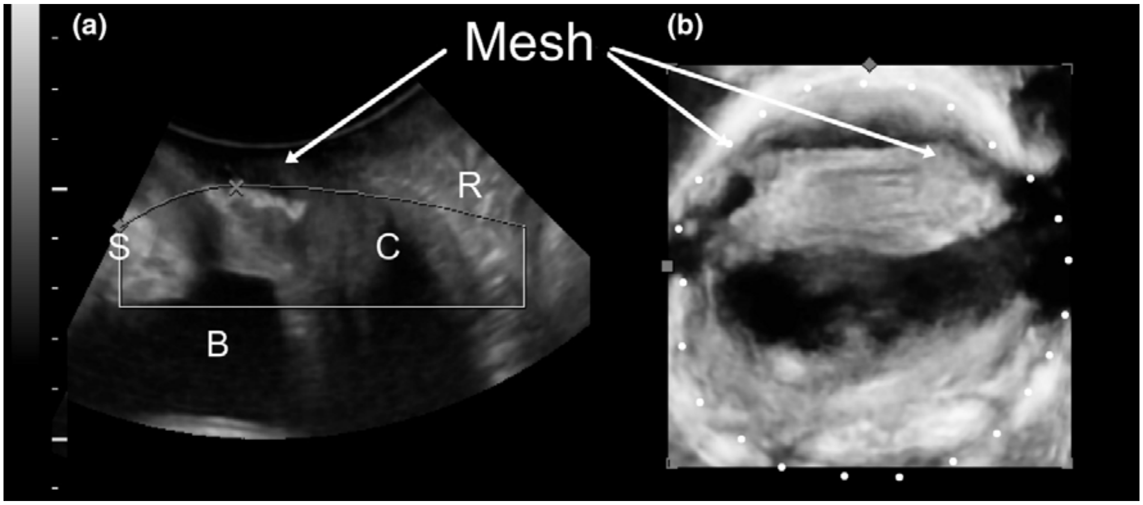

Figure 13. Ballooning of the levator hiatus in a patient with recurrent uterine prolapse after anterior compartment mesh and bilateral avulsion. The hiatus was measured at 42 cm^2 (severe ballooning) as outlined by dots in an axial plane rendered image in (b). S = pubic symphysis, B = bladder, C = cervix, R = rectal ampulla.

4.6 Evaluation of anal sphincter morphology

Imaging of maternal birth trauma serves a dual role for both the clinician and researcher. On the one hand, imaging provides new and clinically relevant outcome measures for obstetric research. On the other hand, it is a useful tool for clinical audit and practice improvement activities. It is now understood that many obstetric anal sphincter tears are either not recognised or misidentified.[38-40] Levator trauma is rarely diagnosed as it is occult unless exposed by a large vaginal tear.[6]

Postpartum, and in the puerperium, anatomy may be obscured by oedema, suture material and bleeding such that visualisation of the external anal sphincter on ultrasound is impaired. Additionally, patient discomfort may limit the pressure that can be applied, resulting in artefacts. A steady state is thought to be reached after 10–12 weeks, which might be the ideal time for imaging.[51]

The advent of inexpensive and accessible imaging afforded by TPUS is invaluable to obstetric units because it will facilitate clinical audit of both obstetric outcomes and perineal trauma, and assess the efficacy of diagnosis and repair of OASI.[51] In addition, episiotomy location and angle can be determined; see Figure 14.[52, 53] The consequences of maternal birth trauma may only manifest much later in life. Hence, imaging may prove useful as a surrogate outcome measure in short-term studies.[51]

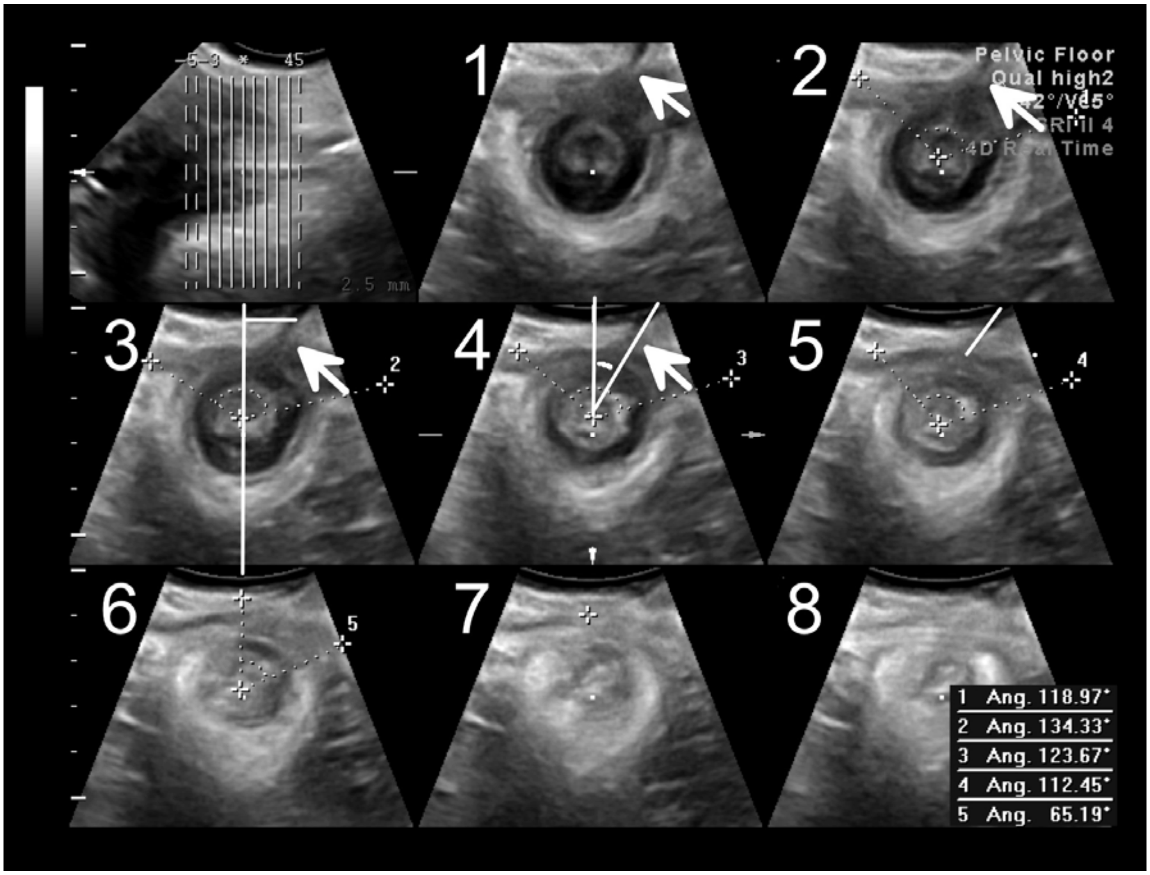

Figure 14. Exoanal 4D ultrasound of an unrepaired (overlooked) 3B perineal tear in the presence of a poorly cut episiotomy (oblique line in panels 1–5). Measurements indicate defect angle in panels 2–6. The lines in panel 4 show the episiotomy angle. The horizontal line in panel 3 documents a 'contralateral' episiotomy, i.e., an episiotomy that was commenced on the wrong side of the midline. Modified from: Dietz, 2018,[54] with permission from Wiley

4.7 Diagnosis of residual sphincter defects

Up to 40% of patients with previous OASI have residual sphincter tears detected in follow-up TPUS.[54] A residual sphincter defect is classified as a defect in the circumference of the external anal sphincter of more than or equal to 30 degrees in at least two out of three slices on endoanal sonography.[55] Transperineal sonography uses eight slices, of which six are usually assessed; the two-of-three rule of endoanal sonography is extended as a four-of-six rule in this case.[51] Endoanal ultrasound has been the historical gold-standard examination for residual anal sphincter defect, but is relatively invasive and costly. TPUS has good agreement with endoanal ultrasound.[56] Figure 14 shows a residual defect after a 3B perineal tear, which was overlooked in the labour ward. The tear occurred in the context of a poorly performed episiotomy.

Imaging, in the setting of residual/old sphincter injury, may not always change a clinician's management strategy. It may, however, be valuable in the sphere of patient counselling and add to the vocabulary with which physicians and patients discuss the cause and treatment modalities of faecal incontinence. Additionally, the information gained from imaging may aid in the discussion regarding future deliveries. For example, while the Royal College of Obstetricians and Gynaecologists (RCOG) recommends that a caesarean section be offered to patients with previous severe sphincter damage following a vaginal delivery,[57] there is evidence that those with previous OASI who are asymptomatic and without residual EAS defect may deliver vaginally with comparable outcomes to patients without previous OASI.[58, 59]

5 Conclusion

Pelvic floor ultrasound is an easy-to-access assessment tool for evaluating urogynaecological conditions. Standard views enable reproducible measurements to aid in diagnosis and treatment of various conditions. The method is internationally standardised and taught in an online course of the International Urogynecology Association. Future areas of research include the use of TPUS findings in predicting success of procedures for prolapse and incontinence, predicting obstetric injury and assessing treatment outcomes.

Disclosure of interests

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Contribution to authorship

FR was the principal developer of the article. All authors contributed to the writing and revision of the article. All authors approved the final version.

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