Transperineal and endovaginal ultrasound for evaluating suburethral masses: comparison with magnetic resonance imaging

N. A. OKEAHIALAM1, A. TAITHONGCHAI1, A. H. SULTAN1,2 and R. THAKAR1,2

1Urogynaecology and Pelvic Floor Reconstruction Unit, Croydon University Hospital, Croydon, London, UK; 2St George’s University of London, London, UK

KEYWORDS: magnetic resonance imaging; pelvic floor ultrasound; periurethral mass; suburethral mass; three-dimensional endovaginal ultrasound; transperineal ultrasound; urethral diverticulum

CONTRIBUTION

What are the novel findings of this work?
The agreement between pelvic floor ultrasound (US) and magnetic resonance imaging (MRI) for detecting a suburethral mass was 85%. MRI had good-to-excellent agreement with both two-dimensional transperineal US and three-dimensional endovaginal US for the measurement of the distance between the suburethral mass and the bladder neck and the largest diameter of the mass.

What are the clinical implications of this work?
Pelvic floor US could become an important imaging modality for the diagnosis and assessment of suburethral masses, and for surgical planning and counseling of patients.

ABSTRACT

Objective To evaluate the utility of pelvic floor ultrasound (US) in the detection and evaluation of suburethral masses, using magnetic resonance imaging (MRI) as the reference standard.

Methods This was a retrospective analysis of US and MRI scans of all women with a suburethral mass on clinical examination at a single urogynaecology clinic over a 13-year period (February 2007 to March 2020). All women were examined using two-dimensional transperineal US (2D-TPUS) with or without three-dimensional endovaginal US (3D-EVUS). All patients underwent unenhanced T1-weighted and T2-weighted MRI, which was considered the reference standard in this study. Presence of a suburethral mass and its size, location, connection with the urethral lumen and characteristics were evaluated on both pelvic floor US and MRI. Agreement between pelvic floor US and MRI was assessed using intraclass correlation coefficients (ICC; 3,1).

Results Forty women suspected of having a suburethral mass on clinical examination underwent both MRI and US (2D-TPUS with or without 3D-EVUS). MRI detected a suburethral mass in 34 women, which was also detected by US. However, US also identified a suburethral mass in the remaining six women. Thus, the agreement between US and MRI for detecting a suburethral mass was 85% (95% CI, 70.2–94.3%). The ICC analysis showed good agreement between MRI and 2D-TPUS for the measured distance between the suburethral mass and the bladder neck (ICC, 0.89; standard error of measurement (SEM), 3.64 mm) and excellent agreement for measurement of the largest diameter of the mass (ICC, 0.93; SEM, 4.31 mm). Good agreement was observed between MRI and 3D-EVUS for the measured distance from the suburethral mass to the bladder neck (ICC, 0.88; SEM, 3.48 mm) and excellent agreement for the largest diameter of the suburethral mass (ICC, 0.94; SEM, 4.68 mm).

Conclusions 2D-TPUS and 3D-EVUS are useful in the imaging of suburethral masses. US shows good-to-excellent agreement with MRI in identifying and measuring suburethral masses; therefore, the two modalities can be used interchangeably depending on availability of equipment and expertise. © 2020 The Authors. Ultrasound in Obstetrics & Gynecology published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.
INTRODUCTION

Suburethral masses are either congenital or acquired in etiology. It is difficult to estimate their incidence due to the low number of cases reported, however, reported rates are less than 1% in population-based studies. Suburethral masses occur in all ages and most frequently in women aged 30–60 years. Differential diagnoses include urethral diverticulum, Gartner duct cysts, vaginal inclusion cysts, Skene gland abscess and urethral caruncle. Urinary leakage is the most common, accounting for approximately 80% of cases.

Congenital suburethral masses arise from various embryological components and remnants of the genitourinary system, particularly Müllerian. They may display columnar, ciliated-columnar or stratified squamous epithelium. Inclusion cysts are lined with stratified squamous epithelium and may contain purulent material. Urethral diverticula are lined typically with transitional epithelium, but may undergo squamous or glandular metaplasia secondary to chronic inflammation. Suburethral masses have a smooth external surface and may be filled with caseous, purulent or thin mucoid material. They are usually small but vary in size, ranging from a few mm to over 5 cm in diameter.

Signs and symptoms of suburethral masses include presence of a painful palpable mass, dyspareunia, vaginal discharge, dysuria and voiding dysfunction. Most suburethral masses are benign and can be successfully excised surgically. However, operation of an undiagnosed urethral diverticulum can result in complications including urethral stricture and urethrovaginal fistula. Therefore, accurate diagnosis with imaging and preoperative planning is important.

Although magnetic resonance imaging (MRI) has not been established formally as the imaging reference standard in this context, it is the recommended modality for the detection of suburethral masses. In recent years, pelvic floor ultrasound (US) has gained increasing popularity among urogynecologists for the diagnosis of pelvic floor disorders. Compared with MRI, US offers better availability of equipment and healthcare professionals to report the imaging results, reduced cost, less patient restriction as well as better patient tolerance. Moreover, MRI failed to detect a urethral diverticulum in 7.3% of cases in a previous report.

The aim of this study was to evaluate the utility of pelvic floor US in the detection and evaluation of suburethral masses, using MRI as the reference standard.

METHODS

This was a retrospective analysis of US and MRI scans of all patients diagnosed on clinical examination with a suburethral mass in a single urogynecology clinic (Urogynaecology and Pelvic Floor Reconstruction Unit, Croydon University Hospital, London, UK) over a 13-year period (February 2007 to March 2020). Women with a vaginal lump or lower urinary tract symptoms suggestive of a suburethral mass were referred to the clinic by either their general practitioner or a different specialty team within the hospital.

All women were examined using two-dimensional transperineal US (2D-TPUS) with or without three-dimensional endovaginal US (3D-EVUS), using the Flex Focus 500 US system or Pro Focus 2202 system (BK Medical, Herlev, Denmark). 2D-TPUS was performed using a convex transducer applied to the perineum. Images were obtained in the coronal, axial and sagittal planes. 3D-EVUS was performed by inserting the endocavitary probe into the vagina in a neutral position and obtaining images in the mid-sagittal view and a 3D volume of the surrounding structures. If the mass was too large or distal, assessment using 3D-EVUS was not possible. US was performed with the woman in the supine position and the bladder partially filled. The urethra was seen as a hypoechoic structure extending from the bladder base to adjacent to the vaginal opening. Cystic structures were seen as hypoechoic areas and solid masses of mixed echogenicity. Images were analyzed by reporting on the presence of a suburethral mass, its size, location and whether there was communication with the urethral lumen. The three perpendicular diameters of the mass were measured in mm in the coronal, axial and sagittal planes and the largest diameter of the mass was used in the analysis. The location of the mass was determined by measuring the distance between the most proximal edge of the mass and the bladder neck in the sagittal plane. Communication with the urethral lumen was diagnosed when there was disruption of the hyperchoic rhabdosphincter, with a hypochoic connection between the mass and the urethral lumen.

MRI was considered the reference standard in this study. Unenhanced T1-weighted and T2-weighted MRI images were obtained. A suburethral mass was diagnosed if a mass lesion was present and located posterolateral to the urethra. The two perpendicular diameters of the mass were measured in mm in the axial and sagittal planes, and the largest diameter of the mass was used in the analysis. The location of the mass was measured as the distance between the most proximal point of the mass and the bladder neck in the sagittal plane. Communication with the urethral lumen was diagnosed when there was a hypointense disruption within the hyperintense rhabdosphincter, connecting the mass and the urethral lumen.

Pelvic floor US images were analyzed blinded to MRI results. In addition to imaging results, outcome management (conservative or surgical) and histology results were noted. All clinical and imaging information was entered into a dedicated Microsoft Excel database. Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as n (%) and continuous variables as median (range) or median (interquartile range (IQR)). The normality of distribution of continuous variables was tested using the Shapiro–Wilk test. Differences between the measurements obtained by US and MRI were analyzed.
using the Wilcoxon signed-rank test. To assess the agreement between US imaging and MRI, intraclass correlation coefficients (ICC; 3,1) were used. A value between 0.75 and 0.9 indicated good agreement and > 0.90 indicated excellent agreement. Standard error of measurement (SEM) was then calculated to measure the range of error for each measurement.

RESULTS

Forty women underwent both US (2D-TPUS with or without 3D-EVUS) and MRI. Their median age was 50 (range, 22–78) years. The most common symptoms leading to referral were sensation of a vaginal lump (n = 26; 65.0%), stress urinary incontinence (n = 16; 40.0%), voiding dysfunction (n = 6; 15.0%) and dysuria (n = 6; 15.0%). On clinical examination, all 40 women had a palpable suburethral mass. Table 1 presents the baseline characteristics of the patients.

MRI detected a suburethral mass in 34 women. 2D-TPUS detected correctly a suburethral mass in all 34 women, 27 of whom also had 3D-EVUS. However, pelvic floor US also detected a suburethral mass in the remaining six women. Therefore, the agreement between US and MRI for detecting a suburethral mass was 85.0% (95% CI, 70.2–94.3%).

The US and MRI characteristics of the suburethral masses detected on both modalities are shown in Table 2. On US, most suburethral masses were classified as simple and unilocular (67.6%) with hypoechoic contents (82.4%), while 32.4% were complex due to septations leading to a number of fluid-filled locules within the mass. In addition, 20.6% of masses encircled the urethra, described as horseshoe in appearance. Figures 1 and 2 demonstrate different appearances of suburethral masses on 3D-EVUS and 2D-TPUS.

The six suburethral masses detected on US but not on MRI were distal (median distance from the cyst to the bladder neck of 30.9 (range, 28.3–34.0) mm) with a median diameter of 7.8 (range, 5.0–15.0) mm. All six masses were unilocular and two were hyperechoic, two had mixed echogenicity and the other two were hypoechoic.

Connection to the urethra (Figure 2b,d) was detected on 2D-TPUS in the sagittal plane in seven women. In total,

Table 1 Baseline characteristics of 40 patients with suburethral mass included in study

| Characteristic                                   | Value |
|-------------------------------------------------|-------|
| Age (years)                                     | 50 (22–78) |
| Parity                                          | 2 (0–6) |
| Palpable suburethral mass on clinical examination| 40 (100) |
| Presenting symptom(s) leading to referral       |       |
| Vaginal lump                                    | 26 (65.0) |
| Stress urinary incontinence                     | 16 (40.0) |
| Voiding dysfunction                             | 6 (15.0) |
| Dysuria                                         | 6 (15.0) |
| Recurrent urinary tract infection               | 5 (12.5) |
| Dyspareunia                                     | 5 (12.5) |
| Vaginal pain                                    | 5 (12.5) |
| Postmicturition dribble                         | 4 (10.0) |
| Urge urinary incontinence                       | 4 (10.0) |
| Vaginal discharge                               | 2 (5.0) |
| Hematuria                                       | 2 (5.0) |

Data are given as median (range) or n (%).

Table 2 Characteristics of 34 suburethral masses detected by both pelvic floor ultrasound (US) and magnetic resonance imaging (MRI)

| Characteristic               | US (n = 34) | MRI (T2 weighted) (n = 34) |
|-----------------------------|-------------|----------------------------|
| Largest diameter of mass (mm)| 19.2 (1.0–72.1)* | 19.5 (2.7–79.0) |
| Distance from mass to bladder neck (mm) | 12.5 (0.0–40.0)† | 15.6 (0.0–36.0) |
| Urethral connection          | 7 (20.6)‡ | 1 (2.9) |
| Encircling the urethra       | 7 (20.6) | 10 (29.4) |
| Type of mass                 |            |                           |
| Unilocular                   | 23 (67.6) | 26 (76.5) |
| Multilocular                 | 11 (32.4) | 8 (23.5) |
| Echogenicity                 |            |                           |
| Hyperechoic                  | 3 (8.8)   | —                         |
| Mixed echogenicity           | 3 (8.8)   | —                         |
| Hypoechoic                   | 28 (82.4) | —                         |
| Signal intensity             |            |                           |
| Low                          | —          | 3 (8.8)                   |
| Intermediate                 | —          | 4 (11.8)                  |
| High                         | —          | 27 (79.4)                 |

Data are given as median (range) or n (%). *Largest measurement obtained on either two-dimensional transperineal US (2D-TPUS) or three-dimensional endovaginal US (3D-EVUS) was used. †Smallest measurement obtained on either 2D-TPUS or 3D-EVUS was used. ‡Urethral connection was seen only on 2D-TPUS in the midsagittal plane.

Figure 1 Three-dimensional endovaginal ultrasound images of different types of suburethral mass: (a) large simple suburethral mass involving the left anterolateral vaginal wall; (b) large simple circumferential suburethral mass; (c) suburethral mass with low-level ground-glass echogenicity; and (d) distal suburethral mass with low-level ground-glass echogenicity, displacing the urethra.
17/34 women underwent cystoscopy (used traditionally to diagnose a urethral connection)\textsuperscript{4} and a urethral connection was seen in five of them. Of the seven women diagnosed with urethral connection on 2D-TPUS, two underwent cystoscopy and the finding was confirmed in both. Connection to the urethra was seen in one patient on MRI, and this finding was confirmed on cystoscopy.

Agreement between the measurements obtained on 2D-TPUS and 3D-EVUS in comparison to those taken on MRI is presented in Table 3. There was no significant difference between MRI and 2D-TPUS and 3D-EVUS with regards to the measured distance between the suburethral mass and the bladder neck or the largest diameter of the mass. The ICC analysis showed good agreement between MRI and 2D-TPUS for the measured distance from the suburethral mass to the bladder neck (ICC, 0.89; SEM, 3.64 mm) and excellent agreement for measurement of the largest diameter of the suburethral mass (ICC, 0.93; SEM, 4.31 mm). Good agreement between MRI and 3D-EVUS was observed for the measured distance between the suburethral mass and the bladder neck (ICC, 0.88; SEM, 3.48 mm) and excellent agreement for measurement of the largest diameter of the suburethral mass (ICC, 0.94; SEM, 4.68 mm).

Eighteen (45\%) women underwent surgical excision of their suburethral mass. The masses were detected in all 18 women on both US and MRI. Of the remaining patients, 12 (30\%) declined surgical intervention, five (12.5\%) did not attend further follow-up and in five (12.5\%) the suburethral mass resolved spontaneously. The most common histological finding described by pathology was urethral diverticulum in 11 patients. Of these, 36.4\% had evidence of nephrogenic metaplasia and 36.4\% had evidence of chronic inflammation and ulceration. Histological diagnoses in the remaining seven women included a benign suburethral cyst in two (with ciliated and squamous epithelium, respectively, and so likely of congenital origin), a large Bartholin’s cyst in one, a leiomyoma in two, a malignant mesonephric adenocarcinoma in one and a malignant melanoma in one.\textsuperscript{16} The only US feature that allowed distinction between suburethral masses of differing etiology was the presence of a urethral connection in urethral diverticula, which was seen on US in three (27.3\%) cases with a urethral diverticulum. On MRI, urethral connection was seen only in one (9.1\%) case with urethral diverticulum. Table 4 further describes the US and MRI findings of the different histological diagnoses, highlighting that both modalities identified similar features.

**DISCUSSION**

The findings of this study show that pelvic floor US has good correlation with MRI in the detection and measurement of suburethral masses. All masses identified on MRI were also seen on US. Moreover, the two modalities identified similar features and characteristics of the suburethral masses.

Our imaging findings concur with sonographic and gross macroscopic features described by others\textsuperscript{5,7,10,17–20}. The suburethral mass size ranged between 0.1 and 7.2 cm in our cohort, with most being unilocular
Table 4 Pelvic floor ultrasound and magnetic resonance imaging (MRI) findings in 18 patients with a suburethral mass who underwent surgical treatment, according to the histological origin of the mass

| Characteristic | Urethral diverticulum (n = 11) | Benign suburethral cyst (n = 2) | Bartholin’s cyst (n = 1) | Leiomyoma (n = 2) | Adenocarcinoma (n = 1) | Melanoma (n = 1) |
|---------------|---------------------------------|---------------------------------|-------------------------|------------------|----------------------|------------------|
| Ultrasound    |                                 |                                 |                         |                  |                      |                  |
| Distance from mass to bladder neck (mm)* | 11.0 (8.0–40.0) | 10.2 (8.0–12.4) | 17.0 | 0.0 | 11.0 | 5.0 |
| Largest diameter of mass (mm)† | 17.0 (5.0–27.0) | 29.7 (24.3–35.0) | 44.9 | 69.7 | 48.0 | 36.0 |
| Urethral connection | 3 (27.3) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Encircling the urethra | 5 (45.5) | 0 (0) | 1 (100) | 0 (0) | 0 (0) | 0 (0) |
| Type of mass | Unilocular | 6 (54.5) | 1 (50.0) | 1 (100) | 2 (100) | 0 (0) |
|               | Multilocular | 5 (45.5) | 1 (50.0) | 0 (0) | 0 (0) | 1 (100) |
| Echogenicity | Hyperechoic | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
|               | Mixed echogenicity | 2 (18.2) | 0 (0) | 1 (50.0) | 1 (100) | 1 (100) |
|               | Hypoechoic | 9 (81.8) | 2 (100) | 1 (100) | 1 (50.0) | 0 (0) |
| MRI           |                                 |                                 |                         |                  |                      |                  |
| Distance from mass to bladder neck (mm) | 12.0 (6.0–36.0) | 10.0 (6.6–13.4) | 13.5 | 0.0 | 13.6 | 3.6 |
| Largest diameter of mass (mm) | 17.0 (5.0–29.0) | 31.5 (29.0–34.0) | 45.0 | 66.0 | 31.0 | 40.0 |
| Urethral connection | 1 (9.1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Encircling the urethra | 4 (36.4) | 0 (0) | 1 (100) | 0 (0) | 0 (0) | 0 (0) |
| Type of mass | Unilocular | 8 (72.7) | 1 (50.0) | 1 (100) | 2 (100) | 1 (100) |
|               | Multilocular | 3 (27.3) | 1 (50.0) | 0 (0) | 0 (0) | 1 (100) |
| Signal intensity | Low | 1 (9.1) | 0 (0) | 0 (0) | 0 (0) | 1 (100) |
|               | Intermediate | 0 (0) | 0 (0) | 1 (50.0) | 0 (0) | 1 (100) |
|               | High | 10 (90.9) | 2 (100) | 1 (100) | 1 (50.0) | 0 (0) |

Data are given as median (range) or n (%). *Smallest measurement obtained on either two-dimensional transperineal ultrasound (2D-TPUS) or three-dimensional endovaginal ultrasound (3D-EVUS) was used. †Largest measurement obtained on either 2D-TPUS or 3D-EVUS was used.

MRI is the recommended imaging modality for the detection of suburethral masses\(^4\), as it provides good delineation of the urethral anatomy due to its soft tissue contrast. T2-weighted images typically demonstrate suburethral masses well, as their fluid contents appear bright\(^23,24\). MRI has been reported to be able to delineate the ostium of a urethral diverticulum in 85% of cases, which other modalities, such as cystoscopy and US, have been described to often miss\(^24\). However, Gillor and Dietz\(^20\) recently showed, in a large retrospective study of 4121 women, that multiplanar TPUS can be used to identify urethral diverticulum. In this study, a diverticulum ostium was demonstrated on US and confirmed on cystoscopy in 40% of patients, compared to 20% with MRI.

We showed that US is comparable to MRI in its ability to assess the structure and consistency of suburethral masses. Agreement between US and MRI was 85% for the detection of suburethral masses and good to excellent for the measurement of the largest mass diameter and the distance between the mass and bladder neck. Figures 3 and 4 demonstrate the ability of 2D-TPUS and 3D-EVUS to produce images consistent with and comparable to MRI. Other studies have compared 3D-US to MRI.
Pelvic floor US did not miss any suburethral mass detected on MRI. However, a possible suburethral mass was seen in an additional 15% (6/40) of women in comparison to MRI. These masses were smaller in size and more distal in comparison to those detected on both modalities. It is important to note that these women did not have diagnostic confirmation with histology, so we were unable to confirm whether this was a true abnormality or artifact; however, as these women presented with symptoms, we believe it is unlikely that the mass seen on US was an artifact. MRI errors in detecting suburethral masses have previously been described in the literature. In a cohort of 41 patients who underwent urethral diverticulum surgery, Chung et al.\textsuperscript{13} showed that preoperative MRI failed to identify the presence of a urethral diverticulum in 7.3% of cases. A potential reason for this is that MRI has limited sensitivity in identifying masses with little fluid content and those of small size. Also, MRI is not dynamic and captures a sequence of images at a single timepoint\textsuperscript{13}. These image slices can be relatively thick (3–6 mm) with spacing between them, which could result in areas being missed and lesions not being identified\textsuperscript{29}.

3D-US offers advantages, including its real-time imaging and superior temporal and spatial resolution\textsuperscript{30}. Furthermore, the ability to manipulate the high-resolution 3D volumes in all planes, including the axial plane, previously only visible on MRI, allows for effective visualization of the pelvic floor anatomy and pathology\textsuperscript{30}. Although the 3D-EVUS modality can obtain anatomical views that 2D-TPUS cannot, essential images can still be obtained using solely 2D imaging. The limitation of 3D-EVUS is that it may cause discomfort, particularly in case of large and inflammatory masses, and can compress and displace the urethra\textsuperscript{31}. This may explain the inability to identify a diverticulum ostium on 3D-EVUS in this series. Therefore, in this situation 2D-TPUS would suffice. However, multiplanar transperineal systems are also available which allow real-time 3D (or four-dimensional) assessment of the pelvic floor\textsuperscript{30}.

US has the advantage that the examination and assessment of history and US findings can be performed in the same clinic appointment, which allows correlation of the findings with patient symptoms, and subsequent discussion and counseling for further management if required. Furthermore, US can be a valuable tool in preoperative planning and can be used intraoperatively to anticipate possible complications, such as bladder or urethral injury based on anatomical proximity, therefore potentially improving surgical outcome. Pelvic floor US is not readily available in all units, it is highly operator dependent and requires expertise for interpretation. However, it is rapidly becoming a popular tool amongst pelvic floor clinicians.
The main strength of this study is that it comprises the largest cohort to date of women with a suburethral mass and that it compared US to MRI, which is the recommended imaging modality for the detection of suburethral masses. Additionally, US images were analyzed blinded to MRI results. Limitations include its retrospective design and that US and MRI imaging were not performed on the same day, which may have resulted in fluctuations in the size of the suburethral mass. Furthermore, as not all women underwent surgical excision, only 45% of diagnoses were confirmed histologically. However, in keeping with a previous large series which found that 84% of suburethral masses were secondary to a urethral diverticulum, we found the same results. However, in keeping with a previous large series which found that 84% of suburethral masses were histologically. However, in keeping with a previous large series which found that 84% of suburethral masses were secondary to a urethral diverticulum, we found the same result.

In conclusion, 2D-TPUS and 3D-EVUS are useful in the imaging of suburethral masses. Pelvic floor US shows good-to-excellent agreement with MRI in identifying and measuring suburethral masses, therefore, the two modalities can be used interchangeably depending on availability of machines and expertise.

REFERENCES

1. Blaivas JG, Flisser AJ, Bleustein CR, Panagopoulos G. Periurethral Masses: Etiology and Diagnosis in a Large Series of Women: Obstet Gynecol 2004; 103: 842–847.
2. El-Nashar SA, Bacon MM, Kim-Fine S, Weaver AL, Gebhart JB, Klinge CJ. Incidence of female urethral diverticulum: a population-based analysis and literature review. Int Urogynecol J 2014; 25: 73–79.
3. Patel AK, Chapple CR. Female urethral diverticula. Curr Opin Urol 2006; 16: 248–254.
4. Archer R, Blackman J, Stott M, Barrington J. Urethral diverticulum. Obstet Gynecol 2015; 125: 125–129.
5. Cross JJL, Fynes M, Berman L, Perera D. Prevalence of Cystic Paraurethral Structures Obstet Gynecol 2005; 105: 1106–1106.
6. Lene F, Sultan AH, Thaker R. Long-term outcome of transurethral injection of hyaluronic acid/xanthanomer (NASHA/Dx gel) for the treatment of stress urinary incontinence (SUI). Int Urogynecol J 2010; 21: 1359–1364.
7. Deppisch LM. Cyts of the Vagina: Classification and Clinical Correlations. Obstet Gynecol 1975; 45: 632–637.
8. Cocco AE, MacLennan GT. Unusual Female Suburethral Mass Lesions. J Urol 2005; 174: 1106–1106.
9. Migliari R, Pistolesi D, U’uso I, Muto G. Recurrent Pseudodiverticula of Female Urethra: Five-year Experience. Urology 2009; 73: 1218–1222.
10. Shobeiri SA, Rostaminia G, White D, Quiroz LH, Nihira MA. Evaluation of Vaginal Cysts and Masses by 3-Dimensional Endovaginal and Endoanal Sonography. J Ultrasound Med 2013; 32: 1499–1507.
11. Dietz HP. The evolution of ultrasound in urogynecology. Ultrasound Obstet Gynecol 2010; 36: 635–637.
12. Chaudhuri VV, Patel MK, Douek M, Raman SS. MR Imaging and US of Female Urethral and Periurethral Disease. Radiographics 2010; 30: 1857–1874.
13. Chung DE, Parodi RS, Grishman J, Blaivas JG. Urethral Diverticula in Women: Discrepancies Between Magnetic Resonance Imaging and Surgical Findings. J Urol 2010; 183: 2265–2269.
14. Itani M, Kielar A, Menias CO, Dughe MK, Surabhi V, Prasad SR, O’Malley R, Gangadhar K, Lahav N. MRI of female urethra and periurethral pathologies. Int Urogynecol J 2016; 27: 191–204.
15. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. J Clin Epidemiol 2016; 15: 155–163.
16. Shoer S, Bablachandran AA, Wang J, Sultan AH. Mesonephric adenocarcinoma of the vagina masquerading as a suburethral cyst. BMJ Case Rep 2018; bcr2018224758.
17. Gugliotta G, Calagna G, Adle B, Polito S, Speciale P, Perino A, Adle B. Use of trans-labial ultrasound in the diagnosis of female urethral diverticula: A diagnostic option to be strongly considered: Trans-labial US for urethral diverticula. J Obstet Gynecol Res 2015; 41: 1108–1114.
18. Kreef R, Warshauer DM, Tucker MS, Mittelstaedt CA. Diverticula of the female urethra: diagnosis by endovaginal and transperineal sonography. AJR Am J Roentgenol 1991; 156: 1195–1197.
19. El-Gez T, Khoury N, El-Gez Y, Bulbul M, Bariyan G. Intrareoperative translabial ultrasound for urethral diverticula: A road map for surgeons. Eur J Radiol 2009; 70: 133–137.
20. Gillor M, Dietz HP. Translabial ultrasound imaging of urethral diverticula. Ultrasound Obstet Gynecol 2019; 54: 552–556.
21. Goss J. Evaluation of Urethra and Anterior Wall Vaginal Lesionomy by Translabal/Transurethral Sonography: J Diag Med Sonogr 2010; 26: 42–45.
22. Pavlica P, Bartronole A, Gaudiano C, Bazzoli C. Female parietal urethral lesionomy: ultrasonographic and magnetic resonance imaging findings. Acta Radiol 2004; 45: 796–798.
23. Hahon WY, Israel GM, Lee VS. MRI of Female Urethral and Periurethral Disorders. AJR Am J Roentgenol 2004; 182: 677–682.
24. Greiman AK, Rofel J, Rovner ES. Urethral diverticulum: A systematic review. Arab J Urol 2019; 17: 49–57.
25. Haanswoth AJ, Pillington SA, Giersson C, Rutherford E, Schuas AUP, Nugent KP, Williams AR. Accuracy of integrated total pelvic floor ultrasound compared to defaecatory MRI in females with pelvic floor defaecatory dysfunction. Br J Radiol 2018; 91: 20180322.
26. Wang X, Ren M, Liu Y, Zhang T, Tian J. Perineal Ultrasound Versus Magnetic Resonance Imaging (MRI) Detection for Evaluation of Pelvic Diaphragm in Resting State. J Urol 2014; 89: 20160522.
27. Wang X, Ren M, Liu Y, Zhang T, Tian J. Perineal Ultrasound Versus Magnetic Resonance Imaging (MRI) Detection for Evaluation of Pelvic Diaphragm in Resting State. J Urol 2014; 89: 20160522.
28. Notten KJB, Klivers KB, Futterer JJ, Schweitzer KJ, Stoker M, Mulder FE, Berits-Tan RG, Vliegen RFA, Bossuyt PM, Kreutzwagen RFPM, Roovers JPFR, Weenhoff M. Translabial Three-Dimensional Ultrasonography Compared With Magnetic Resonance Imaging in Detecting Levator Ani Defects. Obstet Gynecol 2014; 124: 1190–1197.
29. Javadan P, O’Leary D, Rostaminia G, North J, Wagner J, Quirou LH, Shobeiri SA. How does 3D endovaginal ultrasound compare to magnetic resonance imaging in the evaluation of levator ani anatomy? Neurourology Urodynamics 2017; 36: 409–413.
30. Del Gaudio A, Silva AC, Lam-Himlin DM, Allen BC, Leyendecker J, Kawashima A. Magnetic resonance imaging of solid urethral and peri-urethral lesions. Insights Imaging 2013; 4: 461–469.
31. Dietz HP. Ultrasound imaging of the pelvic floor. Part II: three-dimensional or volume imaging. Ultrasound imaging of the pelvic floor. Ultrasound Obstet Gynecol 2004; 23: 615–625.
32. Umek WH, Obermair A, Stutterrecker D, Häusler G, Leodolter S, Hanzel E. Three-dimensional ultrasound of the female urethra: comparing transvaginal and transrectal scanning: 3D ultrasound of the urethra. Ultrasound Obstet Gynecol 2001; 17: 425–430.

Ultrasound imaging of suburethral masses

Ultrasound Obstet Gynecol 2021; 57: 999–1005.