MR Imaging Assists in Diagnosis of Stress Urinary Incontinence in Women: Results from a pilot prospective trial

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Background:
Stress urinary incontinence (UI) is one of the most common health problems in aging female population and has a severe economic and psychosocial impact. Sphincteric type of stress UI in women can be related to intrinsic sphincter deficiency (ISD) and/or urethral hypermobility (UH). Management of patients with UI depends on the type of sphincteric deficiency. Traditional diagnosis of UI and distinction between ISD and UH is based on urodynamics (UDs). To date, MR imaging is not recommended in the initial management of UI. Since MR imaging provides superior soft tissue contrast and allows direct visualization of the urethra and its supporting structures, MR imaging has a potential to contribute important information that can guide in patient diagnosis and management. Our purpose for this study was to assess whether MR imaging findings can predict the type of UI, ISD versus UH, when correlated to UDs.

Methods:
We evaluated 18 women with stress UI (mean age 54, range 36-72; body mass index mean 28 kg/m^2; parity – mean 2 vaginal deliveries, range 0-4) documented by clinical exam and UDs. MR imaging protocol for 1.5T GE Signa Excite included endocavitary and standard pelvic imaging with high resolution T2-weighted FSE images in three planes. Techniques for T2W images: intraurethral MRI (14F endourethral coil, Surgi Vision, Inc., TR/TE 3000-6300/60-75 ms, slice/space 3/0.5-2.0 mm, FOV 5-7 cm, 6-8 NEX, 256x256), endovaginal or endorectal MRI (Medrad coil, TR/TE 4000/90 ms, slice/space 3/0-1 mm, FOV 14 cm, 256x192), pelvic MRI with pelvic phase array coil (TR/TE 4500/90 ms, slice/space 3/1 mm, FOV 20 cm, 512x256), dynamic strain imaging SSFSE (TR/TE ∞/80 ms, slice/space 6/2 mm, FOV 20 cm, 512x256). We analyzed thickness and length of urethral sphincter muscle, status of urethral support (periurethral ligament PEL, paraurethral ligament and pubourethral ligament, levator ani muscle), symmetry of vaginal attachments, urethra and bladder neck mobility. Based on MR imaging patients were classified into UH, ISD, or mixed category. MR imaging criteria for UH included: urethral mobility angle > 30 º, abnormal bladder neck descent (below the level of pubococcygeal line), PEL disruption (partial -- such as laxity/fluttering, focal attenuation, or complete – such as discontinuity, Figure 1), paravaginal defects (widening of the attachments and distance between the vagina and levator muscle/fascia). MR imaging criteria for ISD included: sphincter length above pubis < 3 cm, sphincter defect (disruption, diverticulum) or thinning (at or below 1 mm striated muscle anteriorly in mid urethra), funneling of bladder neck. Subsequently, diagnosis from MR imaging was compared to results from UDs. We also correlated MR imaging findings with UDs parameters (Valsalva leak point pressure -VLPP, maximum urethral closure pressure –MUCP, functional urethral length, and Q-tip test for urethral mobility). Pearson's product moment correlation coefficient was used for the assessment of correlation between paired variables.

Results:
There was very high correlation (r = 0.93) between VLPP and sphincter muscle length, high correlation (r = 0.83) between Q-tip mobility and hypermobility angle on MRI, and (r = - 0.74) between MUCP and posterior striated muscle thickness of mid urethra. There was moderate correlation (r = 0.68) between functional length of urethra by UDs and length of sphincter muscle on MRI.
Diagnosis of UH, ISD or mixed UI was established when at least two of imaging criteria were present per UI category. Based on UDs, UH was diagnosed with Q-tip angle > 30 º and VLPP > 60 H2O, and ISD was diagnosed with MUCP ≤ 20 cm H2O and VLPP ≤ 60 cm H2O. Mixed UI category included findings from both UH and ISD groups. In predicting UH, MRI showed sensitivity 92%, specificity 100% (1 patient who had no specific MR findings of UI had hypermobility on UDs). In predicting ISD, MRI sensitivity and specificity was 100%. Patients with ISD showed short or thinned urethra sphincter and bladder neck funneling. All patients with UH showed partial or complete disruption/laxity of periurethral ligaments and 10 showed vagino-levator separation.

Conclusions and Clinical relevance:
MRI contributes findings that characterize urethral sphincter dysfunction in women and are predictive of ISD and UH type of urinary incontinence. MRI supplements UDs evaluation and may assist in classification of incontinent patients into hypermobility and ISD category, which may guide the choice of therapy and post treatment follow-up. Further research on imaging contribution to diagnosis of UI is warranted.

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Figure 1. Imaging of the female urethra using different MRI techniques in four patients. A. Visualization of intact periurethral ligament PEL (arrow) on standard imaging with pelvic phased array coil in a continent volunteer. B. Visualization of laxity of right PEL (arrow) on endovaginal MRI in a woman with UH. C. Visualization of completely disrupted left PEL (arrow) on endorectal imaging. D. Intraurethral MR shows details of urethral sphincter muscles (outer T2 dark striated muscle and inner T2 bright smooth muscle). E. Strain imaging SSFSE of urethra mobility and bladder neck competence assessment. Note hypermobility of urethra that assumed horizontal position and bladder neck funneling (arrow).