DISCUSSION

Stress urinary incontinence (SUI) and pelvic floor prolapse are significant and costly health problems. [45]

Pelvic floor dysfunction is a complex condition that can involve some or all of the pelvic viscera abnormal descent of the bladder (cystocele), uterus or vagina (uterine or vaginal vault prolapse), small bowel (enterocele), or rectum (rectocele). It is a significant women's health problem that primarily affects parous women over 50 years of age. Symptoms and signs most commonly include pelvic pressure, protrusion of tissue through the pelvic floor, and urinary incontinence. [45]

Urinary incontinence, defined as involuntary leakage of urine, it is one of the most common conditions in the female population that causes significant anxiety and negatively affects the quality of life. [45]

Diagnosis of SUI is made primarily on the basis of findings at pelvic physical examination. But physical examination is often insufficient.

Thus, pre-operative imaging is needed to plan appropriate surgery, and the clinician can choose among a wide range of imaging modalities, which can confirm clinical suspicions and reveal unsuspected defects. [45]

The traditional methods for evaluation of urinary incontinence in women include urodynamics, cystourethroscopy, cystourethrography, and ultrasonography. High-resolution MR imaging allows detailed visualization of the urethral sphincter and supporting ligaments in women and may contribute to the diagnosis and staging of sphincteric incompetence related to intrinsic sphincter deficiency or urethral hypermobility.[46] Both the anatomy and the function of the female urethra can be depicted on MR images. The spectrum of abnormalities detected at MR imaging in women with stress urinary incontinence are classified as (a) findings related to the urethral sphincter deficiency and (b) defects of the urethral support ligaments and urethral hypermobility. These abnormalities include a small urethral muscle volume or a short urethra, defects in the urethral sphincter, funneling at the bladder neck, distortion of the urethral support ligaments, cystocele, an asymmetric pubococcygeus muscle, abnormal shape of the vagina, and an increased vesicourethral angle (hypermobile urethra). [46]

Imaging findings in the evaluation of female urethral sphincter anatomy and function can be divided into assessment of the status of the urethral sphincter muscle itself and the status of urethral support structures. [46]

In this research we made an attempt to study the relation between the age and SUI as well as the parity status and the incidence of SUI and pelvic floor laxity. We realized that aging alone could not be regarded as an effective underlying cause, as 1/2 of the patients were below the age of 50 years. This can be explained by the fact that a young continent nulliparous female may have some congenital laxity of the pelvic floor support structures or even a para-vaginal tear as 23% of our symptomatic patients are nulliparous. [47]

The relation between age as a sole denominator and pelvic floor weakness could not be found in other studies, thus rather a combination between age and parity status together was considered [47]. However other studies showed that there is a relation between age and pelvic floor weakness with a prevalence of 9.7%-49.7% that increase with age [48].

Obstetric trauma is believed to be a main cause of incontinence in older women, this is seen in our research since 77% of our patients are multiparous and suffered stress incontinence after birth trauma.[48] Other studies carried out in the last few years assured the conclusion that structural pelvic floor damage is now thought to be a major contributor, fueling current debate about the risks and benefits of elective cesarean delivery. [49] Some women may prefer an elective cesarean to avoid the disabling complications of incontinence. Many studies have shown that disruption of the hammock-like support structure is closely related to the development of stress urinary incontinence in women. [49]

Our results are therefore compatible with the hypothesis of vaginal delivery as a contributory factor to stress incontinence in older parous women since 77% of our patients are multiparous, still such results require confirmation in a larger study population. [49]

The two striated muscle groups that can potentially increase urethral closure pressure during pelvic muscle contraction are the striated urogenital sphincter muscle and the pubococcygeal portion of the levator ani muscle. Abnormal signal in the levator muscle, when compared to the obturator internus, and thinning can be observed in patients with stress incontinence and can be a result of fatty infiltration and atrophy as well as direct muscle injury.[50] Whereas the striated urogenital sphincter muscle increases closure pressure by shortening its circumferentially oriented muscle fibers and constricting the lumen, the contraction of the pubococcygeus muscle results in urethral compression against adjacent tissues [51]. The pubococcygeus muscle can be well evaluated with MR imaging . Loss of the symmetric appearance of the pubococcygeus muscle and lateral deviation and thinning or complete attenuation have been shown in patients with urinary incontinence, in our research 57% showed asymmetric thinning of the puborectalis muscle sling, while 43% showed bilateral diffuse thinning of the muscle.[51] Disruption of the pubococcygeus muscle may influence stress continence, as the additional occlusive force on the urethral wall may be lost, particularly during events associated with an increase in intraabdominal pressure.[51]

Some studies have found little difference in the asymmetry of this structure between stress-urinary-incontinent and continent women [52]. It is important to realize that asymmetry can also be a physiologic finding in nulliparous women and, thus, is not necessarily a result of birth trauma and episiotomy. It is a sum of different morphologies and not the asymmetry alone. This was proved to be the more accurate relationship between levator thickness and pelvic floor dysfunction. [53]

The vagina with maintained paravaginal attachments assumes an H-shaped (butterfly) configuration, as seen on axial images. Alteration of the morphologic features of the vagina may be indicative of paravaginal tears. These tears lead to urinary incontinence by weakening the urethral support mechanism provided by the vagina to the middle and distal portions of the urethra embedded in the anterior wall of the vagina. This is seen in our research since 60 % of the patients with SUI lost the H shape configuration of the vagina, indicating partial or complete paravaginal tears. The trend towards abnormal vaginal shapes in the stress incontinence correlates well with the previous work. In

agreement with our work Klutke et al [54] described loss of the normal vaginal shape likely caused by tearing of supporting fascia in women with stress incontinence. Hudleston et al.[55] correlated abnormal vaginal shapes with defects in facial supports of the vagina. This information will be relevant to the surgeon because repair of the cystocele alone will not be sufficient, and fascial repair may also be necessary [56]

Descent of the bladder base below the PCL either at rest or during strain is abnormal[57]. Most research has shown that the location of the urethrovesical junction is an important contributing factor to the overall maintenance of continence. However, continent cystoceles with inferior urethral displacement as far as the introitus have been reported [57]. In our research there are 53% of the patients with cystocele associated with SUI, suggesting the relation between SUI and cystocele. In contrast to other study which showed that bladder neck descent is not associated with SUI, since in their study only 6% of the cases had SUI associated with cystocele and they mentioned that even these cases had defects in the urethral supporting structures on static MRI.[58] In agreement with our findings is the hammock hypothesis suggested by DeLancey [57], who reported that loss of level III endopelvic fascial support at the vesical neck is one of the factors responsible for SUI. Our findings demonstrate at imaging what had been hypothesized. Furthermore, in more recent studies, static MR imaging revealed a higher prevalence of lesions of the urethral supporting system in patients with SUI. [58]

Patients with urethral hypermobility can have urinary incontinence. In our study approximatly 97% of the patients have hypermobile urethra, suggesting strong correlation between SUI and hypermobile urethera. In agreement with our findings Klutke et al[59], who used static MR imaging, and others [60],who used dynamic MR imaging, have suggested urethral hypermobility as one of the causes of SUI. Yang et al [54], who used only dynamic MR imaging, did not resolve the paradoxical lack of urinary incontinence in some patients with large cystocele because they believed it was unclear whether the cause was kinking of the urethra or other factors. [54]

Widening of the proximal urethra at the vesical neck, called funneling, was found to be the common denominator underlying stress incontinence. when the intrinsic closure of the urethra begins to weaken. This is seen in 33% of our patients, proving that weakening of the proximal muscle sphincter contribute to SUI. [60]

The importance of the functional (dynamic) sequences was particularly highlightened in the cases of urethral hypermobility and cystoceles, where no abnormalities were observed on the static images as the bladder neck was above the PCL at rest, while on straining not only the number of patients which were already diagnosed clinically as cystocele were discovered to have different grades of cystocele, but about 70% of the total number of patients with different clinical diagnosis revealed to have multi-compartmental defects on the dynamic images. Yang et al. [54] reported that the normal vertical distance of the bladder neck at strain should be less than 1 cm from the pubococcygeal line. The distal two thirds of the urethra is inseparable from the anterior vaginal wall. [54]

In patients with stress urinary incontinence, the support from the anterior vaginal wall is diminished; increased intraabdominal pressure results in descent of the bladder neck below the PCL and prolapse of the urinary bladder through the anterior vaginal wall, resulting in a cystocele. Because the bladder neck and proximal urethra are mobile, descent of the bladder neck during strain may result in clockwise rotational descent of the bladder

neck and proximal urethra. When the proximal urethra rotates more than 30°, urethral hypermobility results and can cause kinking of the proximal urethra that may mask stress urinary incontinence. In a study by Kim et al. [61], distortion of the periurethral and paraurethral ligaments was frequently noted in patients with stress urinary incontinence, suggesting that a defect of connection between the urethra and the puborectalis sling is one of the principal causes of urethral hypermobility, and this is proved by our study as we mentioned earlier that 57% of the cases had asymmetric puborectalis muscle slings while the other 43% had bilateral diffuse muscle thinning. [61]

Again this is confirmed by the above mentioned statement, that "complete relaxation of pelvic floor muscles occurs only during defecation and micturition, thereby allowing urethral hypermobility, cystocele and other pelvic organ prolapse to manifest itself to the fullest extent", which was actually used as an argument to rationalize the drawback of physical examination. [61]

Insensitivity of the physical examination is almost certainly related to the patient's inability to strain maximally while being examined. Complete relaxation of pelvic floor muscles occurs only during defecation and micturition, thereby allowing urethral hypermobility and pelvic organ prolapse to manifest itself to the fullest extent helping to determine cause of urinary incontinence. The degree of straining achieved by the patient while encumbered by an examining digit (with or without a vaginal speculum) is clearly less than that achieved during defecation. [61]

The advantages of MRI are considerable. This technique provides a cine loop of pelvic organs simultaneously, which allows assessment of their relative positions both at rest and straining (pelvic floor descent). Dynamic evaluation of the urethral sphincter during strain is possible with MR imaging, and simultaneous functional and morphologic assessment may assist in classification of incontinent patients into hypermobility and intrinsic sphincter deficiency categories. Its multiplanar representation has the potential to yield far more diagnostic information, especially about the pelvic floor musculature and other support structures and the urethral supporting ligaments. Oral and rectal barium administration, as well as bladder opacification are unnecessary (non-invasive). There is no associated radiation exposure. Finally, the bony reference points are far easier to identify on MRI [62].

A limitation of the study is the lack of correlation of imaging findings with physical examination, because as we mentioned before a young continent nulliparous woman may have some congenital pelvic floor laxity or chronic straining causing such laxity. Still our measurements derived from the anatomy of healthy young women provide a baseline to which symptomatic women can be compared. [62]

The use of MR imaging to analyze pelvic floor musculature is rapidly growing and has contributed considerably to our understanding of urinary incontinence and pelvic floor dysfunction. Our results suggest that dynamic MRI offers a promising method for quantifying pelvic floor motion in stress urinary incontinence. Interestingly, subjects with considerable pelvic floor laxity on POPQ and MRI can remain continent and asymptomatic. [62]

The standard report from MR imaging examination in a patient with urinary incontinence should include a summary of the status of both the urethral sphincter muscle

and the urethral support structures. For the urethral sphincter muscle, the following items should be reported: (a) muscle integrity (muscle disruption,), and (b) bladder neck competence during strain (especially the presence of funneling). For the urethral support structures, the following items should be reported: (a) an estimate of ligamentous disruption, (b) the degree of urethral hypermobility from the resting position, (c) the presence and size of a cystocele, and (e) asymmetry and defects of the pubococcygeus muscle.[62]

In our study the difference between the clinical diagnosis and the MRI diagnosis of the different types of pathologies is considerably high, that it concurs with the demand that pre-operative assessment by imaging is mandatory. In our study almost 26.6% of the patients investigated by MR imaging for urethral hypermobility had abnormalities in all three pelvic compartments in comparison to other study where only 12.5% had SUI combined with pelvic organ prolapse in three compartments, 13.3% of our patients had isolated SUI in comparison to other study 30% had isolated SUI, while the rest of our patients have abnormality in only one or two compartments along with SUI. [63]

Moreover, it was observed that cases of Hernia of the Douglas pouch with its various subtypes were only diagnosed on imaging. This was confirmed by other comparative research studies that have confirmed the relative insensitivity of physical examination to detect enterocoeles and sigmoidocoeles [63]. In one study of 300 women, enteroceles were revealed on dynamic cystoproctography in 111, of which 93 (84%) were missed clinically[64].

A more fundamental benefit of imaging is that it directly visualizes site of weakness and cause of incontinence, where as physical examination only states presence of incontinence and if there is moderate to severe prolapse of any organ. It must be emphasized however, that these two diagnostic approaches are based upon entirely different reference points; the hymeneal ring and the PCL. A common reference system would be beneficial[65].

It appears likely that the limitations of physical examination have contributed to the frequent need for re-operation. One study found that the diagnosis of rectocoele, enterocoele and cystocele was changed in 75% of patients who underwent imaging and thus the treatment plan of the urinary incontinence was changed [63].It is advisable to identify all the areas of pelvic floor weakness associated with urethral abnormalities as well as ligamentous tears because they may all require surgical correction, and ideally this is done at one operative setting [65].

Moreover, a subsequent study confirmed the role of functional (dynamic) MRI, as it allows ***a)*** pre-operative detection of urethral abnormalities, ***b)*** detection of hidden prolapses and ***c)*** assessment of muscle trophicity [66].

Pre-operatively, it aids in the choice of therapy, which includes many different surgical and non-surgical procedures. Women with intact pelvic floor support structures would respond well to behavior modification techniques and estrogen replacement therapy, whereas those with disruption of urethral ligaments and levator ani would benefit from surgery. [67]

Goals of surgery include ***a)*** treatment of stress incontinence and other symptoms, ***b)*** restoration of anatomic relationships and ***c)*** preservation of organ function [68].

More accurate pre-operative assessment by imaging should hopefully reduce the incidence of operative failure [69].

Lastly, it allows ***a)*** post-operative assessment of surgical results and failures or recurrences, or ***b)*** if conservative methods are used such as biofeedback, it allows follow-up and whether the condition resolved or stayed the same or even got worse allowing for choosing another modality of treatment [70].

Another potential objection is that we did not quantify straining. In an attempt at standardization, all patients practiced the Valsalva's maneuver several times under supervision before undergoing MR imaging and the volunteer was placed on an absorbent pad to minimize the fear of leakage. [71] Furthermore, only the image showing maximal depressant effect was used for subsequent analysis.[72,73] We decided against using a device to measure intra-abdominal pressure, in case the device itself (i.e., the rectal balloon) influenced the straining effect. [74]

SUMMARY

Urinary incontinence is a common problem among women in all age groups. It may manifest as stress incontinence, urge incontinence or mixed incontinence. Stress incontinence is caused by urethral hypermobility and/or intrinsic sphincter deficiency. Numerous risk factors for urinary incontinence have been identified, among them are age, parity, menopause, obesity, hysterectomy and neurologic disorders.

Imaging for SUI includes cystourethrography, ultrasound and magnetic resonance imaging (MRI). Recently, MRI has been used in the diagnosis and evaluation of pelvic floor dysfunction. MRI provides anatomic details of the pelvis including assessment of bladder neck and urethral hypermobility and cystocele, additional findings include rectocele, enterocele and uterine prolapse in a single non-invasive study without exposing the patient to ionizing radiation. It is helpful in evaluating the pelvic floor after vaginal delivery, and surgery.

This study aimed at assessment of females with stress urinary incontinence using dynamic MRI. The study was conducted on thirty female patients with SUI presenting at Radio-diagnosis department, Alexandria Main University Hospital. All patients were subjected to static and dynamic MRI.

Certain parameters were measured using dynamic MRI, these are the degree of bladder descent, hypermobile urethra, urethrovesical angle, H-shaped configuration of vagina and bladder neck funneling.

Sixteen case showed bladder descent, twenty-seven showed hypermotile urethra, eighteen lost the H-shape configuration of vagina and ten showed bladder neck funneling. Urethral supporting ligaments were redundant in twenty-six case, and twenty-nine case had ano-rectal junction descent.

As a conclusion, dynamic MRI is a valuable and accurate imaging modality in the evaluation of pelvic floor anatomy. It is important to asses the exact reason of SUI and any associated findings, to asses multi compartmental defect which may not be so accurate with other modalities. This is important specifically pre operatively to give full image of the case to the surgeon to avoid failed surgery or undergoing unnecessary procedures.