Introduction

Urinary incontinence is a health problem with a great impact on people's quality of life ***(Torres-Zambrano et al., 2007).***

Urinary Incontinence (UI): Defined by the International Continence Society (ICS) as the complaint of any involuntary urine loss ***(Abrams et al., 2002).***

Urinary incontinence is categorized as urodynamic stress urinary incontinence [USUI], urge urinary incontinence [UUI] or mixed urinary incontinence [MUI] ***(Abrams et al., 2003).***

Urodynamic stress urinary incontinence [USUI] is defined as involuntary urine leakage on effort or exertion without rise in detrusor pressure ***(Abrams et al., 2002).***

Urodynamic stress urinary incontinence [USUI] has an observed prevalence of between 4 and 35% ***(Karl et al., 2005).***

The most common type of incontinence in middle aged women is urodynamic stress incontinence, which affects primarily parous women and in many cases is believed to be caused by injury of pelvic floor support structure during childbirth. Currently, it is believed that deformity of levator ani causes muscle dysfunction. Possibly due to tearing and denervation that leads to an increased burden on the endo pelvic fascia. When the pubocervical portion of this fascia stretches or tears, the urethra and bladder neck become hypermobile. Increased abdominal pressure, often during a cough or laugh, then exceeds urethral closing pressure and urinary leakage occur ***(Delancy, 1988).***

The association between vaginal delivery and urodynamic stress urinary incontinence was present regardless of the age of the patient at the time of childbirth ***(Kuh et al., 1999).*** Forceps delivery was associated with high risk of urodynamic stress urinary incontinence compared with spontaneous vaginal delivery ***(Arya et al., 2001).*** Possible explanation for this relationship lie in pelvic floor denervation due to compression during pregnancy and delivery and stretching or tearing of pelvic floor connective tissue and musculature during pregnancy and delivery ***(Farrell et al., 2001).***

Pelvic floor weakness resulting in anterior vaginal wall prolapse may be associated with lower urinary tract symptoms, such as urinary incontinence. These symptoms may overlap with those of structural abnormalities of urethra, for instance, a urethral diverticulum may be associated with urinary incontinence due to weakening of the urethral sphincter; however incontinence may also result from weakening of the pelvic floor support structures,causing bladder descent and urethral hypermobility ***(Macura and Genadry, 2008).***

Hypermobility of the urethra refers to inferior descent of the urethra below the pubococcygeal line and rotation from its resting axis resulting from laxity of the urethral supporting structure (***Macura, 2006 and Macura et al., 2006).*** Hypermobility of the urethra was defined as horizontal translation of the urethra away from the normal vertical axis, with strain at an angle greater than 30 degree ***(Bergman et al., 1987).***

The urethra is supported by fascia of pelvic floor. If this support is insufficient, the urethra can move downward at times of increased abdominal pressure, allowing urine to pass. Most laboratory results such as urine analysis, cystometry and post void residual volume are normal. Some sources distinguish between urethral hypermobility and intrinsic sphincter deficiency ***(Haliloglu et al., 2010).***

Urodynamic testing to evaluate urethral function,bladder capacity and stability and voiding function is not routinely indicated before the initiation of most treatments for urodynamic stress incontinence ***(Weidner et al., 2001 and Nygaard and Heit, 2004).*** While several studies have compared the use of perineal sonography and x-ray cystourthrography in women suffering from urinary incontinence,only a few authors have reported on the comparison between the diagnostic accuracy of urodynamic variable and findings at sonography thus allowing the latter modality to be proposed as an alternative diagnostic tool for pre-operative selection of patients ***(Minardi et al., 2007).***

The advantage of MRI for diagnosis of urethral abnormalities in women with lower urinary tract symptoms have been well established ***(Hahn et al., 2004 and Ryu and Kim, 2001).***

Several studies reported that MRI could depict distinct abnormalities in USUI and change patient management ***(ElSayed et al., 2007***).

Magnetic resonance imaging assessment of women with the pelvic floor dysfunction provided significant information, which changed clinical management in 41.6% of patients with USUI ***(El Sayed et al., 2005***).

To make a definite diagnosis of pelvic prolapse preoperatively, dynamic magnetic resonance (MR) is an alternative to conventional fluoroscopic or sonographic examination, with the advantage of providing greater details, and thus helping the surgeon to have a good preoperative plan ***(Chi and Chen, 2007).***

MR imaging provides superior soft tissue contrast and allows direct visualization of the urethra and its supporting structures. So MR imaging has a potential to contribute important information that can guide in patient diagnosis and management ***(Macura et al., 2007)***.

A recent study using MRI analyzed the association between the urethral sphincter anatomy, urethral function and pelvic floor function and reported that a smaller striated urogenital sphincter was related to USUI and poorer pelvic floor muscle ***(Morgan et al., 2009).***

Aim of the Work

The aim of this work is to investigate the use of magnetic resonance imaging to assess pelvic floor in cases of hypermobile urethra in women with urodynamic stress urinary incontinence.

Research Question:

In cases of hypermobile urethra in women with urodynamic stress urinary incontinence, is there any role of magnetic resonance imaging for assessment of pelvic floor?

Research hypothesis:

There is important role of MRI in assessment of pelvic floor in cases of hypermobile urethra in women with urodynamic stress urinary incontinence.

Anatomy of Pelvic Floor

The pelvic floor is divided into three compartments ***(Fig. 1)***. The anterior compartment contains the urinary bladder and the urethra; the middle compartment contains the uterus, cervix, and vagina; and the posterior compartment contains the rectum. The support for these structures arises from the attachment of the muscles, fascia, and ligaments to the bony pelvis ***(Law and Fielding, 2008)***.

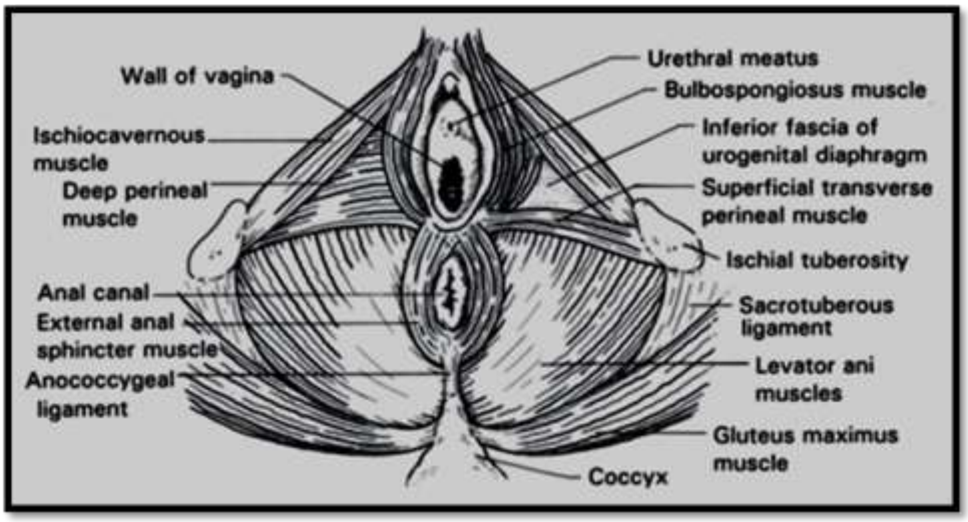

Fig. (1): Anatomy of the pelvic floor in women ***(Law and Fielding, 2008)***

The pelvic floor consists of several components lying between the pelvic peritoneum and the vulvar skin. These are (from above downwards) the peritoneum, viscera and endopelvic fascia, levator ani muscles, perineal membrane, and external genital muscles. The eventual support for all of these structures comes from their connection to the bony pelvis and its attached muscles. The viscera are often thought of as being supported by the pelvic floor; however, they are actually a part of it. Through such structures as the cardinal and uterosacral ligaments and the pubocervical fascia, the viscera have an important role in forming the pelvic floor ***(DeLancey, 2001).***

Bony pelvis:

The maintenance of continence and prevention of pelvic organ prolapse rely on the support mechanisms of the pelvic floor. The bony pelvis is comprised of the sacrum, coccyx, and two innominate bones, formed by the fusion of the iliac, ischial, and pubic bones ***(Fig. 2)***. An opening is found between the pubic and ischial bones, medial to the acetabulum, known as the obturator foramen. The ischiopubic ramus is the medial fusion of the pubic and ischial bones. Transobturator devices used during anti-incontinence procedures are passed around the midpoint of this structure through the obturator foramen. The pectineal line on the anteromedial aspect of the pubic bone is an important surgical landmark for retropubic urethral suspensions. The supporting sutures are often placed in Cooper’s (pectineal) ligament, which overlies the pectineal line ***(Brooks, 2002)***.

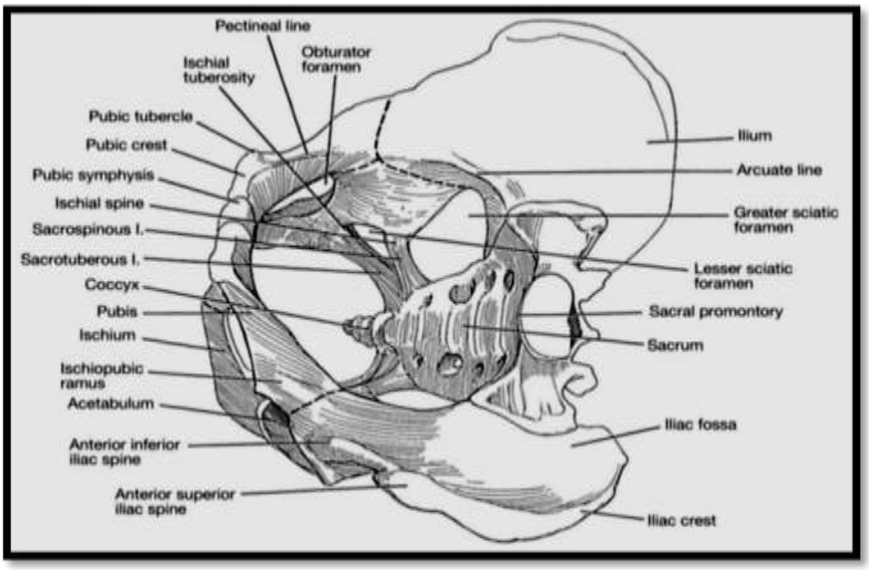

Fig. (2): The bones of the pelvis ***(Fischer et al., 2007).***

The obturator foramen*:*

The obturator foramen (OF) is the result of the fusion of the pubic bone and the ischium. The OF allows surgeons to approach the female urethra from the lateral aspect, as opposed to the traditional suprapubic approach. The OF is traversed by the obturator nerve artery and vein, all at the most inferiolateral aspect, via the obturator canal. The OF is covered medially and laterally by the obturator internus/ externus, respectively. Using cadaveric dissections, the transobturator needle was an average of 2.3 cm inferior-medial to the obturator canal. The needle was passed through the gracilis, adductor brevis, obturator externus, and obturator membrane, and beneath or through the obturator internus muscle and periurethral endopelvic connective tissue ***(Whiteside and Walters, 2004).***

Musculature and fasciae of the pelvis:

The striated musculature of the pelvic floor provides dynamic support for the visceral contents of the abdominopelvic cavity. The pelvic floor consists of the pelvic diaphragm and the perineal membrane, which are described separately ***(DeLancey, 2003).***

The pelvic diaphragm refers to the levator ani group (LAG), the coccygeus muscles, and the associated fasci ***(Fig. 3)***a. The coccygeus muscle runs between the ischial spine and the lateral aspect of the sacrum and coccyx, overlying the sacrospinous ligament (SSL). The LAG is comprised of the puborectalis, pubococcygeus, and iliococcygeus, named according to their respective points of origin. These muscles form a shelf of support for the pelvic organs. The puborectalis play role in elevating the bladder neck and compressing it against the pubic symphysis ***(Law and Fielding, 2008)***. The muscles will be described in details later on.

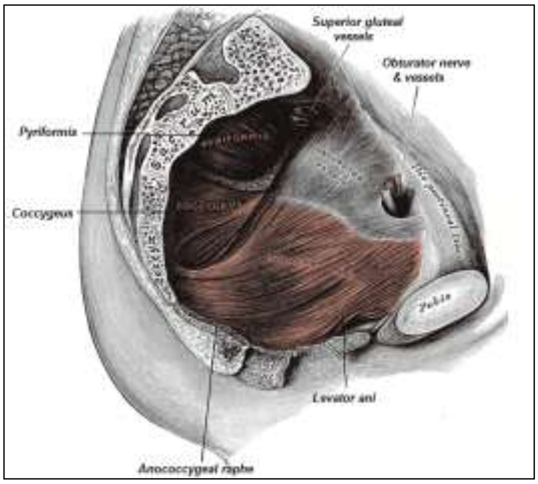

Fig. (3*):* Muscles of the pelvis - lateral view. Visceral organs have been omitted for clarity ***(Quoted from Gray's, 2005).***

Pelvic fascia:

The pelvic fascia consists from cranial to caudal of:

(1) The endopelvic fascia

(2) The pelvic diaphragm

(3) The urogenital diaphragm.

The endopelvic fascia:

Includes the parametrium and the paracolpium, giving support to the uterus and upper vagina, respectively. The paracolpium, which attach the upper vagina to the pelvic walls, can be divided into three levels ***(Fig.4)****:*

- ***Level I (suspension)*** the portion of the vagina adjacent to the cervix (the cephalic 2–3 cm of the vagina) is suspended from above by the relatively long connective tissue fibers of the upper paracolpium.

- ***Level II (attachment)*** in the midportion of the vagina, the paracolpium become shorter and attach the vaginal wall more directly to the arcus tendineus fascia pelvis at the lateral pelvic wall. This attachment stretches the vagina transversely between the bladder and rectum and has functional significance; the structural layer that supports the bladder (the pubocervical fascia) is composed of the anterior vaginal wall and its attachment through the endopelvic fascia to the pelvic wall.

- ***Level III (fusion)*** near the introitus, the vagina is fused laterally to the levator ani and posteriorly to the perineal body, whereas anteriorly it blends with the urethra. At this level, which corresponds to the region of the vagina that extends from the introitus to 2–3 cm above the hymenal ring, there is no intervening paracolpium between the vagina and its adjacent structures, contrary to the situation at levels I and II ***(El-Sayed, 2012)***.

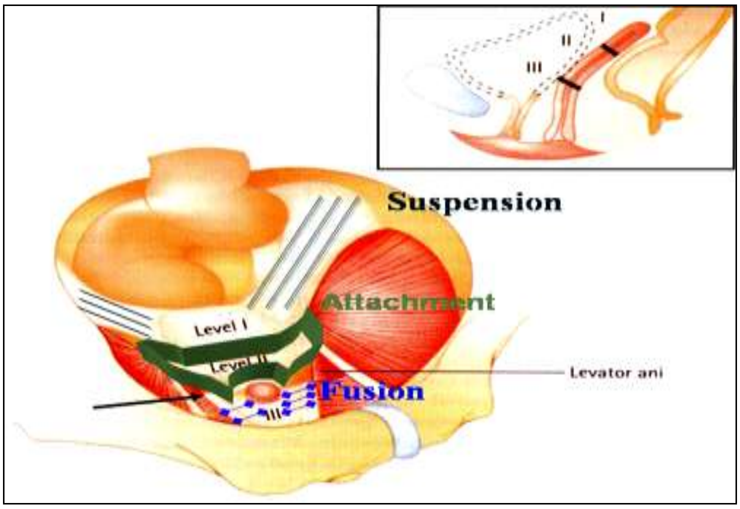

Fig. (4): Levels of vaginal support after hysterectomy. In level I (suspension), the paracolpium suspends the vagina from the lateral pelvic walls. Fibers of level I extend both vertically and Posteriorly toward the sacrum. In level II (attachment), the vagina is attached to the arcus tendineus fasciae pelvis (solid arrow) and the superior fascia of levator ani. In level III (fusion), the vagina, near the introitus, is fused laterally to the levator ani. ***(Quoted from El Sayed, 2012).***

Pelvic diaphragm:

The pelvic diaphragm is a muscular partition formed by the levator ani and coccygei. It separates the pelvic cavity above from the perineal region below ***(O'Rahilly et al., 2008)*** ***Fig. 5(A& B):***

A) The levator ani muscles which is composed of:

1- The puborectalis muscle.

2- The pubococcygeus muscle.

3- The iliococcygeus muscle.

B) The ischiococcygeus (coccygeus) muscle.

These muscles are an integral part of the pelvic floor and together provide continuous tone ***(Woodfield et al., 2010).***

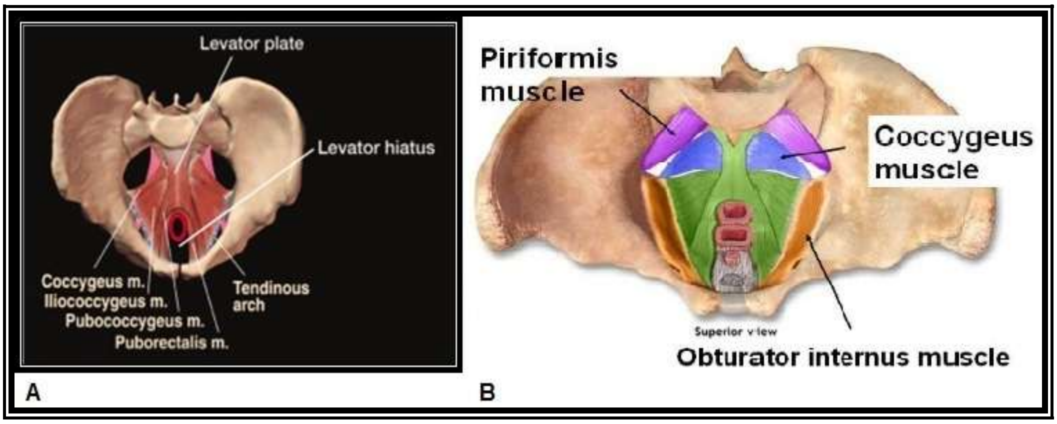

Fig. 5 (A& B): Pelvic diaphragm ***(Quoted from Herschorn 2004).***

A) Levator ani muscles:

The levator ani muscles have a critical role in supporting the pelvic visceral organs and play an integral role in urinary, defecatory, and sexual function. The levator ani muscle complex consists of the pubococcygeus (also called pubo-visceral), the puborectalis, and the iliococcygeus muscles ***(Fig.6) (Kearney et al., 2004).***

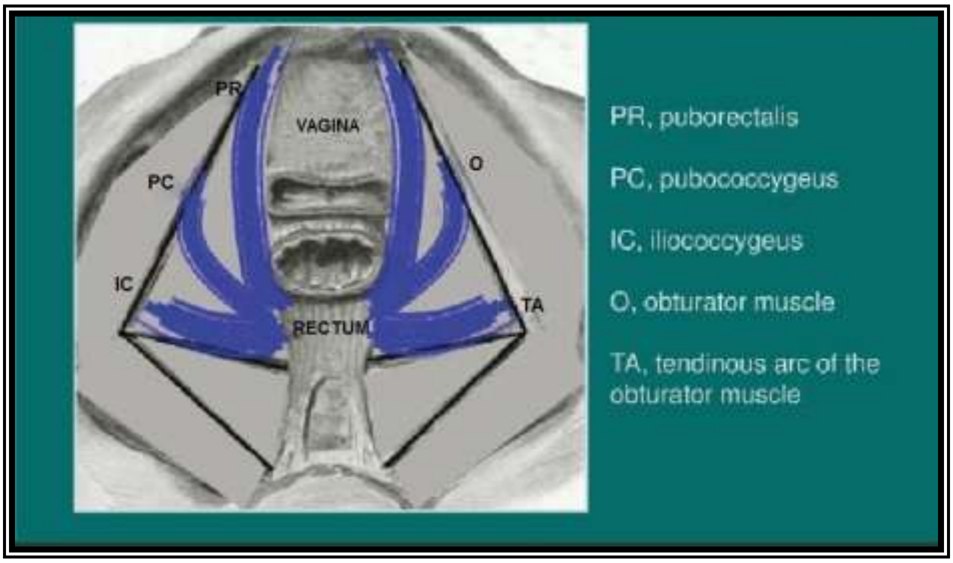

Fig. (6): Diagram showing the components of the levator ani muscles ***(Kearney et al., 2004).***

1) The iliococcygeus: This is a very thin muscle**.**

Origin: it arises from the ischial spine and posterior part of the white line of the pelvic fascia covering the obturator internus; arcus tendinous levator ani ***(ATLA).***

Course: The fibers run downward, backward and medially Inserted into the sides of the last two pieces of the sacrum and into the anococcygeal raphe of the levator muscles, a median fibrous band which stretches between the anus and the superior surface of the coccyx.

2) The Pubococcygeus:

Origin: on the posterior inferior pubic rami and the anterior part of the obturator fascia.

Course: it is directed almost horizontally backward along the side of the lower part of the rectum as a flat band which lies superior to the inner-most fibers of the iliococcygeus region to fuse with its fellow of the opposite side to constitute a broad fibrous band lying on the anococcygeal raphe formed by the iliococcygeus. This is continued up in front of the coccyx.

Insertion: into the anterior aspect of the first piece of the coccyx and last segment of the sacrum.

Action: The pubococcygeus supports the urethra, bladder, vagina and rectum. The position of the urethra and adjacent vagina are controlled by these two attachments to levator ani muscles and to the white line. These portions of levator ani are responsible for the position and mobility of the proximal urethra and vesical neck ***(Delancey& Starr 1990).***

3) The Puborectalis:

This name is sometimes applied to those fibers of the pubococcygeus, which unite with the corresponding fibers of the opposite side to form a sling behind the rectum at the ano-rectal junction.