INTRODUCTION

Mixed urinary incontinence (MUI) is defined as the complaint of involuntary loss of urine, associated with urgency and also with effort or physical exertion or on sneezing or coughing ***(Gleason et al., 2015).***

MUI is common, with an estimated prevalence of 30% of all women with urinary incontinence ***(Lee et al., 2011).***

Women with MUI are twice as likely to be bothered by their symptoms as compared to those with SUI alone ***(Abdel-Fattah et al., 2016)***.

Urodynamic studies (UDS) are widely considered the gold standard investigation for determining the type of incontinence. UDS findings provide valuable informaion for the confirmation or rejection of the clinical diagnosis and play a crucial role in the determination of the therapeutic strategy ***(Athanasiou et al., 2013).***

Women with both stress and urgency urinary incontinence can be challenging to manage. It is important to determine which component is more bothersome as it will help in directing treatment. Urodynamic studies are frequently advocated prior to surgery in patients with MUI, as leakage with stress and urgency often coexists. In patients without detrusor over activity there is some limited data suggesting they have a higher chance of resolution of their urgency symptoms

after a sling than those with urodynamic detrusor over activity. In patients with a predominant stress component, the Midurethral sling (MUS) has been shown to improve urgency and urge urinary incontinence (UUI) ***(Paick et al., 2008).***

Management of women with MUI is relatively more difficult, as it involves addressing both the SUI and overactive bladder (OAB) symptoms. Conservative management is usually the first line, including pelvic floor muscle training, bladder retraining, and pharmacological treatment. If the above fails, surgery for SUI may be contemplated in women with predominant SUI symptoms; anumber of options are usually discussed with the patient including MUS. Transobturator tension-free vaginal tapes (TO-TVT) have been described in 2001 and 2003 ***(Delorme, 2001; de Leval, 2003)*** and have rapidly gained wide popularity among surgeons due to the avoidance of the blind retro-pubic pathway. It was also hypothesized that TO-TVT could be preferred in women with MUI compared to retro-pubic tension-free vaginal tapes (RP-TVT) due to the more horizontal position of the tape and consequently, less postoperative OAB symptoms ***(Abdel-Fattah et al., 2016).***

In a recent systematic review and meta-analysis Jain et al examined the effectiveness of MUS in women with mixed urinary incontinence**.** The authors showed that MUS is associated with reasonable overall subjective cure rates (56.4%) in women with MUI. However, the cure rate for the urge

component (30% to 85 %) was lower than that for the stress component (85% to 97%) ***(Jain et al., 2011).***

AIM OF THE WORK

The aim of the present study is to evaluate the safety and efficacy of transobturator tape (TOT) procedure in treatment of women with mixed urinary incontinence using subjective and objective measures.

ANATOMY OF FEMALE PELVIC FLOOR

Our knowledge of pelvic floor dysfunction can be greatly enhanced through a better appreciation and knowledge of the anatomic principles that define pelvic floor support in women ***(Maldonado and Wai, 2016).***

Increased knowledge of the anatomy of the pelvic floor and lower urinary tract has led to a better understanding of the pathophysiology of incontinence. This, in turn, has led to the development of newer and minimally invasive treatment options for stress incontinence. Although these treatment options are widely applicable, not all patients are candidates or will respond. It is in the setting of the complex patient with incontinence with or without pelvic organ prolapse that the clinician must call on his or her knowledge of anatomy to guide treatment decision making ***(Herschorn, 2004).***

The term pelvic floor is used broadly to include all the structures supporting the abdominal and pelvic cavity. Conceptually, pelvic floor anatomy is commonly divided into passive and active structures: The passive structures are (1) the pelvic bones and (2) the supportive connective tissue of the pelvis, which consists of ligaments and endopelvic fascia,The active support structures are the pelvic floor muscles, with their neurological wiring that results in sustained (tonic) and intermittent voluntary muscle contractions during activity; These passive and active components of the pelvic floor

function as an integrated multilayer system. From craniad to caudad, it consists of the endopelvic fascia, the pelvic diaphragm, and the urogenital diaphragm ***(Rania, 2013).***

The pelvis is divided into three compartments: an anterior compartment containing the bladder and urethra, a middle compartment containing the uterus and cervix or the vaginal cuff in women who have undergone a hysterectomy, and a posterior compartment containing the rectum and anal canal ***(Woodfield et al., 2010).***

The pelvic floor is important for the support of the pelvic organs, to assist fecal and urinary continence, and to improve pelvic and spinal stability; furthermore, it plays a key role in sexual pleasure ***(Graziottin and Gambini, 2015).***

The bony pelvis:

The pelvis **(Fig. 1)** is aring composed of the two innominate or hip bones which are joined anteriorly at the symphysis pubis and posteriorly to the sacrum and coccyx ***(Graziottin and Gambini, 2015).***

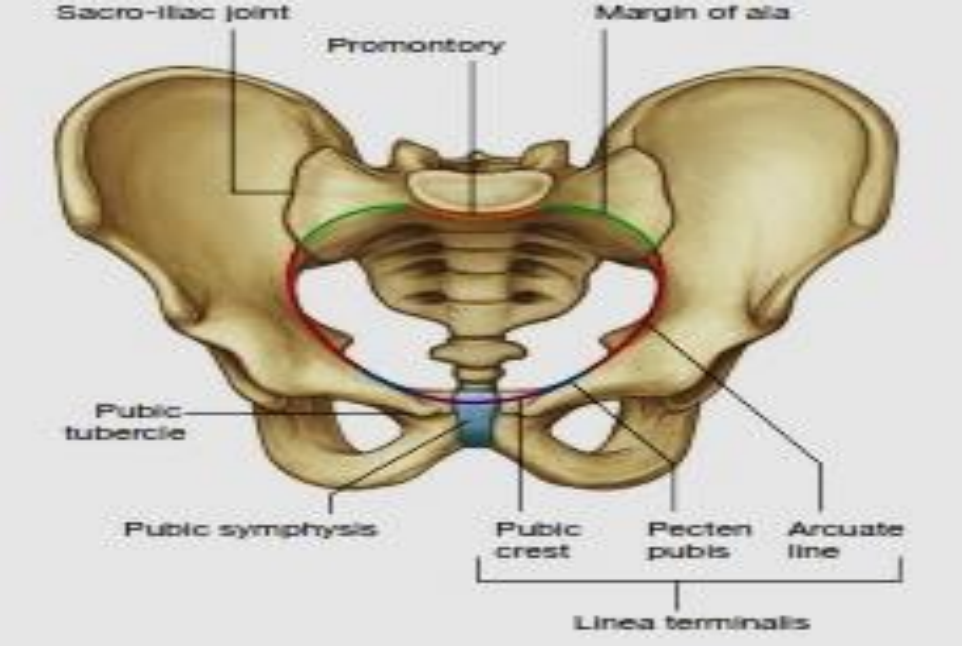

Figure (1): The bony pelvis ***(Standring, 2008).***

The female pelvis **(Fig. 2-A)** have a wider diameter and a more oval inlet as compared to males. This aids in parturition but also contributes to weakness of the pelvic floor ***(Rodriguez et al., 2016).***

The bones are also lighter and thinner compared to the male. Men have more clearly demarcated areas of muscular attachment, and women have smaller iliac fossa ***(MacLennan, 2012).***

More relevant to pelvic floor support is the true pelvis, which is located below the pelvic brim. Within the true pelvis are the sacrotuberous and sacrospinous ligaments **(Fig.2-B)**, which attach from the ischial tuberosities and ischial spines bilaterally to the sacrum, respectively. Together, these

ligaments contribute significantly to the stability of the pelvis ***(Maldonado and Wai, 2016).***

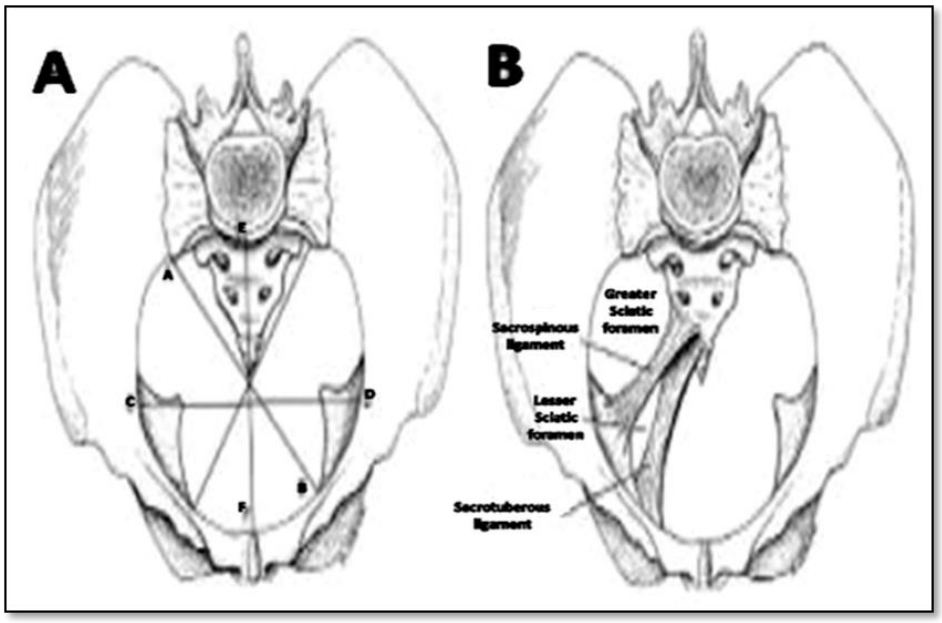

Figure (2): (A) The diameters of the female minor pelvis (superior aperture): A, sacroiliac joint; B, iliopubic eminence; C and D, middle of pelvic brim; E, sacral promontory; F, pubic symphysis. (B) The female pelvis from above: The sacrospinous ligament extends from the ischial spines to the lateral margins of the sacrum and coccyx anteriorly to the sacrotuberous ligament, which extends from the ischial tuberosity to the coccyx. The sciatic foramina are above and below the sacrospinous ligament and anterior to the sacrotuberous ligament ***(Herschorn, 2004).***

The pelvis allows transfer of weight bearing forces between the trunk and lower limbs, protects the pelvic organs, gives insertion for muscles, fascia, and ligaments and plays an important role during sex and labor ***(Graziottin and Gambini, 2015).***

Pelvic Fascia:

The pelvic fasciae may be conveniently divided into the parietal pelvic fascia, which forms the coverings of the pelvic muscles, and the visceral pelvic fascia, which forms the coverings of the pelvic organs and their neurovascular supply.

Parietal pelvic fascia:

The parietal pelvic fascia consists of the obturator fascia, the fasciae over piriformis, and over levator ani (the pelvic diaphragm) and the presacral fascia ***(Delancy et al., 2016).***

Special condensations of parietal fascia in the pelvis provide muscle attachments to the bony pelvis and anchoring points for visceral fascia.Examples include the arcus tendineus levator ani (ATLA), arcus tendineus fascia pelvis (ATFP), and arcus tendineus fascia rectovaginalis (ATFR) **(Fig-3)** ***(Maldonado and Wai, 2016).***

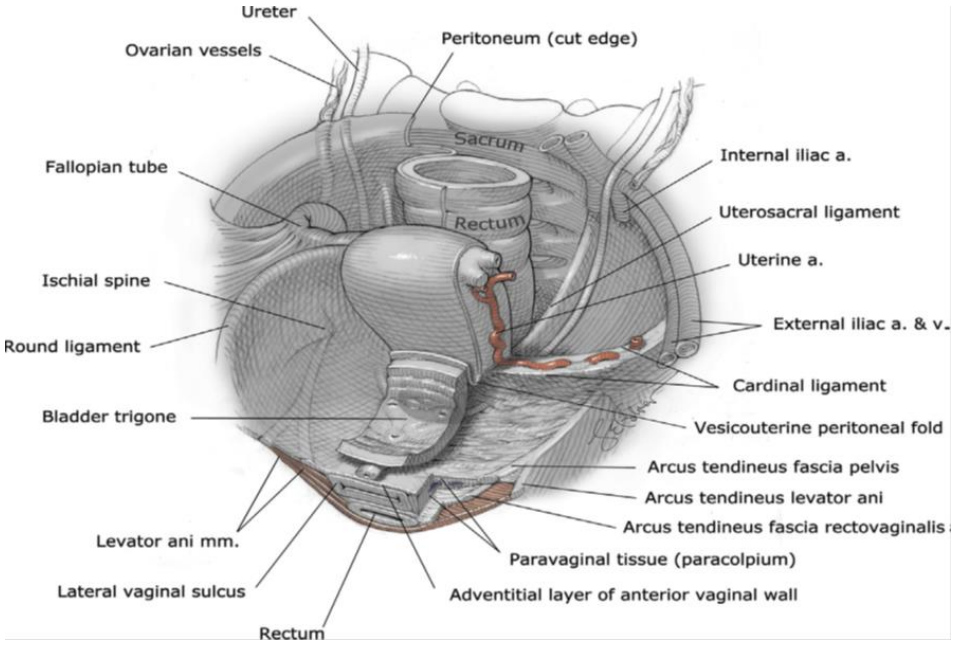

Figure (3): Pelvic viscera and associated connective tissue support. Note distinction of the ATFP, ATLA, and ATFR, relative to the paracolpium. a, artery; mm, muscles; v, vein ***(Hoffman et al., 2012).***

Obturator Fascia:

The parietal pelvic fascia on the pelvic (medial) surface of obturator internus is well differentiated. It is connected to the posterior part of the arcuate line of the ilium and is continuous with iliac fascia. Anterior to this, as it follows the line of origin of obturator internus, it is gradually separated from the attachment of the iliac fascia, and a portion of the periosteum of the ilium and pubis spans between them. It arches below the obturator vessels and nerve, investing the obturator canal, and is attached anteriorly to the back of the pubis. Behind the obturator canal, the fascia is markedly aponeurotic and gives a firm attachment to the iliococcygeal portion of levator ani,

usually called the tendinous arch of levator ani (arcus tendineus musculi levatoris ani). Above the attachment of levator ani, the fascia is thin and is effectively composed only of the epimysium of the muscle and overlying connective tissue; posteriorly, it forms part of the lateral wall of the ischio-anal fossa in the perineum, and anteriorly, it merges with the fasciae of the muscles of the deep perineal space, which is continuous with the ischio-anal fossa. The obturator fascia is continuous with the pelvic periosteum and, thus, the fascia over piriformis ***(Delancy et al., 2016).***

Fascia over levator ani (pelvic diaphragm):

Both surfaces of levator ani have afascial covering; the combination of the two fascial layers and the intervening muscle is called the pelvic diaphragm. On the inferior surface, the thin fascia is continuous with the obturator fascia below the tendinous arch of levator ani laterally. It covers the medial wall of the ischio-anal fossa and blends below with fasciae on the urethral sphincter and the external anal sphincter. The superior fascia of the pelvic diaphragm is markedly thicker than the inferior fascia and is attached anteriorly to the posterior aspect of the body of the pubis, approximately 2cm above its lower border. It extends laterally across the superior pubic ramus, blending with the obturator fascia and continuing along an irregular line to the spine of the ischium. It is continuous posteriorly with the fascia over piriformis and the anterior sacrococcygeal ligament. Medially, the superior fascia of the

pelvic diaphragm blends with the visceral pelvic fascia to contribute to the endopelvic fascia ***(Delancy et al., 2016).***

Tendinous arch of the pelvic fascia/white line of the parietal pelvic fascia: (Fig.4)

Low on the superomedial aspect of the upper fascia over levator ani, a thick, white band of condensed connective tissue extends from the lower part of the pubic symphysis to the superior margin of the ischial spine. It provides attachment for the condensations of visceral pelvic fascia that provide support to the urethra and bladder, and to the vagina in females ***(Delancy et al., 2016).***

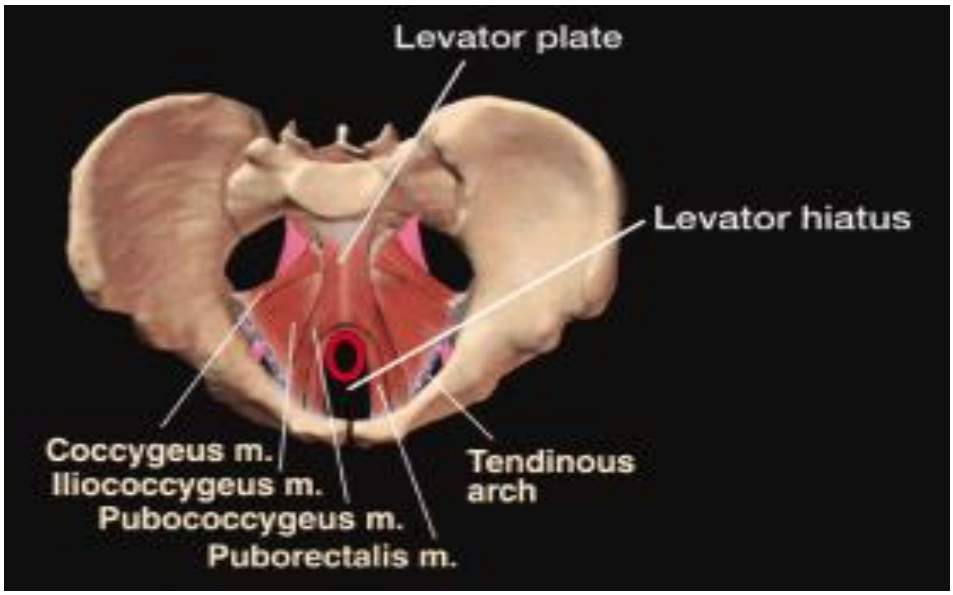

Figure (4): Illustration of the female pelvic floor ***(Herschorn, 2004).***

Visceral pelvic fascia:

Visceral fascia in the pelvis, also known as endopelvic fascia, provides subperitoneal perivascular connective tissue attachments from different pelvic visceral organs to the pelvic walls ***(Maldonado and Wai, 2016).***

The fascial tissues contain varying amounts of connective tissue and smooth muscle; where they either are unusually dense or form visible ridges, they are called ligaments (e.g. cardinal ligament, uterosacral ligament) ***(Delancy et al., 2016).***

Also endopelvic fascia contain pubocervical/pubovesical fascia and rectovaginal fascia ***(Maldonado and Wai, 2016).***

The portions that attach to the uterus and vagina are sometimes called the parametrium and paracolpium, respectively ***(Delancy et al., 2016).***

The uterosacral ligaments: support the cervix and the upper part of the vagina by their attachment to the sacrum, having also an important role of vaginal receptiveness in sexual intercourse ***(Graziottin and Gambini, 2015).***

The cardinal ligaments or **Mackenrodt's ligaments:** extend from the cervix to the posterolateral pelvic wall ***(Ramanah et al., 2012).***

The pubocervical fascia: also extends to the arcus tendineus laterally and the pericervical ring superiorly. **The rectovaginal fascia** extendsto the perineal body inferiorly and to the arcus tendineus laterally and unites with the uterosacral ligaments superiorly. Additional supportive ligaments of the pelvic floor include **the periurethral, paraurethral, and pubourethral ligaments**, which provide support to the urethra and bladder neck ***(Woodfield et al., 2010).***

The broad ligaments connect the uterus to the lateral pelvic walls on both side, and on its upper end it encases the fallopian tubes, round ligaments, utero-ovarian ligaments, and ovaries ***(Graziottin and Gambini, 2015).***

The round ligaments extend from the lateral side of the uterine body and, passing through the inguinal canal, insert into the labia majora ***(Graziottin and Gambini, 2015).***

Pelvic Diaphragm:

Levator ani and ischio coccygeus form the pelvic diaphragm and delineate the lower limit of the true pelvis. The fasciae investing the muscles are continuous with visceral pelvic fascia above, perineal fascia below, and obturator fascia laterally ***(Delancy et al., 2016).***

The Levator ani (pubococcygeus, iliococcygeus and puborectalis):

Levator ani is a broad muscular sheet of variable thickness attached tothe internal surface of the pelvis. It forms a large portion of the pelvicfloor ***(Delancy et al., 2016).***

The muscle is subdivided into named portions according to their attachments and the pelvic viscera to which they are related (pubococcygeus, iliococcygeus and puborectalis). These parts are often referred to as separate muscles but the boundaries between each part cannot be easily distinguished and moreover, they perform many similar physiological functions. Ischiococcygeus (coccygeus) lies immediately cranial to levator ani and is contiguous with it. Pubococcygeus is often subdivided into separate parts according to the pelvic viscera to which each part relates (puboperinealis, puboprostaticus or pubovaginalis, puboanalis, puborectalis), the fibres are more nearly continuous with those of the opposite side ***(Delancy et al., 2016).***

Attachments:

Pubococcygeus: Pubococcygeus originates from the posterior aspect of the body of the pubis and passes back almost horizontally. The most medial fibres run directly lateral to the urethra and its sphincter as it passes through the pelvic floor; here, the muscle is correctly called puboperinealis, although, because of its close relationship to the upper half of the urethra,