FEMALE URINARY INCONTINENCE: SPECTRUM OF FINDINGS AT PELVIC MRI AND URODYNAMICS

El-Sayed H. Zidan * M.D, Mohamed I Amin* M.D,
Esam M Hemat* M.D, and Ibrahim Samaha MD**
Radiology,and, Surgical Urology**Departments,*
Faculty of Medicine, Zagazig University.

ABSTRACT

Background: Weakening of the female pelvic floor is a common debilitating disorder. It leads to abnormal descent of the urinary bladder, the uterovaginal vault and the rectum, resulting in urinary incontinence, fecal incontinence and pelvic organ prolapse.

Objective: is to focus on the role of urodynamic pelvic MRI for cases with stress urinary incontinence.

Patients and Methods: This study was carried out from Feb 2015 to April 2016 at radiology department of Zagazig University hospitals. It included 30 female patients; with stress incontinence and 10 volunteer normal females. The mean age 59 ± 12.4 yrs (ranged from 25 to 78 yrs). They were referred from the outpatient clinics of Zagazig University hospitals to radiology department for urodynamic pelvic MRI examination.

Results: Regarding the stress urinary incontinence, MRI parameters has marked agreement (P: 0.00) with urodynamic studies.

Conclusion: The use of urodynamic pelvic MRI has a promising results in assessment of stress incontinence of urine. It is free from any radiation hazards. MRI has larger field of view making it suitable for accurately estimating larger degrees of proplase.

Key words: Pelvic MRI; stress incontinence; urodynamic; pelvic organ prolapse.

Corresponding author:
Name: Esam M Hemat
E-mail: esamhemat@yahoo.com

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INTRODUCTION

Stress urinary incontinence (SUI) due to impairment of the pelvic floor and supporting structures as a result of aging, obesity, pregnancy and vaginal delivery, is the involuntary voiding during sneezing, coughing and exertion resulting in significant effect on the life quality due to psychosocial and hygienic problems [1, 2].

Treatment options vary from the pelvic floor exercises to different surgical techniques, depending on the severity of structural defects as it is linked to unequal urethral walls mobility, urethral instability and weakness in the pelvic supporting structures [3].

The diagnosis of SUI depends on history, clinical examination and video-urodynamics including urethral pressure profilometry, but these methods have a limitation, as only the physiological defect of sphincter dysfunction can be assessed [4].

So, previous reports concerning MRI in the urinary continence mechanism considered the urethra and underlying structure to function as a combined mechanism [5].

MRI with its excellent soft tissue resolution and multiplanar acquisition allows the assessment of supportive mechanism of urethra, levator ani muscle defects, and paravaginal fascia [6], furthermore, the precise imaging of kinematics of pelvic floor muscle functions is very important for the diagnosis and treatment selection [7].

The purpose of this study is to assess the value of MRI urodynamic as a pre-operative tool of stress incontinence surgery and its accuracy in severity scoring classification.

PATIENTS AND METHODS

Patient characteristics:

This is a retrospective study which was compliant with our institution committee ethics with written consent from all patients. This study started from February 2015 to April 2016 in which we compared 30 women with stress urinary incontinence with a mean age,59 ± 12.4 yrs. (ranged from 25 to 78 yrs), and 10 controls with a mean age, 50.3 ±14.3yrs (ranged from 20 to 66 yrs). According to findings of MRI urodynamic, physical examination and surgery outcome, the incontinence group was scored based on MRI findings and correlated with clinical examination.

Clinical data were available for review in all 30 patients. The patients symptoms and physical examination findings associated with SUI (e.g. total number of pregnancies, vaginal deliveries, C.S deliveries and trauma during childbirth) for each patient was registered.

Our study inclusion criteria were: (a) SUI based on urodynamic study; (b) Suitable for MRI study (i.e. no contraindication). Patients excluded from the study were as follows: (a) invalid informed consent; (b) pregnancy and (c) presence of any contraindication to MRI, e.g., metallic implants.

Technique:

DP-MRI was performed during rest and with straining for full bladder women as patients were asked no to void at least two hours prior to examination. Pelvic MRI was performed by 1.5 T. superconducting magnet (Phillips, Achieva) using 16-channel pelvic phased array coil.

After obtaining scout images, sagittal image plane using T2-weighted turbo spin-echo and Dyn. BFFE in sagittal plane both at rest and during Valsalva maneuver.

Examination was done in supine position, patients were instructed about maximum straining technique and were trained.

The slices started from level of upper margin of the urinary bladder denoted from T2-weighted images down to level of external meatus level in planes perpendicular and parallel to the long axis of the urethra.

MR Image Interpretation:

By using reference points reported by ***Kim and colleague***[5], the levels for standardized measurements are:

(1) The vesico-urethral angle was assessed by two lines had been drawn. One through the long axis of urethra and one parallel to the bladder base and the intersection of these lines determined the vesico-urethral angle. (2) The degree of the bladder neck prolapse was made if the bladder floor descend more than one cm below pubococcygeal line that determines the pelvic floor level, it extends from the lower corner of the symphysis pubis and last coccygeal articulation [8]. Grading of prolapse was based on the distance of a perpendicular line drawn from the pubococcygeal line to the inferior margin of the organ of interest as follows; negative < 1 cm; mild <2; moderate 2-4 cm; and severe 4 cm. [9].

Urodynamics technique:

Urodynamics study was done on a SD-1000 MMS (Medical Measurement System) using Micro-tip 12 F catheter transducers. Post-voiding residual urine is measured. The patient is sitting at 45°, the sensors have been set at zero atmospheric pressure before usage and a dual sensor catheter is introduced in the urethra, the proximal sensor in the bladder and the distal one in the area of maximal urethral closure pressure (MUCP).

Another sensor catheter is fixed in the vagina to measure indirectly the abdominal pressure. The detrusor pressure is measured automatically as a subtracted pressure. A saline is infused as 50 ml/min. Then the volume at initial desire, maximum desire and urge to micturate were figured. After injection of 260 ml saline into the urinary bladder, the pressure of Valsalva leak point (VLPP) was recorded, the patient was ordered to bear down maximally to determine the presence of incontinence and then incrementally, in which the minimum pressure needed to cause incontinence is measured.

Standard for reference:

Patient results were compared with 10 control females, together with the results of the urodynamic studies and surgical findings

Statistical Analysis:

All collected data was reviewed, coded, tabulated and introduced to personal computer for analysis. All data manipulation and analysis were performed using the 11th. version of SPSS (Statistical Package for Social Sciences). Qualitative data is presented in the form of frequency tables (numbers and percent), while quantitative data is presented in the form of mean ± standard deviation and range.

RESULTS

This study included 30 female patients clinically diagnosed to have stress urinary incontinence and 10 normal females as control group.

The mean age of the study group was 59 ± 12.4 yrs.(ranging from 25 to 78 yrs), which was significantly different (P < 0.98) from that of the control group where the mean age was 50.3 ± 14.3 yrs (ranging from 20 to 66 yrs). Twenty eight (95.8%) patients delivered vaginally, while the remaining 2 patients (4.2%) were delivered by cesarean section. Twenty tow (70%) of our patients were postmenopausal, the other 8 patients (30%) were still menstruating. The operative history of the cases involves 5 cases (14.6%) of prolonged labor. Twenty cases with previous episiotomy, 13 cases had a perineal or vaginal tear (37.5 %), and one case delivered a large birth weight infant (6.3 %). The dynamic posterior urethral angle was significantly different between patients with GSUI and control group (P = 0.01). There was also significant difference in the posterior urethral angle during resting and straining phases in patients with SUI (P < 0.001).

No significant difference in the dynamic angle of urethral inclination between patients with GSUI and control group (P =0.1), yet, the angle of urethral inclination differed significantly in resting and straining phases in SUI patients (P < 0.001).

The urinary bladder wall thickness not differed significantly between the seven patients with stress incontinence and control group (*P* = 0.16).

The posterior urethrovesical angle is significantly different between patients with SUI and control group (P = 0.00).

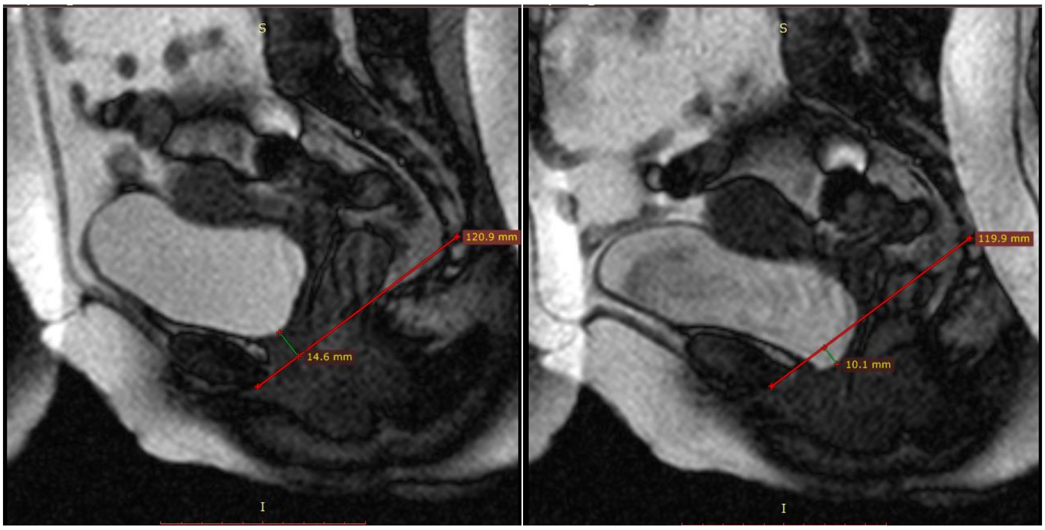
MRI have high (the same) agreement (P: 0.00) with urodynamic exam

MRI has very good agreement with operative management (P < 0.58). Urodynamic study and MRI have moderate (nearly the same) agreement (P: 0.00 for MRI and 0.00 for urodynamics) with clinical exam. The sensitivity and specificity of MRI parameters at rest and strain are (96.7-100.0 & 80-100.0 respectively).

Table (1) Suggested protocol for MRI urodynamic examination for stress urinary incontinence.

Sequence	Plane	TR	TE	FOV	Slice Th./Gap	Matrix a	NEX
Localizer	Axial Coronal Sagital	7.7	4.6	500	15/10	288	1
TSE T2-WI	Sagittal	4047.3	90.0	230	4/1	320	4
Dyn_BFFE b	Sagital	2.7	1.3	250	10/30	242	1

NEX=number of excitation
a =Frequency x Phase
b = sequence is repeated at rest and maximum strain



(a) (b)

Figure 1. 42-year-old female (a) sagittal BFFE MR image at rest and (b) at maximal strain show minimal bladder neck descent below pubococcygeal line

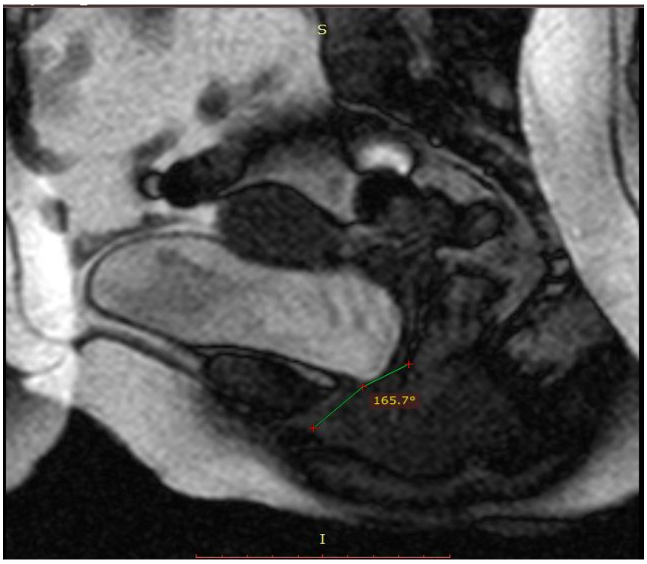
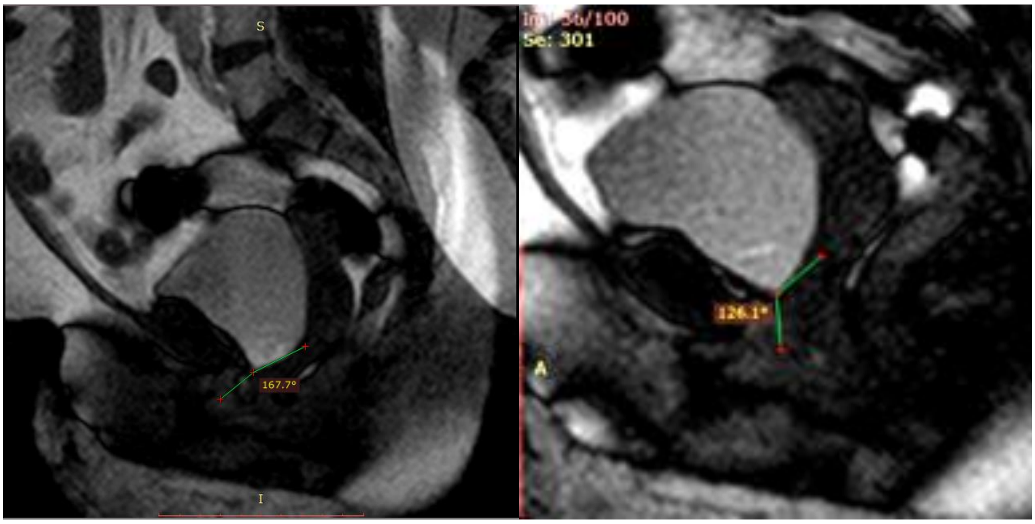
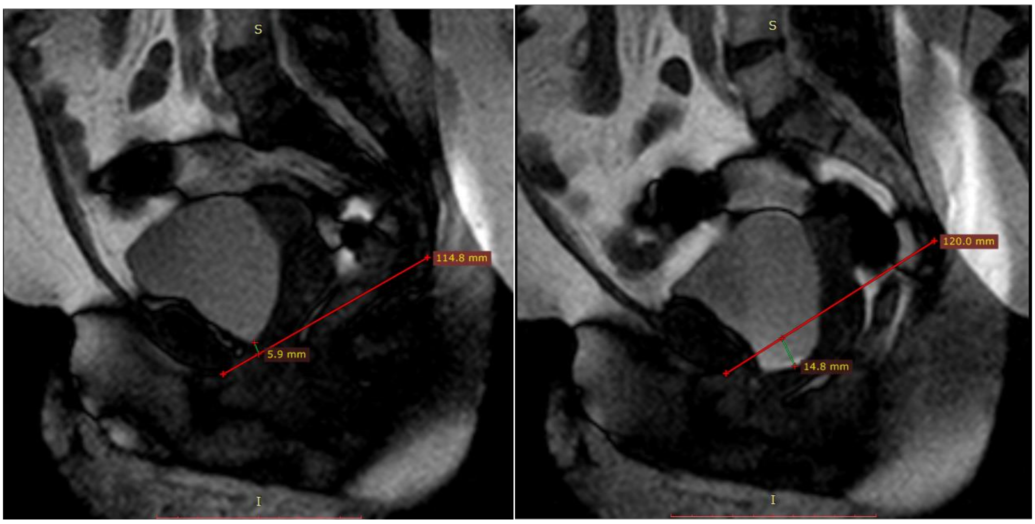


Figure 2. Sagittal BFFE MR image in a 52-year-old female shows posterior urothrovesical angle measuring 165 degree.



(a) (b)

Figure 3. Sagittal Dyn.BFFE MR image in a 47-years-old female (a) at rest and (b) at maximal strain shows PUVA =167 degree.



(a) (b)

Figure 4. Sagittal BFFE MR image in a 55-year-old female (a) at rest and (b) at maximal strain show bladder neck descent below the pubococcygeal line (PCL) by about 14.5mm.

Table (2): Patients demographic data and scoring parameters at rest and straining.

	Cases no= 30	control; no=10	t	P
age(yrs.)			.11	.98
mean±SD	59.3±12.4	50.3±14.3		
range	(25-78)	(20-66)		
Score				
mild	10(3.33)			
moderate	12(40.0)			
severe	8(26.7)			
PUVA rest			12.6	.00*
mean±SD	130.2±9.6	92.9±2.7		
range	(118-149)	(89-98)		
PUVA strain			29.7	.00*
mean±SD	177.5±6.9	108.6±4.3		
range	165-189	102-116		
DBF rest		2.5±.3	14.7	.00*
	.93±.3	(2.3-3.10)		
mean±SD	(.2-1.40)			
range				
DBF strain			man=.47.0	.01*
median	2.8	.4		
range	(1-4.9)	(0.1-.8)		
VLPP			man=66.0	.00*
mean±SD	80	94		
range	(35-97)	(94-98)		
treatment				
TVTO	17)56.7			
TVT	13)43.3			

Table (3): Multiple parameters measurements at rest and straining of all patients.

	Absent bladder funneling no= 6	present bladder funneling no=24	test	P
Score			3.86=x2	.15
mild	4(66.7)	7(29.2)		
moderate	2(3.33)	9(37.5)		
sever		8(33.3)		
PUVA rest			2.61	.01*
Mean ±SD	(124 ±3.8)	131.3±10.1		
range	(119-129)	(118-149)		
PUVA strain			1.56	.24
Mean ±SD	173 ± 8.6	178.1±6.4		
range	(165-184)	(166-186)		
DBF rest			1.31=t	.19
mean±SD	1.1±.2	.91±.34		
range	(.9-1.30)	(.2-1.40)		
DBF strain			man=87	.03*
median	1.4	2.8		
range	(1-3.1)	(1-4.9)		
VLPP			.69	.49
Mean ±SD	90	72.5		
range	(45-95)	(35-79)		
treatment	4(66.7)	13(54.2)	.31	58
TVTO	2(3.33)	11(45.8)		
TVT				

Table (4) The correlation between UD score and the following variables

	r	P
PUVA rest	.93	.00*
PUVA strain	.86	.00*
BFD rest	-.92	.00*
BFD strain	.96	.00*
VLPP	-.57	.00*

Table(5): MRI variables for diagnosis of SUI.

	cut off points	sensitivity	specificity
PUVA STRAIN	< 115.5	100.0	80.0
PUVA REST	< 96.7	100.0	90.0
DBF strain	> 1.35	93.3	100.0
DBF rest	> 85	96.7	100

DISCUSSION

The findings of our study in healthy continent and incontinent females suggests that the urodynamic MRI provides a promising tool for quantifying pelvic floor motion in the stress urinary incontinence.

On MRI, urethral and bladder descent are assessed in reference to the level of the pelvic floor which can be defined by the PCL [(10)].

Yang et al., [(11)] found that the normal vertical distance from PCL to bladder base at strain should not be > 1 cm below the line, which agreed with our results in which bladder neck descended to a mean distance of 0.4 cm below PCL in normal female during strain and 2.4 cm below PCL for incontinent females.

Moreover, in our study, we demonstrated a cutoff value in content and incontinent for bladder neck descent which is more significance in rest than in the strain and to our knowledge , this is the first study to show significance of bladder neck descent at rest in the evaluation of stress urinary incontinence.

In our study we found a large PUVA at rest and at strain in incontinent female than continent with cutoff value (<96.7 & <115.5 respectively), which compatible with results of [(12)].

Valo reported that the posterior urethrovesical angle was significantly increased by an average of 127.7±11.4 pre-operatively and also with [(13)] who stated that although previous studies have reported that a larger (greater than 115) posterior urethro-vesical angle is associated with stress urinary incontinence studies have shown a significant overlap with continent women.

However many radiological techniques have been developed to meet need for accurate visualization and diagnosis of pelvic floor disorders as colpocystorectography [(14)], but, their drawbacks include high exposure to ionizing radiation and lack of information on surroundings soft tissue [(15)], make the role of urodynamic pelvic MRI in this study to evaluate stress urinary incontinence is crucial and this correlates with many authors like [(16)].

In our study the results of urodynamic study and dynamic MRI results are significant with each other and correlates with operative management, however MRI do better than urodynamic study as it gave additional information about all pelvic compartments with high spatial resolution plus quantitative assessment and these findings keeps with results of [(17)] who stated that MRI permits a complete analysis of 3 pelvic compartments in a single procedure without hazards of ionizing radiation and providing a detailed anatomic information.

Also we used in this study advanced sequence which is fast GRE (dynamic BFFE) sequence for fast and better evaluation of pelvic floor during strain, consequently we can get a better quantitative data in the form of dynamic evaluation and overcome the disadvantage of previous study of [(18)] who mentioned that the major disadvantage of their MRI technique is an inability to ensure adequate strains effort as they use a standard T2-WI FSE at rest and modified T2-WI FSE during Valsalva maneuver and coincides with results of [(19)] who stated that the introduction of stronger and faster gradients and ultrafast T2-WI sequence with acquisition time < 1 sec., permits a dynamic evaluation of the pelvic floor at maximal strain.

CONCLUSION

Urodynamic pelvic MRI study is a non-ionized, rapid, non-invasive tool for assessment of urinary bladder base level, motility of urinary bladder neck and bladder funneling as well as posterior urethrovesical angle in urinary stress incontinent women. It can play an important role in pre-operative evaluation as well.

REFERENCES

1- Abrams P, Blaivas JG, Stantan SL, Andersen JT. The standarisation of terminology of lower urinary tract function .The international continency society committee on standardization of terminology.Scand J Urol Nephrol Suppl.1988;114:5-19.
2- Herzog AR and Fultz NH. Prevalence and incidence of urinary incontinence in community dwelling populations. J Am Geriatr Soc.1990;38:273-81.
3- Stoker J, Rociu E, Bosch JL,Embert J, Messelink PM, et al.. High-resolution endovaginal MR imaging in stress urinary incontinence. Eur Radiol.2003;13:2031-7.
4- Macura KJ, Thompson RE, Bluemke DA, and Genadry R. Magnetic resonance imaging in assessment of stress urinary incontinence in women with parameters differentiating urethral hypermobility and intrinsic sphincter deficiency. World J Radiol.2015 Nov 28;7 ID:394-404.
5- Kim JK, Kim YJ, Choo MS, Cho KS. The urethra and its supporting structures in women with stress incontinence: MR imaging using an endovaginal coil. AJR Am J Roentgenol.2003; 180:1037-44.
6- deSouza NM, Daniels OJ, Williams AD, Gilderdale DJ,and Abel PD. Female urinary genuine stress incontinence: anatomic consideration at MR imaging of the paravaginal fascia and urethra, initial observation. Radiology.2003; 225, 433-439.
7- Constantinous CE. Dynamics of female pelvic floor function using urodynamic ultrasound and magnetic resonance imaging (MRI) Eur J Obstet Gynecol Reprod Biol. 2009;144 Suppl 1:S159-S165.
8- Liencmann A and Fischer T. Functional imaging of pelvic floor. Eur J Radiol 2003; 47:117-122.
9- Hecht EM, Tanpitukpongsc TP, Babb JS, Taouli B, Wong S. MRI of the urethra in women with lower urinary tract symptoms. Spectrum of findings at static and dynamic imaging. AJR 2009; 193:1708-1715.
10- Borghesi G, Simonetti R, Goldman SM, Szejnfeld J, Srolgi M, et al. Magnetic resonance imaging urodynamics: technique development and preliminary results. Int Braz I.Urol.2006; 32:336-341.
11- Yang A, Mostwin JL, Roseashein NB, and Zerhouni EA. Pelvic floor descent in women; dynamic evaluation with fast MR imaging and cinematic displays. Radiology.1991; 179: 25-33.
12- Perk H, Oral B, Yesildeg A, Ahmet T ,Screl Mesut, et al. Magnetic resonance imaging for stress incontinence: evaluation of patients before and after surgical correction. Eur J Radiol 2002; 44 (1) 44-47.
13- Huddleston HT, Dunniho DR, Huddleston PM, and Megers PC. Magnetic resonance imaging of defect in De Lancey " vaginal support level I, II and III. Am J Obstet Gynecol 1995; 172:1778-84.
14- Lienemann A, Anthuber C, Baron A, Kohz1 P, and Reiser M. Dynamic MR colpocystorectography assessing pelvic-floor descent. Eur Radiol 1997; 7: 1309-17.
15- Seifert H, Blass G and Leetz HK. Zur bestimmung der ovarialdosis bei der defakographie an einem digitalen c-bogen. Rofo Fortschr Rontgen 1994; 161: 70-4.
16- Huang WC, Yang SH and Yang JM. Anatomical and functional significance of urogenital hiatus in primary urodynamic stress incontinence. Ultrasound Obstet Gynecol 2006; 27:71-
17- Comiters CV, Vasavada SP, Barbaric ZL, Gousse AE, and Raz S. Grading pelvic prolapse and pelvic floor relaxation using dynamic magnetic resonance imaging. Urology 1999; 54:454-7.
18- Tarhan S, Gümüş B, Temeltaş G, Ovali GY and Serter S. The comparison of MRI findings with severity score of incontinence after pubovaginal sling surgery Turk J Med Sci 2010; 40 (4): 549-556.
19- Hsu Y, Suumers A, Hussain HK, Guire KE and Delancey JOL. Levator plate angle in women with pelvic organ prolapsed compared to women with normal support using dynamic MR imaging. Am J Obstet Gynecol. 2006; 194:1427-33.