1110-5704
African Journal of Urology

Vol. 10, No. 1, 2004
30-37

TRANSVAGINAL ULTRASOUND IS A VALUABLE INVESTIGATION IN FEMALE STRESS INCONTINENCE

A.A. AHMAD, H. EL-GENDY, W. EL-BROMBLY* AND T. SOBHY#
Departments of Urology, Gynaecology and Radiology#, Faculty of Medicine, Zagazig University, Zagazig, Egypt*

Objectives : To evaluate the role of transvaginal ultrasound (TVUS) in studying the anatomical basis of genuine stress urinary incontinence (SUI) and understanding the causes of success and failure of operations aiming at the treatment of incontinence.

Patients and Methods: This study included 15 continent females (Group I, healthy control) and 46 patients complaining of SUI (Group II). All cases were subjected to full history, physical examination, urodynamic evaluation and TVUS examination. In 42 patients of Group II, TVUS was repeated one year after treatment of incontinence, while four patients were lost to follow-up. In 36 of these 42 cases (85.7%), treatment was successful (Group IIIa), while treatment failed and SUI persisted or recurred within one year in six cases (Group IIIb, 14.3%). We used TVUS to measure the bladder-symphysis distance (BS), the rotational angle (RA), the bladder neck motility (BNM) and the vertical bladder neck descent.

Results: While the mean BS was insignificantly shorter in Group II compared to Group I (2.24 ± 0.7 cm versus 2.4 ± 0.5 cm, p = 0.08), the mean RA, BNM and vertical bladder neck descent were significantly greater in Group II (115 ± 17°, 29 ± 16° and 1.4 ± 0.4 cm for Group II versus 94 ± 15°, 20 ± 5° and 0.34 ± 0.4 cm for Group I). The comparison between Groups I and II showed that the TVUS-measured parameters correlated well with the clinical condition. A comparison between Group IIIa (BS = 2.2 ± 1 cm, RA = 100 ± 19°, BNM = 22 ± 4° and vertical bladder neck descent = 0.38 ± 0.5 cm) and Group IIIb (BS = 2.2 ± 0.5 cm, RA = 117 ± 16°, BNM = 30 ± 9° and vertical bladder neck descent = 1.4 ± 0.3 cm) showed that the TVUS-measured parameters correlated well with the surgical outcome.

Conclusions: TVUS is a valuable tool for the diagnosis and postoperative evaluation of SUI and may help in understanding the causes of success and failure of surgical treatment of SUI.

Key Words: stress incontinence, transvaginal ultrasound, voiding dysfunction

INTRODUCTION

The descent of the bladder neck and proximal urethra beyond the intra-abdominal pressure transmission zone is considered to be the patho-anatomical basis of stress urinary incontinence (SUI)[1]. The bladder neck descent can be visualized by lateral cystourethrography[2], video cystourethrography[3], rectal[4] and vaginal[5] ultrasound. The advantages of ultrasonography as compared to radiography are its low cost, its availability in most districts, the absence of radiation hazards and the fact that it does not need contrast materials. It provides a good view of the bladder base with vaginal transducers and makes dynamic examination of the bladder neck possible[6]. Different parameters measured by transvaginal ultrasound (TVUS) have been suggested in the literature[5,7,8,9]. This study has been carried out to establish the objective parameters for the diagnosis of SUI and follow-up of patients after surgical correction.

PATIENTS AND METHODS

This prospective study included 15 continent females without any urinary complaint as a control (Group I) (Fig.1) and 46 females

Table 1: Clinical and Urodynamic Data of the Studied Cases

Data	Group I (n=15)	Group II (n=46)
Age in years	52±9	54±8
Parity	3.1±0.5	3.4±0.9
Cystocele	1 (6.66%)	11 (23.9%)
Rectocele	1 (6.66%)	3 (6.5%)
Cystorectocele	-	1 (2.17%)
Detrusor contractions	-	3 (6.5%)
VLPP*	133±16	102±22
Previous surgery#	-	5 (10.87%)
Concomitant surgery##	-	6 (8.69%)

* VLPP = Valsalva leak point pressure

anterior colporraphy (n=3), Stamey endoscopic suspension (n=1), Teflon injection (n=1)

anterior colporraphy (n=4); classical repair (n=1), hysterectomy (n=1)

complaining of SUI (Group II). In all cases, a full history was taken with regard to age, parity, menopausal state, type of incontinence, amount of urine leak, precipitating factors and history of previous treatment. Clinical examination focused on vaginal examination with inspection of the urine leak during stress and the presence of genital prolapse (cystocele, rectocele or both). Urine analysis and culture sensitivity tests were done to exclude infection. Urodynamic evaluation was carried out including filling cystometry to exclude abnormal detrusor contractions and a stress urethral pressure profile to show negative pressure transmission to the proximal urethra with stress maneuvers and recording of the Valsalva leak point pressure (VLPP). We used the Urodyn 1000^{R} (Dantec, Denmark) machine.

TVUS was done with the patient in the lithotomy position and with a comfortably full bladder (at least 200cc) at rest, with Valsalva and during withholding urine (maximum contraction of pelvic muscles). We used the Toshiba diagnostic system (SSA-270A) with a 7.5 MHz endoprobe. The probe was introduced without pressure into the introitus just underneath the external urethral meatus. This allowed visualization of the bladder base, the urethra, vesicourethral junction and symphysis pubis in one field.

Fig. 1A: Normal female without SUI at rest. BS = 2.4 cm, RA = 86°. BNM = 19°, VD = 0.33 cm

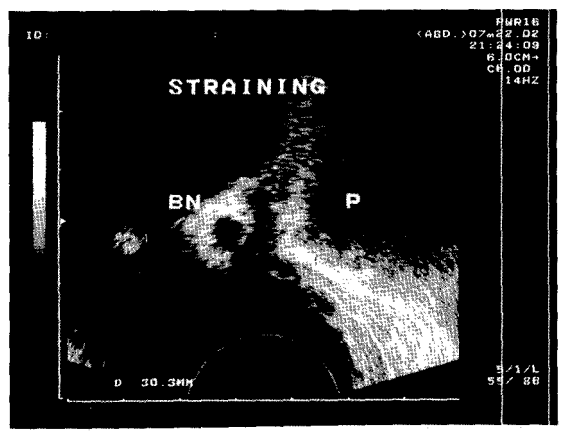


Fig. 1B: Normal female without SUI with straining. BS = 2.2 cm, RA = 91°. BNM = 19°, VD = 0.33 cm

Forty-six patients were candidates for surgery (18 Burch colposuspension[10], 18 tension-free vaginal tape[11] and 10 Stamey endoscopic suspension[12]). 42 patients attended follow-up (17, 16 and 9 respectively).

We used TVUS to measure the following parameters (Fig.2, 3):

1. Bladder-symphysis distance (BS): the distance from the bladder neck to the inferior tip of the symphysis pubis.

2. Rotational angle (RA): the angle between the BS line and the midline of the symphysis pubis.

3. Bladder neck mobility (BNM): the difference between the RA during Valsalva (maximum descent) and withholding (maximum elevation).

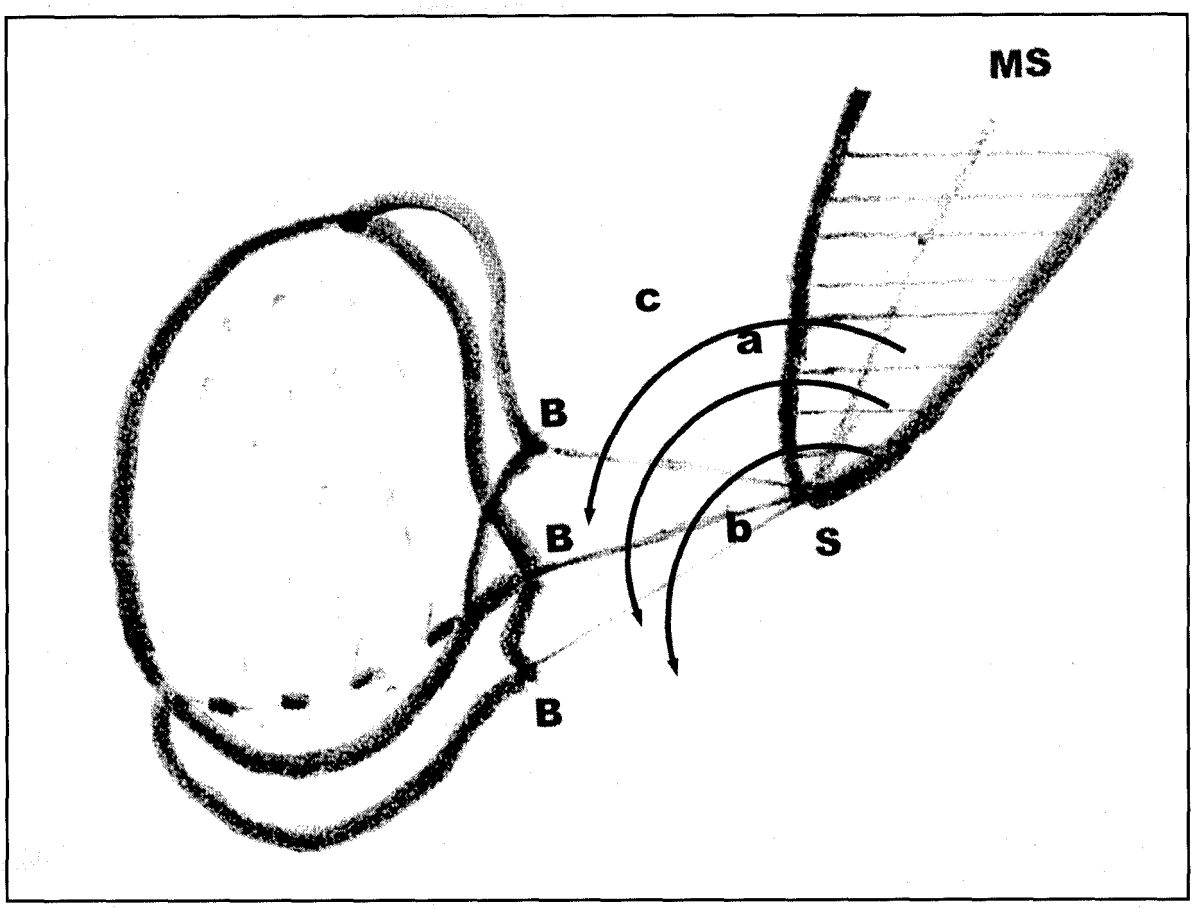


Fig. 2: Diagrammatic illustration of the measured parameters at rest (a), Valsalva (b) and withholding maneuvers (c). B = bladder neck, S = inferior tip of the symphysis pubis, MS = midline of symphysis pubis

4. Vertical bladder neck descent: the vertical distance between the position of the bladder neck at rest and during Valsalva, using the inferior tip of the symphysis pubis as a reference point.

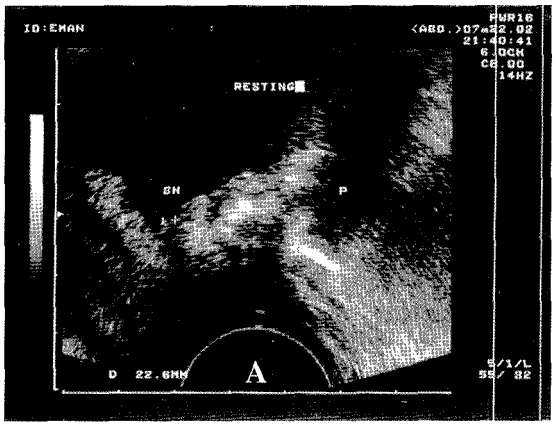
The data were reported as mean value ± standard error. The results were tabulated and analyzed using student's t-test. A probability value of $p<0.05$ demarcated the level of significance.

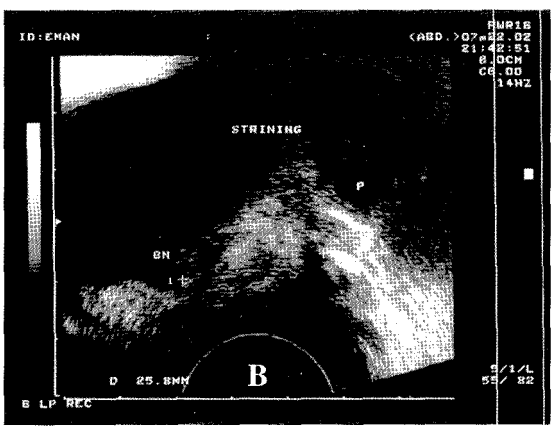
RESULTS

The clinical and urodynamic variables of the studied cases are shown in Table 1. There was no significant difference between Groups I and II regarding age and parity. However, the VLPP differed significantly between Group I (133 ± 16 cm H_2O) and Group II (102 ± 22 cm H_2O). Three cases of Group II showed abnormal detrusor contractions during cystometry and were treated successfully with anticholinergic drugs before surgery.

Out of the 42 patients that attended follow-up, the surgical procedures (tension-free vaginal tape in 16 (Fig. 4), Burch colposuspension in 17 (Fig. 5), and Stamey endoscopic suspension in 9 cases) were successful in 36 cases (85.7%) (Group IIIa), while treatment failed and SUI persisted or recurred within one year in the remaining six cases (Group IIIb, 14.3%). There was no statistically significant difference between the three types of intervention with respect to the preoperative clinical and urodynamic data. The details of the results of the surgical treatment after one year follow-up are shown in Table 2.

The mean BS was insignificantly shorter in Group II (2.24 ± 0.7cm) compared to Group I (2.4 ± 0.5 cm) ($p=0.08$) and in Group IIIb (2 ± 0.5 cm) compared to Group IIIa (2.2 ± 1 cm)





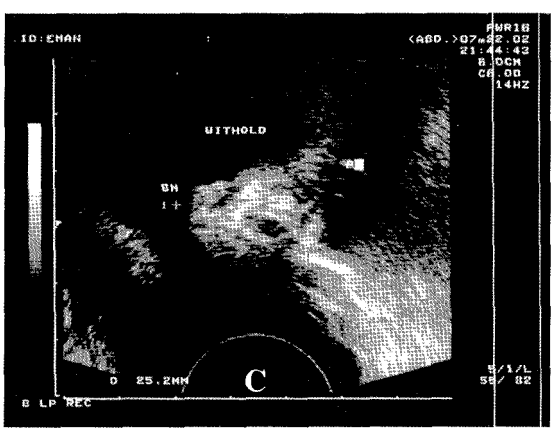


Fig. 3: A case of SUI (preoperative): **A:** At rest. BS = 2.2 cm, RA = 99°. **B:** At straining. BS = 2 cm, RA = 126°. **C:** At withholding. BS = 2.3 cm, RA = 92°. BNM = 34° and VD = 1.5 cm

(p=0.072). The mean RA, BNM and vertical bladder neck descent was significantly larger in Group II (115 ± 17°, 29 ± 16°, 1.4 ± 0.4cm) compared to Group I (94 ± 15°, 20 ± 5°, 0.34 ± 0.4cm) (p<.01) and in Group IIIb (117 ± 16°, 30 ± 9°, 1.4 ± 0.3 cm) compared to Group IIIa (100 ± 19°, 22 ± 4°, 0.38 ± 0.5 cm) (p<0.01) (Table 3).

For the TVT group of patients, we found that the procedure created a urethral knee angle between the proximal and distal segments of the urethra (Fig. 4) which may have a role in its anti-incontinence effect.

DISCUSSION

Anatomic SUI is usually diagnosed by history, physical examination and selected clinical tests. At times, urodynamic evaluation is used for a more objective demonstration of the associated dynamic changes and exclusion of the urge element. Lateral chain cystography used to be the gold standard for radiological diagnosis of anatomic SUI[13]. More recently, ultrasonography has been considered an effective and acceptable technique for assessing the anatomy of the bladder outlet and the urethra[14,15,16,17]. Ultrasound is a safe, simple and cost-effective tool; it does not involve radiation hazards and does not need contrast materials[6].

Some authors prefer transperineal ultrasound over TVUS in evaluating females with SUI on the assumption that the pressure of the TVUS probe may alter the anatomy of the pelvic structures[6,18,19,20]. We found that gentle introduction of the TVUS probe without pressure into the introitus just beneath the external urethral meatus will not alter the anatomic features and, moreover, will allow adequate visualization of the urethra, bladder neck, bladder base and symphysis pubis in one field[9].

Since TVUS was introduced in the diagnosis and postoperative evaluation of anatomic SUI, different endosonographic parameters have been suggested in the literature. Some authors deny the importance of the BN position at rest and the BS distance[21,22]. However, BNM was found to be an important parameter by many authors[16,17,18,22,23]. The vertical bladder neck descent was considered of high value by others[22,24]. The posterior urethro-vesical angle (PUVA) is considered more valuable by

Table 2: Distribution of the Patients According to the Operative Procedures and their Results after one Year

Procedure	Treated Cases		Followed Cases		Success		Failures	
	No.	%	No.	%	No.	%	No.	%
Burch	18	39%	17	94.4%	15	88.2%	2	11.8%
TVT	18	39%	16	88.9%	14	87.5%	2/12.5%	
Stamey	10	22%	9	90%	7	77.7%	2	22.3%
Total	46	100%	42	91.3%	36	85.7%	6	14.3%

Table 3: TVUS-Measured Parameters

Parameter	Group I (n=15)	Group II (n=46)	Group IIIa (n=36)	Group IIIb (n=6)
BS	2.4±0.5	2.24±0.7	2.2±1	2±0.5
RA	94±15	115±17	100±19	117±16
BNM	20±5	29±16	22±4	30±9
VD*	0.34±0.4	1.4±0.4	0.38±0.5	1.4±0.3

* *vertical bladder neck descent*

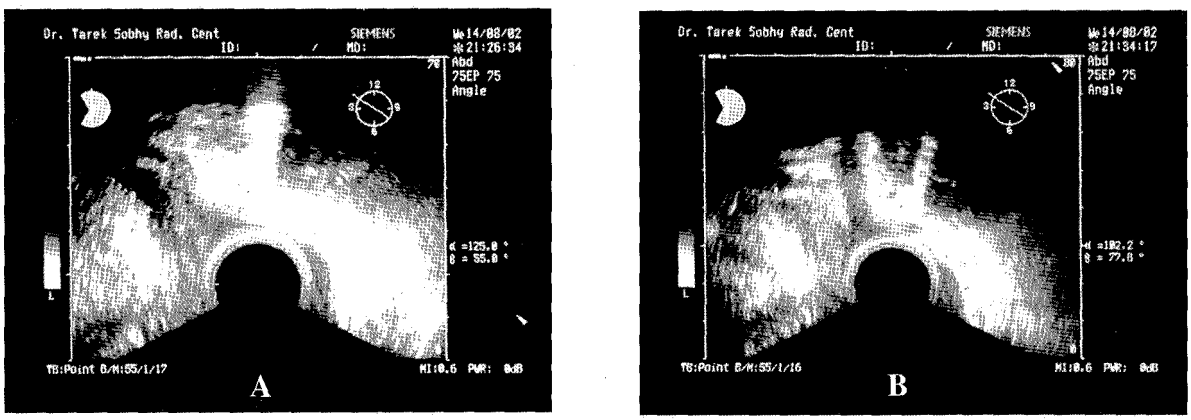


Fig. 4: Follow-up TVUS one year after successful TVT. **A:** At rest. Note the urethral knee angle. **B:** Urethral angulation increases with straining.

many[9,19,24], whereas others stressed the importance of the rotational angle[9,17,22]. Lo et al.[25] and Pergazzi et al.[20] found that the urethral angle (the angle between the proximal and distal urethral segments) was correlated with the continence state to a larger extent than the PUVA.

In this work we studied four parameters and found that RA, BNM and the vertical bladder neck descent were valid parameters for the diagnosis and postoperative evaluation of SUI and correlated well with the clinical condition and postoperative outcome. Continent females had a narrower RA (94±15°), less BNM (20±5°)

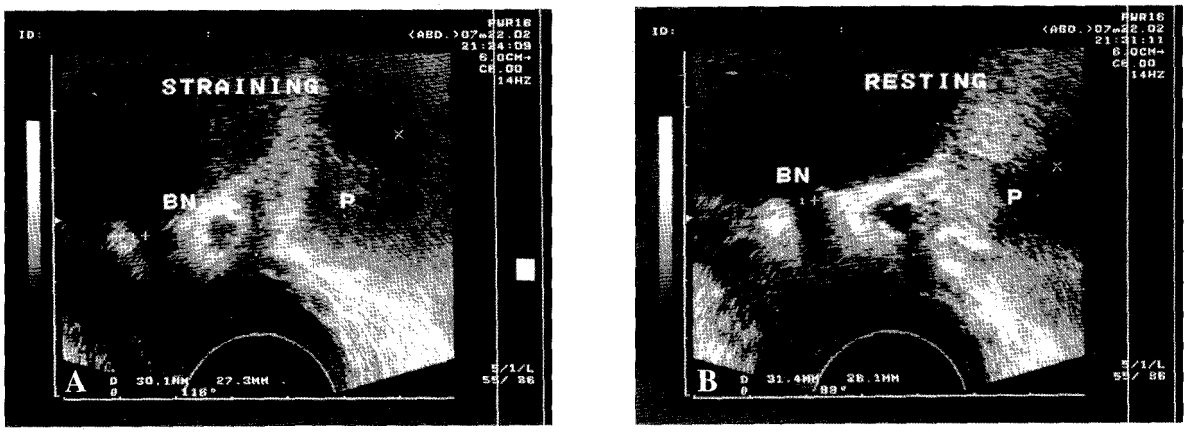


Fig. 5: Follow-up TVUS one year after successful Burch colposuspension. **A:** At rest. BS = 2.8 cm, RA = 98°. **B:** With straining. BS = 2.6 cm, RA = 103°. BNM = 18°, VD = 0.36 cm

and less vertical bladder neck descent (34 ± 0.4cm) than incontinent females (RA = 115 ± 17°, BNM = 29 ± 16°, vertical bladder neck descent = 1.4 ± 0.4cm). The BS was found insignificantly shorter in incontinent females and could not discriminate between failed and successful surgery. Moreover, a successful anti-incontinence operation should alter the anatomic features toward the continence side as presented by changes of the postoperative parameters to be nearer to the parameters of continent females. Failure of the anti-incontinence operation may be due to the failure of the surgical technique applied to achieve this goal[15,16]. This is shown by the insignificant change of the postoperative endosonographic parameters of the failed cases (RA = 117 ± 16°, BNM = 30 ± 9° and vertical bladder neck descent = 1.4 ± 0.3 cm) from their preoperative parameters (RA = 115 ± 17°, BNM = 29 ± 16° and vertical bladder neck descent = 1.4 ± 0.4 cm). Our results agree with those of other authors[9,16,17,22].

During the postoperative evaluation of our patients we found that TVT created a urethral knee angle (Fig. 4) between the proximal and distal urethral segment producing a relative increase in urethral resistance which may be the basic anti-incontinence mechanism of this procedure. This observation is in agreement with that of Klutke et al[26]. Moreover, Lo et al.[25] in their study on 90 females cited that the procedure seemed neither to change hypermobility nor to elevate the position of the bladder neck. They claimed that urinary continence after surgery was most probably achieved by creating a dynamic mid-urethral knee angulation by which the urethra is closed i.e. kinked at stress. However, the exact continence mechanism of this specific procedure and whether it can correct the anatomic defect of the bladder neck and urethra or just produces a relative increase of urethral resistance need to be elucidated in a more comprehensive study.

In conclusion, TVUS is a safe and simple method of investigation for the diagnosis and postoperative evaluation of anatomic SUI. It may help in understanding the anatomical basis of success and failure of anti-incontinence procedures. The TVT procedure creates a urethral knee angle which may be the underlying anti-incontinence mechanism of this technique.

REFERENCES

1. Enhorning GE. Simultaneous recording of intravesical and intraurethral pressure. A study of urethral closure in normal and incontinent women. *Acta Clin Scand* 1961, 176:168.

2. Olesen K. Descent of the female urinary bladder. MD Thesis. University of Copenhagen, Denmark, 1982.

3. Dundas D, Hilton P, Williams JE *et al.* Aetiology of voiding difficulties postcolposuspension. Proceedings of the 12th Annual Meeting of the International Continence Society, Leiden/Netherlands, 1982.

4. Bergman A, McKenzie CJ, Richmond J *et al.* Transrectal ultrasound versus cystography in the evaluation of anatomical stress urinary incontinence. *Br J Urol* 1988, 62:228.

5. Quinn MJ, Beynon J, Mortensen NJ *et al.* Transvaginal endosonography: a new method to study the anatomy of the lower urinary tract in urinary stress incontinence. *Br J Urol* 1988, 62:414.

6. Ömer TY, Hikmet H, Mete T. A new ultrasonographic method for evaluation of the results of anti-incontinence operations. *Acta Obstetrica et Gynecologica Scandinavica* 2002, 81:151.

7. Koebell H, Bernaschek G, Deutlinger J. Assessment of female urinary incontinence by introital sonography. *J Clin Ultrasound* 1990, 18:370.

8. Johnson JD, Lamensdorf H, Hollander IN, Thuman AE. Use of transvaginal endosonography in the evaluation of women with stress urinary incontinence. *J Urol* 1992, 147:421.

9. Mouritsen L, Rasmussen A. Bladder neck motility evaluated by vaginal ultrasonography. *Br J Urol* 1993, 71:166.

10. Burch JC. Urethrovaginal fixation to Cooper's ligament for correction of stress incontinence, cystocele and prolapse. *Am J Obstet Gynecol* 1961, 81:281.

11. Ulmsten U, Henrikson L, Johnson P *et al.* An ambulatory surgical procedure under local anesthesia for treatment of female urinary incontinence. *Int Urogynecol J* 1996, 7:81.

12. Stamey TA. Endoscopic suspension of the vesical neck for urinary incontinence in females. *Ann Surg* 1980, 192:465.

13. Green TH. Development of a plan for the diagnosis and treatment of urinary stress incontinence. *Am J Obstet Gynecol* 1967, 29:324.

14. Pergazzi R, Sartore A, Bortoli P, Troiano L, Guaschino S. Ultrasonographic assessment of urethrovesical mobility in women. *Arch Ital Urol Androl* 2000, 72:335.

15. Martan A, Masata J, Halaska M, Otcenasek M, Savbik K. Ultrasound imaging of paravaginal defects in women with stress incontinence before and after paravaginal defect repair. *Ultrasound Obstet Gynecol* 2002, 19:496.

16. Yalcin OT, Hassa H, Tanir M. A new ultrasonographic method for evaluation of the results of anti-incontinence operations. *Acta Obstet Gynecol Scand* 2002, 81:151.

17. Yang JM, Huang WC. Discrimination of bladder disorders in female lower urinary tract symptoms on ultrasonographic cystourethrography. *J Ultrasound Med* 2002, 21:1249.

18. Creighton SM, Clark A, Pearce JM, Stanton SL. Perineal bladder neck ultrasound: appearance before and after continence surgery. *Ultrasound in Obstetrics and Gynaecology* 1994, 4:428.

19. Alper T, Cetinkaya M, Okutgen S, Kokcu A, Malatyalioglu E. Evaluation of urethrovesical angle by ultrasound in women with and without urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunction* 2001, 12:308.

20. Pergazzi R, Sartore A, Bortoli P, Grimaldi E, Troiano L, Guaschino S. Perineal ultrasound evaluation of urethral angle and bladder neck mobility in women with stress urinary incontinence. *BJOG* 2002, 109:821.

21. Quinn MJ, Beynon NN, Mortensen M, Smith PJ. Vaginal endosonography in the postoperative assessment of colposuspension. *Br J Urol* 1989, 63:295.

22. Abdel Azim MS, Farouk R, Abaza S, El Mashad S. Role of transvaginal ultrasonography in the diagnosis of stress urinary incontinence. *Egyptian Journal of Urology* 2002, 9:31.

23. Dmochowski RR, Avon M, Ross J *et al.* Transvaginal radiofrequency treatment of the endopelvic fascia: a prospective evaluation for the treatment of genuine stress urinary incontinence. *J Urol* 2003, 169:1028.

24. Virtanen HS, Kiilholma P. Urogynecologic ultrasound is a useful aid in the assessment of female stress urinary incontinence – a prospective study with TVT procedure. *Int Urogynecol J Pelvic Floor Dysfunction* 2002, 13:218.

25. Lo TS, Wang AC, Hong SG, Liang CC, Soong YK. Ultrasonographic and urodynamic evaluation after tension free vaginal tape (TVT) procedure. *Acta Obstetrica Scandinavica* 2001, 80:65.

26. Klutke JJ, Carlin BI, Klutke CG. The tension-free vaginal tape procedure: correction of stress incontinence with minimal alteration in proximal urethral mobility. *Urology* 2000, 55:512.

RESUME

L'Echographie Endovaginale est une Exploration Précieuse dans l'Incontinence d'Effort de la Femme

Objectifs: Evaluer l'apport de l'échographie endovaginale dans l'étude des bases anatomiques de l'incontinence urinaire d'effort avérée de la femme et comprendre les causes du succès et de l'échec de la chirurgie de l'incontinence. **Patients et Méthodes**: Cette étude avait inclus 15 femmes continentes constituant le Groupe I ou groupe contrôle et 46 patients se plaignant d'incontinence urinaire d'effort (le Groupe II ou groupe cas). Pour tous les cas l'histoire de la maladie a été notée et une ex-

ploration clinique, urodynamique et par échographie endovaginale a été réalisée. Chez 36 patientes du Groupe II (85,7%) le traitement était efficace (Groupe IIIa), tandis qu'il y'a eu échec du traitement avec persistance de l'incontinence urinaire d'effort dans une proportion de 14.3% (Groupe IIIb). Nous avions utilisé l'échographie endovaginale pour mesurer la distance vessie-symphyse pubienne, l'angle de rotation, la mobilité du col vésical et la descente verticale du col vésical. **Résultats:** Tandis que la distance moyenne vessie-symphyse était significativement plus courte dans le Groupe II comparé au Groupe I (2.24 ± 0.7cm contre 2.4 ± 0.5 cm, p = 0.08), la moyenne d'angle de rotation, de mobilité du col vésical et de descente du col vésical était significativement plus large dans le Groupe II (115 ± 17°, 29 ± 16° et 1.4 ± 0.4 cm pour le Groupe II contre 94 ± 15°, 20 ± 5° et 0.34 ± 0.4 cm pour le Groupe I). La comparaison entre les deux groupes avait montré que les paramètres mesurés par échographie endovaginale étaient corrélés avec le tableau clinique. Une comparaison entre le Groupe IIIa (distance pubis-symphyse = 2.2 ± 1 cm, angle de rotation = 100 ± 19°, mobilité du col vésical = 22 ± 4° et descente du col vésical = 0.38 ± 0.5 cm) et le Groupe IIIb (distance vessie-pubis = 2.2 ± 0.5 cm, angle de rotation = 117 ± 16°, mobilité du col vésical = 30 ± 9° et descente verticale du col vésical = 1.4 ± 0.3 cm) avait montré que les paramètres mesurés par l'échographie endovaginale avaient une bonne corrélation avec les résultats de la chirurgie. **Conclusions:** L'échographie endovaginale est une exploration précieuse dans le diagnostic et l'évaluation post opératoire de l'incontinence urinaire d'effort. Elle peut aider à la compréhension des causes de réussite et d'échec dans le traitement de l'incontinence urinaire d'effort.

All correspondence to be sent to:

Ahmed El-Ayman, M.D.
Urology Department
Faculty of Medicine
Zagazig University Hospital
Zagazig
Egypt