

Transvaginal Sonographic Assessment of Postvoid Residual Urine Volumes in Women with Pelvic Floor Dysfunction

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Abstract

Objective: To evaluate the correlation between postvoid residual urine volumes assessed by transvaginal ultrasonography and by catheterization in women that had pelvic floor dysfunction.

Methods: Measurement of postvoid residual urine volume was performed in 78 women who presented with pelvic floor dysfunction at the Urogynaecology Clinic, Ramathibodi Hospital. Transvaginal ultrasonography was used to measure three diameters of the bladder in two perpendicular planes. Postvoid residual urine volumes were calculated using the formula “postvoid residual volume = (height × width × depth) × 0.7” and these volumes were compared with those obtained from catheterization in each patient.

Results: Pelvic organ prolapse, stress urinary incontinence and mixed urinary incontinence were found in 53.8%, 46.2% and 41.0% of women, respectively. The postvoid residual urine volumes assessed by transvaginal ultrasonography were significantly correlated with the catheterized urine volumes. These two methods had high correlation coefficient of 0.99 ($P < 0.001$). The mean difference of bladder volume from the two assessments was 6.02 ml (95% CI, 7 - 19)

Conclusions: The transvaginal ultrasonography is a non-invasive technique that has high correlation with catheterized urine volume when was used to assess postvoid residual urine volumes in women with pelvic floor dysfunction.

Keywords: transvaginal ultrasonography, postvoid residual urine volumes, pelvic floor dysfunction

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Introduction

Female pelvic floor dysfunction is a term applied to a wide variety of clinical conditions, including urinary incontinence, anal incontinence, pelvic organ prolapse, sensory and emptying abnormalities of the lower urinary tract, defecatory dysfunction, sexual dysfunction and chronic pelvic pain syndromes¹. From the study among 4,103 women in USA with mean age of 56.5 ± 15.8 years, the prevalence of stress urinary incontinence was 15%, overactive bladder 13%, pelvic organ prolapse 6%, anal incontinence 25% and 37% for any one or more disorders². The pelvic floor relates to more than one organ system, so dysfunction of the pelvic floor influences different functions at the same time. Moreover, the correlation of lower urinary tract dysfunction and pelvic organ prolapse was shown in a previous study³.

Post void residual (PVR) urine volume is defined as volume of urine left in the bladder at the completion of micturition⁴. In a patient that comes with pelvic floor dysfunction, PVR volume measurement is a simple test that can easily be performed in the primary care setting to provide useful information to guide patient care⁵⁻⁷. According to the standardization of terminology of lower urinary tract function recommendation by international continence society, residual urine is commonly estimated by catheter, radiography, ultrasonography and radioisotopes⁸. Urinary catheterization has long been thought to be the gold standard in determining an accurate postvoid residual urine volume, but it carries the risk of infection, traumas to the urethra and may lead to urinary retention from urethral stricture⁸⁻¹⁰. Several studies have investigated the value of bladder ultrasound for this purpose. Ultrasonography is safe, non-invasive and reliable; may detect intravesical abnormalities such as tumor, calculi, diverticular and unlimited repeatability¹¹. The several mode of ultrasonography¹²⁻¹⁴ have been used to measure residual urine such as two- and three-dimensional ultrasound¹⁵ or bladder scan¹⁶⁻¹⁸.

Both transabdominal¹⁹ and transvaginal ultrasonography give reasonable bladder volume assessment^{20, 21} and could be used interchangeably in the postpartum women²². Transvaginal ultrasonography is more appropriate in the patient with pelvic floor dysfunction because it can provide a clear bladder image, can evaluate the wide range of bladder volumes, and it is more accurate in the measurement of postvoid residual urine at lower volumes^{14, 23}. In addition, it can evaluate pelvic structures at the same time. However, there is no data regarding transvaginal sonography in the assessment of postvoid residual urine volumes in women with pelvic floor dysfunction.

This cross-sectional study was designed to evaluate the correlation between postvoid residual urine volumes assessed by transvaginal ultrasound and by catheterization in women that had pelvic floor dysfunction.

Materials and methods

This study was conducted in the Urogynaecology Clinic, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand. The study protocol was approved by Committee on Human Rights Related to Researches Involving Human Subjects, Faculty of Medicine, Ramathibodi Hospital, Mahidol University. The patients who presented with pelvic floor dysfunction according to the standardization of terminology of pelvic floor muscle function and dysfunction¹ at the Urogynaecology Clinic, Ramathibodi Hospital and had willingness to participate in the study were recruited. The written informed consent was obtained from each patient before entering the study. Exclusion criterion included the patient that could not be inserted with transvaginal ultrasound transducer.

The sample size was derived from the previous study of Goode PS, et al.¹³ and a sample of 68 patients was required for a 95% confidence interval. The patients who met the inclusion criteria were enrolled into the study. At the initial visit, informed consent was completed.

Demographic data and medical history were collected. Each patient was asked to empty her bladder and then transvaginal ultrasonography was done to measure three dimensions of bladder and to detect pathology of genital tract by the principal investigator who was standardized according to intra-observer variations. From the three measurements in the same patient, the calculated volume of residual urine was not statistically different. The investigator was blinded to all the demographic data and medical history of the patients. An ALOKA SSD 1000, real time ultrasound machine with a 11 MHz vaginal transducer was used for the ultrasound scan. A trained nurse inserted an intermittent urethral catheter to measure the residual volume of urine. All of these processes were performed within 10 minutes to avoid an artificially elevated result because of diuresis. The amount of the postvoid residual urine volume (PVRUV) in the bladder was estimated by measuring the following parameters in two perpendicular planes and three diameter of the bladder was measured²⁶. Then, it was calculated using the formula of Poston II, et al., which was:

$$\text{PVRUV} = (\text{height} \times \text{depth} \times \text{width}) \times 0.7$$

Height is the greatest superoinferior measurement (cm), depth is the greatest anteroposterior measurement (cm) and width is the maximum transverse diameter (cm). This formula has been used routinely in the Urogynecology Clinic, Ramathibodi Hospital.

The baseline demographic data, postvoid residual urine volume, possible associated factors in retention of urine and pelvic floor dysfunction conditions were analyzed. STATA was used for statistical analysis. The Pearson correlation coefficient was determined to test the strength of correlation of the transvaginal sonography and catheterized urine volume. Student's paired *t* test was used to determine the mean difference

between the postvoid residual urine volume obtained by catheterization and transvaginal sonography. Finally, to verify and compare the accuracy of the two methods, a reliability analysis (intraclass correlation coefficient) was performed. Value of $P < 0.001$ was considered statistically significant.

Results

There were 84 patients who were screened and 78 patients were recruited into this study. The mean age was 54.5 ± 7.9 years and mean body mass index was $25.3 \pm 3.2 \text{ kg/m}^2$. The parity ranged from 0 to 6 with a median of 2. The type of pelvic floor dysfunction are further described in Table 1. Among 42 patients with pelvic organ prolapse, 25 patients (32.1%) had stage I, 9 patients (11.5%) had stage IV and 8 patients (10.3%) had stage II and III.

The mean postvoid residual urine volume was 25.54 ± 49.06 ml on transvaginal sonography and 31.56 ± 48.53 ml on catheterization. The calculated volume using transvaginal sonography was significantly correlated with estimated volume obtained from catheterization ($r = 0.99, P < 0.001$) (Figure 2). The mean difference was 6.02 ml (95% CI 7 - 19) (Figure 3).

Fourteen patients (17.9%) had postvoid residual urine volume more than or equal to 50 ml. on catheterization, transvaginal sonography could identify in 12 patients (85.7% of all abnormal cases). The postvoid

Table 1 Types of pelvic floor dysfunction (N = 78)

Characteristic	n (%)
Pelvic organ prolapse	42 (53.8)
Stress urinary incontinence	36 (46.2)
Urge urinary incontinence	1 (1.3)
Mixed urinary incontinence	32 (41.0)

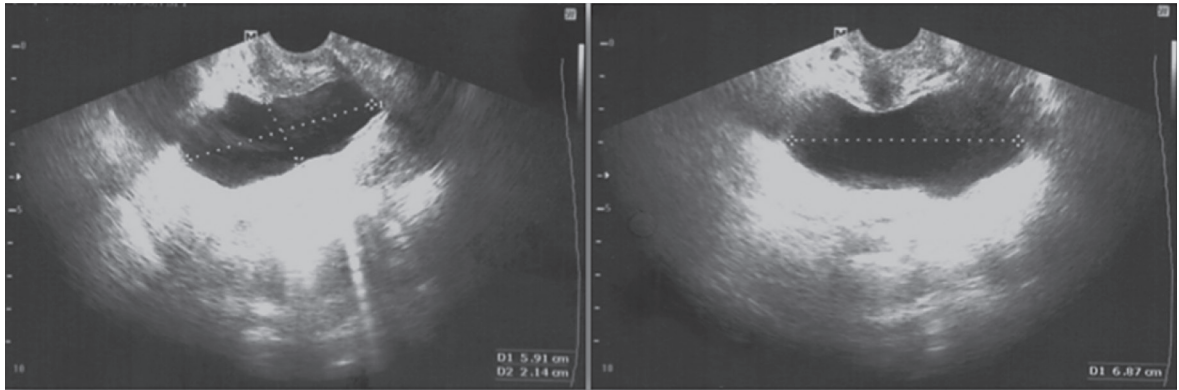


Figure 1 Measurement of bladder using transvaginal ultrasonography

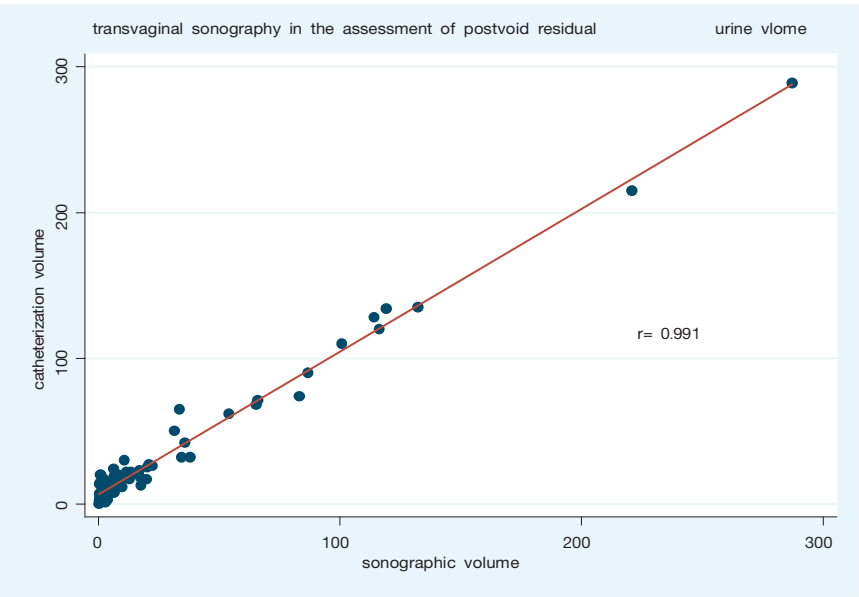


Figure 2 Correlation of postvoid residual urine volume by catheterization and transvaginal sonography

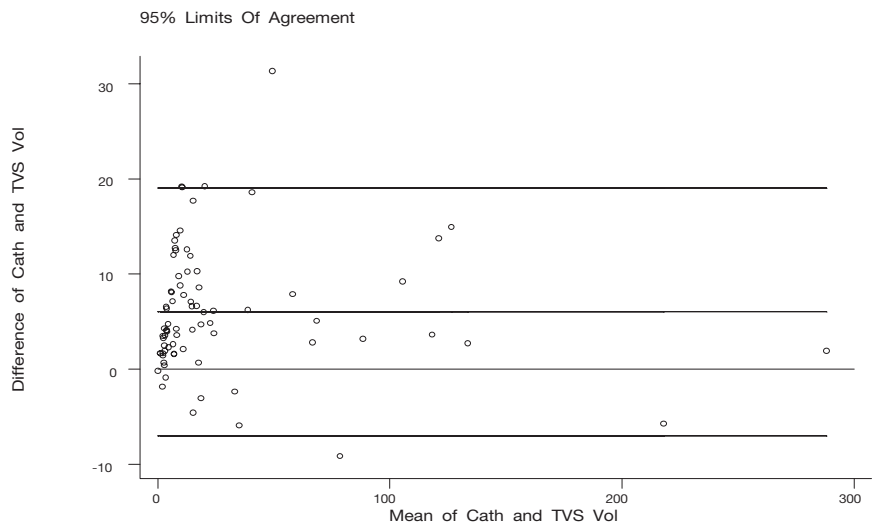


Figure 3 Mean difference of catheterized and transvaginal sonographic (TVS) postvoid residual urine volumes

residual urine volume from catheterization and transvaginal sonography significantly correlated in pelvic organ prolapse stage I ($r = 0.83$) and stage IV ($r = 0.99$), stress ($r = 0.99$) and mixed ($r = 0.99$) urinary incontinence groups with the mean difference 4.97 ml in pelvic organ prolapse stage I (95% limit of agreement -6.22 - 16.16), 6.20 ml in pelvic organ prolapsed stage IV (95% limit of agreement -15.17 - 27.57), 5.57 ml in stress urinary incontinence (95% limit of agreement -7.85 - 18.99) and 6.56 ml in mixed urinary incontinence (95% limit of agreement -7.04 - 20.16).

Discussion

Although, ultrasound measurement of bladder volume has been used as an alternative to catheterization for the past 30 years, there is no study about transvaginal sonographic measurement of postvoid residual urine volume in pelvic floor dysfunction women. This study showed high correlation coefficient in postvoid residual urine volume that was measured by transvaginal sonography and urethral catheterization.

Transvaginal sonography has been used widely, useful in office setting, cheap, and can be used by general practitioners and specialists. Transvaginal approach is more advantageous than transabdominal approach in pelvic floor dysfunction women because in this group, the patients usually have some degree of pelvic organ prolapse that may distort the shape of the bladder and make it difficult to clearly see the bladder edge. The formula used to calculate the bladder volume, obtained from the study of Poston JJ, et al. is easy to calculate at bedside, not complicated and was proved from this study that has high correlation coefficient in

pelvic floor dysfunction women, too. It is generally agreed that a postvoid residual volume level less than 50 ml is normal^{4,24}. The study found that, in the patient that catheterized urine volume is close to 50 ml. Transvaginal sonography cannot distinguish abnormal from normal volume because the calculated volume from transvaginal sonography is less than the catheterized volume. In other patients that had abnormal postvoid residual urine volume (range 62 - 289 ml.), transvaginal sonography could identify the abnormality. The explanation of this may be that, in two patients that catheterized volume close to 50 ml had pelvic organ prolapse stage IV, therefore, distortion of bladder shape could interfere with the sonographic view. However, the correlation analysis found that transvaginal sonography yielded the better result than the previous studies^{13, 16, 17, 21}.

The strength of this study is by means of all sonographic measurements were performed by a single investigator who was already standardized according to intra-observer variation. The limitation of the present study may be a small sample of patients, further studies with larger sample size are warranted. The notable results of this study could be helpful in reassuring the use of a simple, non-invasive and safer bedside technique in PVR evaluation in women with pelvic floor dysfunction.

Conclusion

Transvaginal sonography is a non-invasive technique that has high correlation with catheterized urine volume when was used to assess postvoid residual urine volume in the patients with pelvic floor dysfunction.



References

1. Messelink B, Benson T, Berghmans B, et al. Standardization of terminology of pelvic floor muscle function and dysfunction: report from the pelvic floor clinical assessment group of the international continence society. *Neurourol Urodyn*. 2005;24(4):374-80.
2. Lawrence JM, Lukacz ES, Nager CW, Hsu JW, Lubner KM. Prevalence and co-occurrence of pelvic floor disorders in community-dwelling women. *Obstet Gynecol*. 2008;111(3):678-85. doi:10.1097/AOG.0b013e3181660c1b.
3. Cetinkaya SE, Dokmeci F, Dai O. Correlation of pelvic organ prolapse staging with lower urinary tract symptoms, sexual dysfunction, and quality of life. *Int Urogynecol J*. 2013;24(10):1645-50. doi:10.1007/s00192-013-2072-4.
4. Haylen BT, de Ridder D, Freeman RM, et al. An International Urogynecological Association (IUGA) / International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Int Urogynecol J*. 2010;21(1):5-26. doi:10.1007/s00192-009-0976-9.
5. Haylen BT, Lee J, Logan V, Husselbee S, Zhou J, Law M. Immediate postvoid residual volumes in women with symptoms of pelvic floor dysfunction. *Obstet Gynecol*. 2008;111(6):1305-12. doi:10.1097/AOG.0b013e31817615b2.
6. Tseng LH, Liang CC, Chang YL, Lee SJ, Lloyd LK, Chen CK. Postvoid residual urine in women with stress incontinence. *Neurourol Urodyn*. 2008;27(1):48-51.
7. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology*. 2003;61(1):37-49.
8. Tenke P, Kovacs B, Bjerklund Johansen TE, Matsumoto T, Tambyah PA, Naber KG. European and Asian guidelines on management and prevention of catheter-associated urinary tract infections. *Int J Antimicrob Agents*. 2008;31(Suppl 1):S68-78.
9. Barford JM, Anson K, Hu Y, Coates AR. A model of catheter-associated urinary tract infection initiated by bacterial contamination of the catheter tip. *BJU Int*. 2008;102(1):67-74. doi:10.1111/j.1464-410X.2008.07465.x.
10. Kim MK, Park K. Unusual complication of urethral catheterization: a case report. *J Korean Med Sci*. 2008;23(1):161-2. doi:10.3346/jkms.2008.23.1.161.
11. Griffiths CJ, Murray A, Ramsden PD. Accuracy and repeatability of bladder volume measurement using ultrasonic imaging. *J Urol*. 1986;136(4):808-12.
12. Amole AO, Kuranga SA, Oyejola BA. Sonographic assessment of postvoid residual urine volumes in patients with benign prostatic hyperplasia. *J Natl Med Assoc*. 2004;96(2):234-9.
13. Goode PS, Locher JL, Bryant RL, Roth DL, Burgio KL. Measurement of postvoid residual urine with portable transabdominal bladder ultrasound scanner and urethral catheterization. *Int Urogynecol J Pelvic Floor Dysfunct*. 2000;11(5):296-300.
14. Haylen BT, Frazer MI, Sutherst JR, West CR. Transvaginal ultrasound in the assessment of bladder volumes in women. *Br J Urol*. 1989;63(2):149-51.

15. Farrell T, Leslie JR, Chien PFW, Agustsson P. The reliability and validity of three dimensional ultrasound volumetric measurements using an in vitro balloon and in vivo uterine model. *BJOG*. 2001;108(6):573-82.
16. Choe JH, Lee JY, Lee KS. Accuracy and precision of a new portable ultrasound scanner, the BME-150A, in residual urine volume measurement: a comparison with the Bladder Scan BVI 3000. *Int Urogynecol J Pelvic Floor Dysfunct*. 2007;18(6):641-4.
17. Lukasse M, Cederkvist HR, Rosseland LA. Reliability of an automatic ultrasound system for detecting postpartum urinary retention after vaginal birth. *Acta Obstet Gynecol Scand*. 2007;86(10):1251-5.
18. Lertbunnaphong T, Inthasorn P, Boriboonhirunsarn D, Chuchotirot M, Russameecharoen K, Phattanachindakun B. Transabdominal ultrasound in the assessment of postvoid residual urine volume in patients after hysterectomy. *J Med Assoc Thai*. 2006;89(Suppl 4):S152-7.
19. Yip SK, Sahota DS, Chang AM. A probability model for ultrasound estimation of bladder volume in the diagnosis of female urinary retention. *Gynecol Obstet Invest*. 2003;55(4):235-40.
20. Yip SK, Sahota D, Chang AM. Determining the reliability of ultrasound measurements and the validity of the formulae for ultrasound estimation of postvoid residual bladder volume in postpartum women. *Neurourol Urodyn*. 2003;22(3):255-60.
21. Yip SK, Fung TY, Chung TK. Ultrasonographic estimation of postpartum postvoid residual bladder volume: a comparison between transabdominal and transvaginal ultrasonography. *Int Urogynecol J Pelvic Floor Dysfunct*. 1998;9(1):9-12.
22. Haylen BT. Residual urine volume in a normal female population: application of transvaginal ultrasound. *Br J Urol*. 1989;64(4):347-9.
23. Poston GJ, Joseph AE, Riddle PR. The accuracy of ultrasound in the measurement of changes in bladder volume. *Br J Urol*. 1989;55(4):361-3.
24. Gehrich A, Stany MP, Fischer JR, Buller J, Zahn CM. Establishing a mean postvoid residual volume in asymptomatic perimenopausal and postmenopausal women. *Obstet Gynecol*. 2007;110(4):827-32.



Original Articles/นิพนธ์ต้นฉบับ

การประเมินปริมาณปัสสาวะที่เหลือน้ำ โดยใช้การตรวจคลื่นเสียงความถี่สูงทางช่องคลอดในสตรีที่มีภาวะกระบังลมหย่อน

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความสัมพันธ์ระหว่างการประเมินปริมาณปัสสาวะที่เหลือน้ำ โดยใช้การตรวจคลื่นเสียงความถี่สูงทางช่องคลอดและการสวนปัสสาวะในสตรีที่มีภาวะกระบังลมหย่อน

วิธีการศึกษา: เป็นการประเมินปริมาณปัสสาวะที่เหลือน้ำในสตรีที่มาตรวจที่คลินิกนรีเวชทางเดินปัสสาวะและอวัยวะสืบพันธุ์ โรงพยาบาลรามาธิบดี ด้วยปัญหาภาวะกระบังลมหย่อน จำนวน 78 ราย โดยใช้วิธีการตรวจด้วยคลื่นเสียงความถี่สูงทางช่องคลอด และวัดระยะของกระเพาะปัสสาวะในสองระนาบที่ตั้งฉากกัน รวมทั้งหมด 3 แนว แล้วจึงนำค่าที่วัดได้มาคำนวณหาปริมาณปัสสาวะที่เหลือน้ำอยู่ในกระเพาะปัสสาวะภายหลังการถ่ายปัสสาวะ โดยใช้สูตรคำนวณดังนี้ (ความยาว × ความกว้าง × ความสูง) × 0.7 แล้วจึงนำค่าที่คำนวณได้มาเปรียบเทียบกับปริมาณปัสสาวะที่วัดได้จากการใช้สายสวนปัสสาวะ

ผลการศึกษา: พบภาวะอวัยวะในอุ้งเชิงกรานหย่อน ไอจามปัสสาวะเล็ด และกลั้นปัสสาวะไม่อยู่แบบผสมร้อยละ 53.8, 46.2 และ 41.0 ในสตรีตามลำดับ ปริมาณปัสสาวะที่เหลือน้ำที่คำนวณได้จากการตรวจด้วยคลื่นเสียงความถี่สูงทางช่องคลอดมีความสัมพันธ์อย่างมีนัยสำคัญกับปริมาณปัสสาวะที่ได้จากการสวนด้วยสายสวน การตรวจทั้งสองวิธีมีค่าสัมประสิทธิ์สหสัมพันธ์ สูงถึง 0.99 ความแตกต่างระหว่างค่าเฉลี่ยของทั้งสองวิธี เท่ากับ 6.02 มิลลิลิตร (95% CI, 7 - 19)

สรุป: การตรวจด้วยคลื่นเสียงความถี่สูงทางช่องคลอดเป็นวิธีการตรวจที่ไม่ก่อให้เกิดความเจ็บปวด มีความสัมพันธ์ในระดับสูงกับปริมาณปัสสาวะที่ได้จากการสวนด้วยสายสวนในการประเมินปริมาณปัสสาวะที่เหลือน้ำในสตรีที่มีภาวะกระบังลมหย่อน

คำสำคัญ: การตรวจคลื่นเสียงความถี่สูงทางช่องคลอด ปริมาณปัสสาวะที่เหลือน้ำ ภาวะกระบังลมหย่อน

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