Transabdominal Ultrasound in the Assessment of Postvoid Residual Urine Volume in Patients after Hysterectomy

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Objective: *To evaluate the correlation between assessment of postvoid residual urine by transabdominal ultrasound and catheterization in patients after radical or transvaginal hysterectomy.*
Material and Method: *A cross-sectional study was conducted and 46 patients were enrolled after they had radical and transvaginal hysterectomy. After surgery, urinary catheter was indwelled. After catheter removal and the 3rd private voiding, the patients were sent for transabdominal ultrasound assessment of PVR at the Division of Maternal-Fetal Medicine. Complete drainage of bladder with standard catheterization was then performed and catheterized urine volume was recorded. PVR was calculated from previously published equation and compared with actual PVR from catheterization.*
Results: *Mean age of the patients was 55.9 years. The most common diagnoses were procidentia uteri (23.9%), Carcinoma of cervix stage 1b1 (23.9%), and prolapsed uteri grade 2 (21.7%). Radical hysterectomy with pelvic node dissection and vaginal hysterectomy with anterior colporhaphy and posterior colpoperiniorhaphy was performed each in 50% of cases. Mean duration of urinary catheter indwelling was 7.17 days for those underwent radical hysterectomy and 5 days for vaginal hysterectomy. The calculated PVR was significantly correlated with catheterized urine volume with correlation coefficient 0.93 ($p < 0.001$). If the usual cutoff of PVR > 100 ml was used to determine the necessity of re-indwelling catheter, among those with calculated PVR from ultrasound measurement < 100 ml, still 30% actually had actual PVR of > 100 ml. Among those with calculated PVR from ultrasound measurement >100 ml, all actually had actual PVR of > 100 ml.*
Conclusion: *PVR estimation by ultrasound significantly correlated with actual PVR. This could reduce the process of repeat catheterization and give more comfort to the patients when the PVR is > 100 ml.*

Keywords: *Ultrasound, Postvoid residual urine volume*

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Hysterectomy is the standard operation for many gynecological diseases such as myoma uteri, early stage of carcinoma of cervix, prolapsed uteri[1]. In radical or transvaginal hysterectomy, the urinary system, especially bladder and urethra, was usually affected due to disturbance of neurological function and can cause dysuria, urgency, and asymptomatic bacteriuria[2-5]. However, these changes are usually minor, transient and can be recovered in 6-12 months[2-4].

After radical or transvaginal hysterectomy, all patients require an indwelling catheter for 5-7 days to completely empty the bladder. However, before the removal of the catheter, postvoid residual urine volume (PVR) has to be evaluated to determine the necessity of re-indwelling the catheter. Re-indwelling is usually indicated when PVR is over 100 ml[6].

Urine catheterization is still a standard technique for PVR measurement. It is accurate but can cause

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discomfort to the patient, increase the risk to urethral trauma, and urinary tract infection[7,8]. However, many alternative techniques for estimating PVR have been reported including abdominal palpation and percussion, radionuclide scan, and ultrasonography[9-14].

Physical examination via abdominal palpation and percussion is easy, noninvasive but lack accuracy. Radionuclide scan is accurate but it is expensive, is not available at all settings, and there is a need for experienced radiologist to perform this procedure[9]. Ultrasonography, on the other hand, is an interesting method because it is safe, noninvasive, cost-effective, painless, repeatable, demands little cooperation from the patient and, in most cases, is accurate[10-14]. Although transvaginal ultrasonography is more accurate than transabdominal ultrasonography, it is still invasive and causes discomfort[14].

The purpose of this study is to evaluate the correlation between assessment of PVR by transabdominal ultrasound and catheterization in the patients after radical or transvaginal hysterectomy.

Material and Method

The study was conducted at the Department of Obstetrics and Gynecology, Siriraj Hospital with an approval of institutional Ethics Committee. Forty-six patients who underwent radical or transvaginal hysterectomy, were indicated for PVR assessment, and agreed to participate were enrolled in this study. Exclusion criteria included patients with past history of abdominal or pelvic surgery, history of pelvic radiation, bladder,or ureteral injury during current operation, central nervous system defect, and congenital anomalies of urinary system. Baseline characteristics and data on diagnosis and operation performed were recorded.

After surgery, a urinary catheter was indwelled. After catheter removal, the patients were sent for transabdominal ultrasound assessment of PVR at the Division of Maternal-Fetal Medicine using GE Logic-3 scanner with a 4 MHz transducer. Within 5 minute after the third private voiding, the patient was placed on supine position and ultrasound scan was then performed in sagittal and transverse view (Fig. 1). In sagittal view, the maximum length (L) and maximum depth (Dl), perpendicular to L were measured in millimetres, usually at the midline above pubic symphysis. In transverse view, the transducer was rotated through 90 degrees to find the largest transverse area. The maximum transverse diameter (T) and maximum depth (Dt), perpendicular to T were then measured in millimetres. Three experienced ultrasonologists participated in this study. They were orientated for the method of examination and measurement of various parameters. Measurements of each parameter were performed three times in each patients and the maximum value was recorded. Inter- and intraobserver variations have been tested and resulted in only minimal variations (correlation coefficient > 0.95, $p < 0.001$).

Within 5 minute after ultrasound examination, an assistant who had no knowledge of the ultrasound measurements catheterized each patient to assess the PVR volume under sterile technique. Complete drainage of bladder was confirmed by suprapubic compression of bladder under ultrasound guidance and cessation of urine flow from the catheter. Catheterized urine volume was recorded.

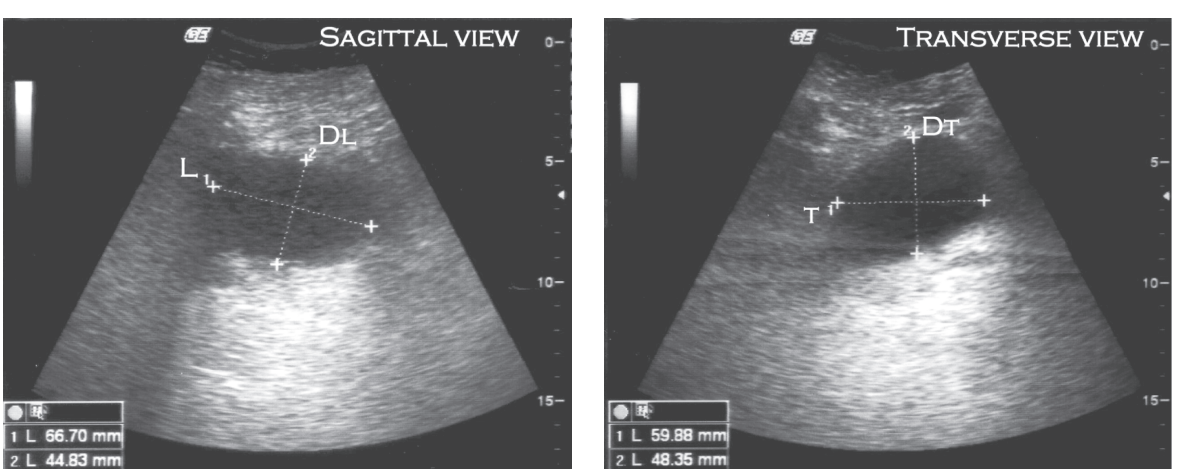

Fig. 1 Sagittal and transverse view for measurement of urinary bladder volume from transabdominal ultrasound

According to previous study[15], PVR can be calculated using the following equation: PVR = 374.057 + (-196.94+V1) + (32.5539 + $V1^2$) + (1.1480 + $V1^3$), where V1 = average of the length in millimetres (L), width in millimetres (T), and anteroposterior distance on transverse section in millimetres (Dt) of the postvoid urinary bladder.

Descriptive statistics were used to describe various baseline data and the measurements using mean, standard deviation, number, and percentage as appropriate. Correlation between PVR from ultrasound measurement and catheterization was calculated.

Results

Forty-six patients were enrolled in this study. Baseline characteristics are shown in Table 1. Mean age of the patients was 55.9 years. The most common diagnoses were procidentia uteri (23.9%), Carcinoma of cervix stage 1b1 (23.9%), and prolapsed uteri grade 2 (21.7%). Radical hysterectomy with pelvic node dissection and vaginal hysterectomy with anterior colporrhaphy and posterior colpoperiniorhaphy was performed each in 50% of cases. Mean duration of urinary catheter indwelling was 7.17 days for those underwent Radical hysterectomy and 5 days for vaginal hysterectomy.

Ultrasound parameters were shown in Table 2. Mean T, Dt, L, Dl were 63.49, 43.42, 64.07, 44.77 mms, respectively. Mean catheterized urine volume was 204.91 ml.

PVR was calculated using the formula described above and compare with the catheterized urine volume. The calculated PVR was significantly correlated with catheterized urine volume with correlation coefficient 0.93 ($p < 0.001$). A scatterplot between the calculated and actual urine volume is shown in Fig. 2.

Table 1. Baseline characteristics of the patients (N = 46)

Characteristics	Number (%)
Mean age ± SD (years)	55.9 ± 14.9
Diagnosis	
Procidentia uteri	11 (23.9)
Prolapsed uteri grade2	10 (21.7)
Prolapsed uteri grade3	2 (4.3)
Adenocarcinoma in situ of cervix	1 (2.2)
Cervical intraepithelial neoplasia 3 with microinvasion	1 (2.2)
Carcinoma of cervix stage 1a2	1 (2.2)
Carcinoma of cervix stage 1b1	11 (23.9)
Carcinoma of cervix stage 1b2	1 (2.2)
Carcinoma of cervix stage 1b2 status post chemotherapy	2 (4.3)
Carcinoma of cervix stage 2a status post chemotherapy	1 (2.2)
Carcinoma of cervix stage 2b status post chemotherapy	4 (8.7)
Leiomyosarcoma of endocervical mass	1 (2.2)
Surgical procedure	
- Radical hysterectomy with pelvic node dissection	23 (50)
- Vaginal hysterectomy with anterior colporhaphy and posterior colpoperiniorhaphy	23 (50)
Mean duration of indwelling urinary catheter ± SD (days)	6.1 ± 2.4
- Radical hysterectomy with pelvic node dissection	7.2 ± 2.3
- Vaginal hysterectomy	5.0 ± 2.1

Table 2. Ultrasonographic parameters and catheterized urine volume

Ultrasonographic parameters	Mean (SD)	Range
T	63.49 (20.25)	29.2-101
Dt	43.42 (19.03)	5.93-80.10
L	64.07 (25.42)	19.5-114
Dl	44.77 (22.43)	5.51-97.4
Urine catheterization	204.91 (163.24)	10-685

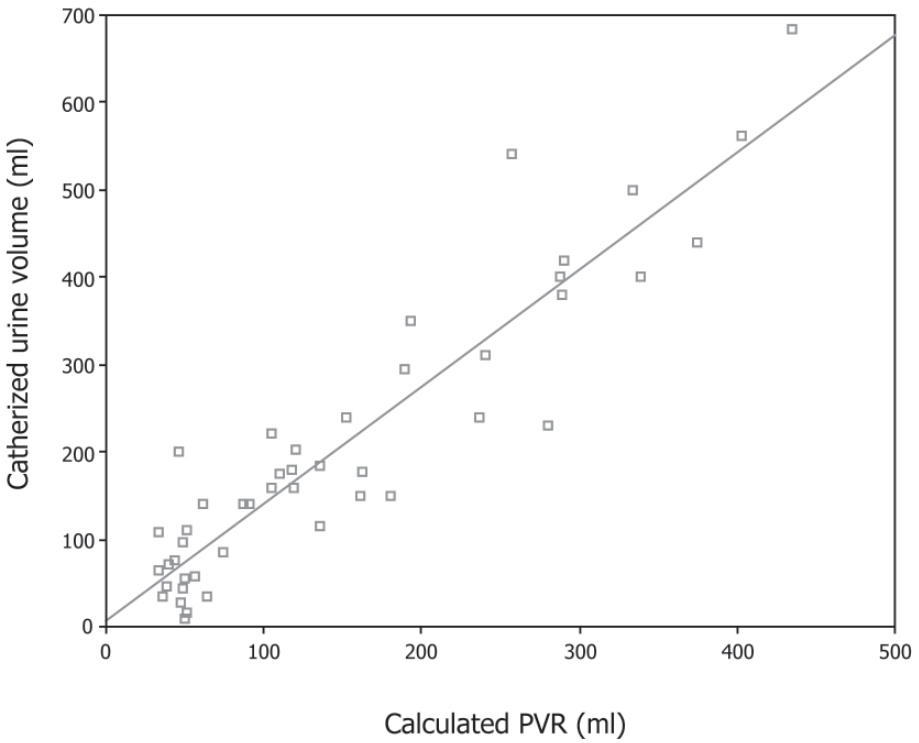

Fig. 2 Scatterplot between calculated PVR and actual catheterized urine volume (correlation coefficient = 0.93, $p < 0.001$)

Table 3 showed the use of PVR from ultrasound estimation compared with actual PVR from catheterization if the usual cutoff of PVR > 100 ml was used to determine the necessity of re-indwelling catheter. Calculated PVR from ultrasound measurement is accurate in 40 of 46 cases (87%). However, among those with calculated PVR from ultrasound measurement < 100 ml (catheter can be removed), still 30% had PVR of > 100 ml (catheter should be re-indwelled). Among those with calculated PVR from ultrasound measurement > 100 ml, all had PVR of > 100 ml.

Discussion

Radical hysterectomy and transvaginal hysterectomy are the standard operations for an early stage of carcinoma of cervix and uterine prolapse, respectively[1]. Previous study showed that, after Wertheim's hysterectomy, half of the patients had urological complications however, they were usually minor[2]. In addition, lower urinary tract dysfunction and transient neurological changes have been reported in the majority of the patients after radical hysterectomy and these changes could be recovered in 6-12 months[3,4]. Another study has shown that clinical and urodynamic effects, such as urge and stress incontinence, significantly changed in the first three months after anterior colporrhaphy and vaginal hysterectomy but showed no significant change in two year postoperatively[5].

Although urine catheterization is still a standard measurement of PVR, it causes discomfort and is an invasive procedure. Urinary catheterization was associated with bacteriuria and symptomatic urinary tract infection and the risk increases with increasing duration of catheterization[7,8]. Because of the risk of these adverse events, alternative methods for measuring residual urine volume have been inves-

Table 3. Comparison between PVR estimated by ultrasound and actual PVR

	Catheterized PVR < 100 ml	Catheterized PVR > 100ml
Ultrasound PVR < 100 ml	14 (70%)	6 (30%)
Ultrasound PVR > 100 ml	0	26 (100%)

tigated. Radionuclide technique for measuring the residual urine showed a good correlation (r = 0.98), and it is also safe and simple[9]. However, the technique is expensive, needs special equipment, and well-trained personnel that might not be available at all settings. Transvaginal ultrasonography in the assessment of bladder volumes in women has also been investigated and found that it can evaluate the wide range of bladder volumes and is more accurate than transabdominal ultrasonography[14]. However, the technique is still invasive, can cause discomfort, and needs well-trained personnel. Transabdominal ultrasonography technique might be more appropriate because it is safe, noninvasive, more cost-effective, painless, and need less expertise.

Many previous studies have also proposed different equations for PVR estimation with different correlation[10-13]. The most recent report by Amole et al. has shown that transabdominal ultrasound was useful and accurate in the assessment of postvoid residual urine volume in the patients after prostate surgery. High correlation (r = 0.98) with actual catheterization volume has been reported[15]. In this study, we used the equation proposed by Amole et al. to evaluate PVR in the patients after radical and transvaginal hysterectomy and found that there is a significant correlation between ultrasound PVR and catheterized PVR ($r = 0.93$, $p < 0.001$).

In this study, the calculated PVR from ultrasound measurement has shown to be 87% accurate, using 100 ml cutoff point. However, if calculated PVR was < 100 ml, 30% of cases actually had PVR of > 100 ml; that these patients might suffer from urinary retention and other complications if only ultrasound estimation was used. On the other hand, if calculated PVE were > 100 ml, all had actual PVR of > 100 ml. Therefore, caution should be exercised if transabdominal ultrasound estimation of PVR is implemented in the future. However, PVR estimation by ultrasound could be useful when PVR is >100 ml. This could reduce the process of repeat catheterization and give more comfort to the patients.

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การประเมินปริมาณปัสสาวะค้างภายหลังการปัสสาวะในผู้ป่วยหลังผ่าตัดมดลูกด้วยคลื่นเสียงความถี่สูงผ่านทางหน้าท้อง

ตรีภพ เลิศบรรณพงษ์, พีรพงศ์ อินทศร, ดิฐกานต์ บริบูรณ์หิรัญสาร, มนศักดิ์ ชูโชติรส, กุศล รัศมีเจริญ, บูรยา พัฒนจินดากุล

วัตถุประสงค์: *เพื่อประเมินความสัมพันธ์ของปริมาณปัสสาวะค้างภายหลังการปัสสาวะในผู้ป่วยหลังการผ่าตัดมดลูกด้วยวิธีถอนรากถอนโคนและผ่านทางช่องคลอดโดยอาศัยคลื่นเสียงความถี่สูงผ่านทางหน้าท้องเปรียบเทียบกับการสวนปัสสาวะซึ่งเป็นวิธีมาตรฐาน*

วัสดุและวิธีการ: *ทำการศึกษาแบบตัดขวางในผู้ป่วยภายหลังการผ่าตัดมดลูกด้วยวิธีถอนรากถอนโคนและผ่านทางช่องคลอดจำนวน 46 ราย ภายหลังการผ่าตัดผู้ป่วยจะได้รับการคาสายปัสสาวะไว้ระยะหนึ่ง เมื่อถอดสายปัสสาวะออกผู้ป่วยจะได้รับการตรวจคลื่นเสียงความถี่สูงผ่านทางหน้าท้องเพื่อวัดปริมาณปัสสาวะค้างภายหลังการปัสสาวะเอง 3 ครั้งที่หน่วยเวชศาสตร์มารดาและทารก หลังจากนั้นจะได้รับการสวนปัสสาวะด้วยวิธีมาตรฐานเพื่อวัดและบันทึกปริมาณปัสสาวะที่เหลือค้างจริง ค่าปริมาณปัสสาวะค้างที่คำนวณได้จากคลื่นเสียงความถี่สูงผ่านทางหน้าท้องและที่วัดได้จริงโดยวิธีมาตรฐานจะถูกนำมาเปรียบเทียบความสัมพันธ์กันด้วยวิธีทางสถิติ*

ผลการศึกษา: *ผู้ป่วยมีอายุเฉลี่ย 55.9 ปี โรคที่เข้ารับการผ่าตัดมากที่สุดได้แก่ ภาวะมดลูกหย่อนออกนอกช่องคลอดทั้งหมด (ร้อยละ 23.9), มะเร็งปากมดลูกระยะต้น (ร้อยละ 23.9) และภาวะมดลูกหย่อนระดับสอง (ร้อยละ 21.7) ตามลำดับ ผู้ป่วยที่ได้รับการผ่าตัดมดลูกโดยวิธีถอนรากถอนโคนร่วมกับการตัดเลาะต่อมน้ำเหลืองในช่องเชิงกรานและการผ่าตัดมดลูกผ่านทางช่องคลอดร่วมกับการซ่อมแซมผนังช่องคลอดมีจำนวนเท่ากันทั้งสองกลุ่ม คือกลุ่มละ 23 คน ระยะเวลาเฉลี่ยในการคาสายปัสสาวะในกลุ่มที่ได้รับการผ่าตัดมดลูกโดยวิธีถอนรากถอนโคนเท่ากับ 7.17 วัน และในกลุ่มที่ได้รับการผ่าตัดมดลูกผ่านทางช่องคลอดเท่ากับ 5 วัน พบว่าปริมาณปัสสาวะค้างที่วัดได้จากคลื่นเสียงความถี่สูงผ่านทางหน้าท้องมีความสัมพันธ์กับปริมาณปัสสาวะที่วัดได้จริงโดยวิธีมาตรฐานอย่างมีนัยสำคัญทางสถิติ โดยมีสัมประสิทธิ์ความสัมพันธ์เท่ากับ 0.93 ($p < 0.001$) ถ้าใช้เกณฑ์ปริมาณปัสสาวะค้างเท่ากับ 100 มิลลิลิตรเป็นจุดตัด ในการพิจารณาเพื่อคาสายปัสสาวะซ้ำ พบว่าหากปริมาณปัสสาวะค้างที่คำนวณได้จากคลื่นเสียงความถี่สูงมีค่าน้อยกว่า 100 มิลลิลิตร ร้อยละ 30 ของผู้ป่วยจะมีปริมาณปัสสาวะที่วัดได้จริงมากกว่า 100 มิลลิลิตร ซึ่งจำเป็นต้องได้รับการคาสายปัสสาวะซ้ำ แต่หากปริมาณปัสสาวะค้างที่คำนวณได้จากคลื่นเสียงความถี่สูงมีค่ามากกว่า 100 มิลลิลิตร ผู้ป่วยทุกรายจะมีปริมาณปัสสาวะที่วัดได้จริงมากกว่า 100 มิลลิลิตรเช่นกัน*

สรุป: *การวัดปริมาณปัสสาวะค้างด้วยคลื่นเสียงความถี่สูงผ่านทางหน้าท้องมีความสัมพันธ์กับปริมาณปัสสาวะที่วัดได้จริงโดยวิธีมาตรฐานอย่างมีนัยสำคัญทางสถิติและมีประโยชน์ในรายที่มีปริมาณปัสสาวะค้างมากกว่า 100 มิลลิลิตร โดยวิธีการนี้จะช่วยลดขั้นตอนการสวนปัสสาวะซ้ำและสร้างความสุขสบายให้กับผู้ป่วยมากกว่า*