Uroflowmetry in Normal Thai Subjects†

THITIPORN SUEBNUKANWATTANA, MSc*,
REAWIKA CHAIKOMIN, MD*,
SUCHAI SOONTRAPA, MD**
SUPATRA LOHSIRIWAT, MD*,
ANUPHANA TANTIWONGSE, MD**,

Abstract

Background and Objectives : Uroflowmetric parameters of urination may be influenced by many factors including age, sex, voiding position, technique used and also anatomical and physiological variations. A cross-sectional study was carried out to measure uroflowmetric parameters in normal Thai subjects and to compare these parameters among different ages and genders. Correlations between peak flow rate and other parameters were also studied.

Method : One hundred and forty healthy Thai subjects were studied. They were classified into two groups. Group I comprised of 50 male and 50 female young adults aged 18-30 years. Group II comprised of 20 male and 20 female pre-elderly aged 50-60 years. A Dantec Urodyn 1,000 uroflowmeter was used. The residual urine measurement was performed using an ultrasonograph.

Result : The techniques revealed the following uroflowmetric parameters. In the young adults, the mean with standard deviation of the peak flow rate was 31.2 ± 9.0 ml/sec, mean flow rate 22.6 ± 7.4 ml/sec, voiding time 24.7 ± 10.6 sec, and voided volume 376.9 ± 147.5 ml. In the pre-elderly group, the peak flow rate was 27.5 ± 9.2 ml/sec, mean flow rate 19.1 ± 6.2 ml/sec, voiding time 24.4 ± 8.5 sec, and voided volume 310.3 ± 107.8 ml. The peak flow and mean flow rates were significantly higher in the young adults ($p < 0.05$). The voided volume in the young was higher with similar voiding time. The peak flow and mean flow rates in females were significantly higher than the males (32.5 ± 10.0 *vs* 27.8 ± 8.0 ml/sec, $p < 0.05$ and 23.5 ± 8.1 *vs* 19.8 ± 5.8 ml/sec, $p < 0.05$ respectively). Voided volume and voiding time did not differ among both genders. The correlation between peak flow rate and voided volume was significant ($r = 0.382$, $p < 0.01$) indicating that the higher the voided volume the higher the peak flow rate. Residual urine was less than 50 ml in all subjects indicating that these

subjects could void completely well. This study yielded normal uroflowmetric parameters in Thai young adult and pre-elderly subjects without urological symptoms. These parameters vary with age and gender, and are useful for the investigations of bladder function in a urological clinic.

Key word : Uroflowmetry, Age, Gender

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* Department of Physiology,
** Department of Urology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.
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Lower urinary tract (LUT) obstruction and/or hypoactive bladder can be diagnosed from the patients' history, symptoms, and physical examinations. Since 1950, uroflowmetry has been another useful aid for urologists in screening for early LUT obstruction or hypoactive bladder without obstruction due to its noninvasiveness and ease of performance[1,2]. The parameters recorded during the urinary flow measurement are reported both numerically as peak flow rate, mean flow rate, voided volume and voiding time, and also graphically in the form of flow curves[3,4]. Most data were obtained from Western subjects or patients. Since these parameters might be affected by age, gender, anatomical variations, posture, hydration status and so on; uroflowmetric study in urologically asymptomatic subjects of Asian races will yield data specific to a local group of people taken care of by their local physicians.

MATERIAL AND METHOD

This study protocol was approved by the Ethics Review Committee on research involving human subjects, Faculty of Medicine Siriraj Hospital, Mahidol University. Informed consent was obtained from all subjects.

One hundred and forty healthy volunteers were included in the study. They were divided into two groups according to their age. Group I: the young adult group, aged 18-30 years, comprised of 50 males and 50 females. Group II: the pre-elderly group, aged 50-60 years, comprised of 20 males and 20 females.

All subjects were healthy without a history of urinary symptoms, prostate or bladder cancer or surgery, benign prostatic hyperplasia, urethral stricture or surgery, urinary tract stone or any operation involving the urinary system. They had no medical conditions known to affect normal voiding such as diabetes mellitus, hypertension and hyperthyroidism, and had taken no medication within one week before the uroflowmetric study.

Each subject completed a validated questionnaire to assess medical history and urinary symptoms equivalent to the American Urological Association (AUA) symptom index[5].

A uroflowmeter, Dantec Urodyn 1,000, was used. It was a rotating-disc flowmeter with an automatic start and stop system[6]. Eight parameters were electronically measured. They were the peak urine flow rate or maximal flow rate (Qmax, ml/sec), mean flow rate (QM90, ml/sec), total voiding time (T100, sec), time to maximal flow rate (Tqmax, sec), voiding time for the central 90 per cent of the voided volume (T90, sec), time of descending leg (Tdesc, sec), the maximal rate of increase of flow rate (dQ/dTmax, ml/

Table 1. Uroflow parameters in mean ± SD.

	Young adults			Pre-elderly		
	Male	Female	All	Male	Female	All
Number	50	50	100	20	20	40
Age (year)	21.8 ± 3.0	22.7 ± 3.6	22.3 ± 3.3	53.8 ± 2.7	54.2 ± 3.6	54.0 ± 3.2
Qmax (ml/sec)	29.7 ± 7.1	32.7 ± 10.5	31.2 ± 9.0	23.1 ± 8.4	32.0 ± 7.9++	27.5 ± 9.2*
Qmax - 2 SD (ml/sec)						
At vol > 150 ml	15	12	13	6	15	9
QM90 (ml/sec) •	21.4 ± 5.6	24.1 ± 8.9+	22.6 ± 7.4	16.2 ± 5.7	21.9 ± 5.5++	19.1 ± 6.2**
T100 (sec)	26.2 ± 9.3	23.2 ± 11.7	24.7 ± 10.6	24.7 ± 9.5	24.1 ± 7.5	24.4 ± 8.5
vol (ml)	403 ± 131	351 ± 159	377 ± 148	270 ± 95	351 ± 107++	310 ± 108**
RU (ml)	1.9 ± 8.1	0.8 ± 5.7	1.4 ± 7.0	0 ± 0	2.2 ± 8.4	1.1 ± 6.0

Qmax = the peak flow rate or maximal flow rate, QM90 = mean flow rate,
T100 = total voiding time, vol = the voided volume, RU = residual urine volume.
* = $p < 0.05$ comparing pre-elderly to young adults of the same sex or of both sexes.
** = $p < 0.01$ comparing pre-elderly to young adults of the same sex or of both sexes.
+ = $p < 0.05$ comparing males to females of the same age.
++ = $p < 0.01$ comparing males to females of the same age.

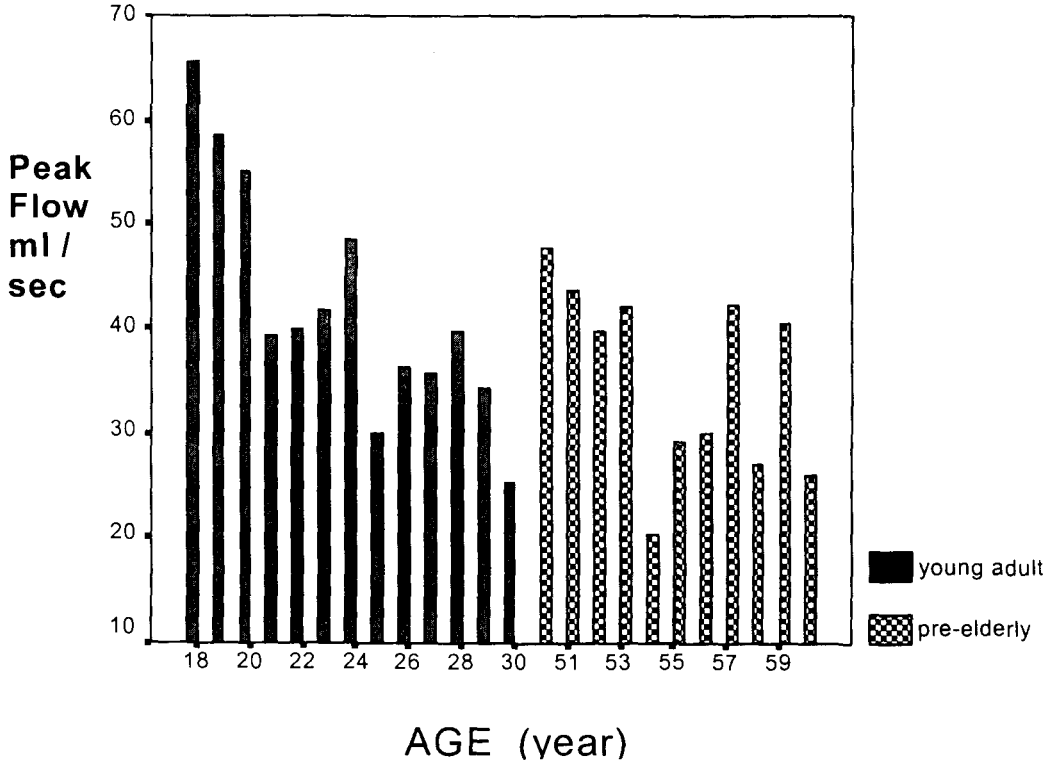

Fig. 1. Peak flow rate in subjects of different ages.

sec), and the voided volume (vol, ml). All measurements were done only when the voided volume was greater than 150 ml.

An ultrasonograph, Toshiba SSA 340 A, was used to measure the residual urine. It measured the transverse (TR), sagittal (SI) and anteroposterior (AP) diameters of the bladder and the volume would be computerized with the equation of "V = 0.7 (TR x SI x AP)"[7,8].

On the day of measurement, subjects came to the lab 3-4 hours after their last urination. They then drank a glass of water to obtain a full bladder. When they felt the urge to void, they voided into the receptacle of the uroflowmeter that would record the result of voiding in the form of graphs of uroflow with computed values of their parameters. Women subjects voided in a sitting position and the men stood. Immediately after voiding, residual urine was measured by ultrasonography.

All data were calculated by a computer with the SPSS program. Results are expressed as means plus/minus standard deviation. Statistical comparisons were run by unpaired *t*-test or Mann-Whitney U test. Pearson and Spearman coefficient were used to assess the relationship in each pair of parameter and were analyzed by linear regression. Statistical significance was assigned for p-value < 0.05.

RESULTS

The mean age of the 100 young adult subjects was 22.3 ± 3.3 years, while that of the 40 pre-elderly was 54.0 ± 3.2 years. The uroflow parameters are presented in Table 1. In the pre-elderly subjects, the peak urine flow rate or maximal flow rate, the

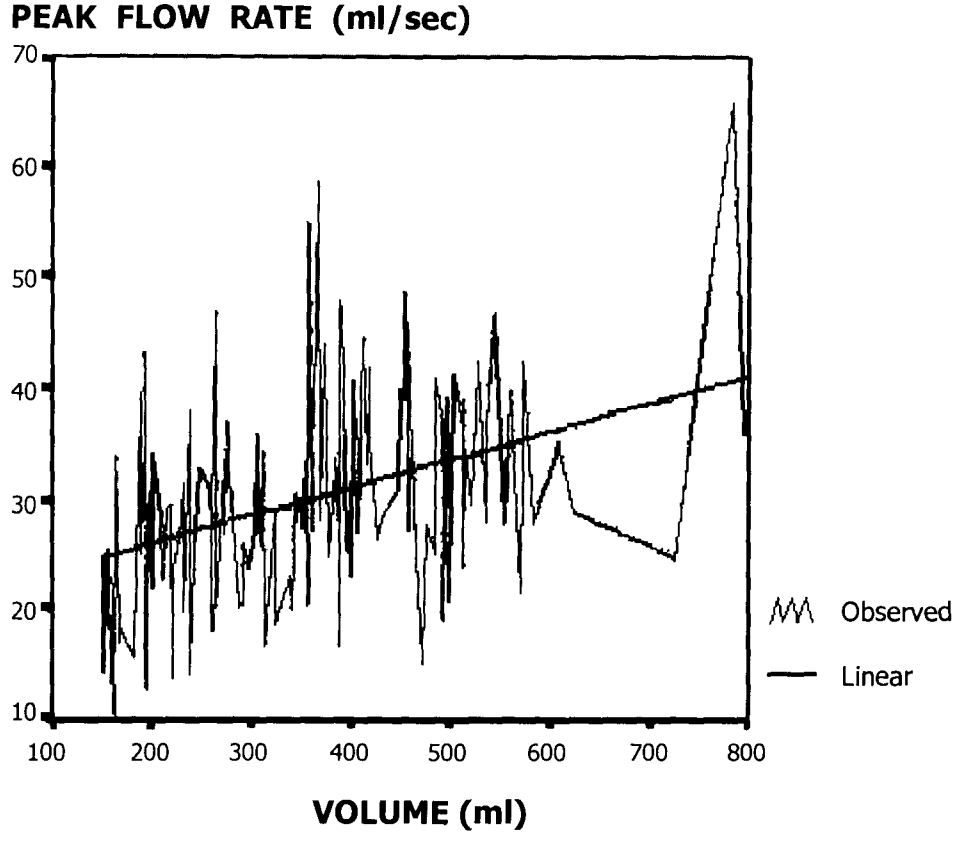

Fig. 2. The relationship between the peak flow rate and the voided volume in 140 subjects.

mean flow rate and the voided volume were significantly lower than the young. The total voiding time and residual urine volume were not different among the two age groups.

The peak flow rate and the mean flow rate were higher in females than in the males of the same age especially in the elderly. The total voiding time and residual urine volume were not different among the two genders of any age group.

The lower limit of the peak flow rate was obtained from the peak flow rate minus 2 times its standard deviation (Qmax - 2SD).

The maximal values of the peak flow rate in the younger subjects were higher than in the older subjects (Fig. 1).

The correlation between the peak flow rate and the voided volume was significant with Pearson's correlation coefficient (r) = 0.382, $p < 0.01$ (Fig. 2). The peak flow rate was higher when the voided volume was greater. The peak flow rate also correlated well with the mean flow rate ($r = 0.902$, $p < 0.01$) in the 140 subjects.

The peak flow rate was greater in female than in male subjects of the same age group especially in the pre-elderly as shown in Fig. 3.

The voiding time correlated significantly with the voided volume with $r = 0.671$, $p < 0.01$ (Fig. 4). The residual volume also correlated with the voided volume ($r = 0.999$, $p < 0.01$) in the 140 subjects.

DISCUSSION

Uroflowmetry is the measurement of urine flow rate and the uroflowmetric parameters are usually shown in either numbers or graphs. The measurements are useful in diagnosing early obstructive lesions in the lower urinary tract. The peak flow rate (Qmax) is an important component of a voiding urodynamic evaluation. In clinical practice and urological research,

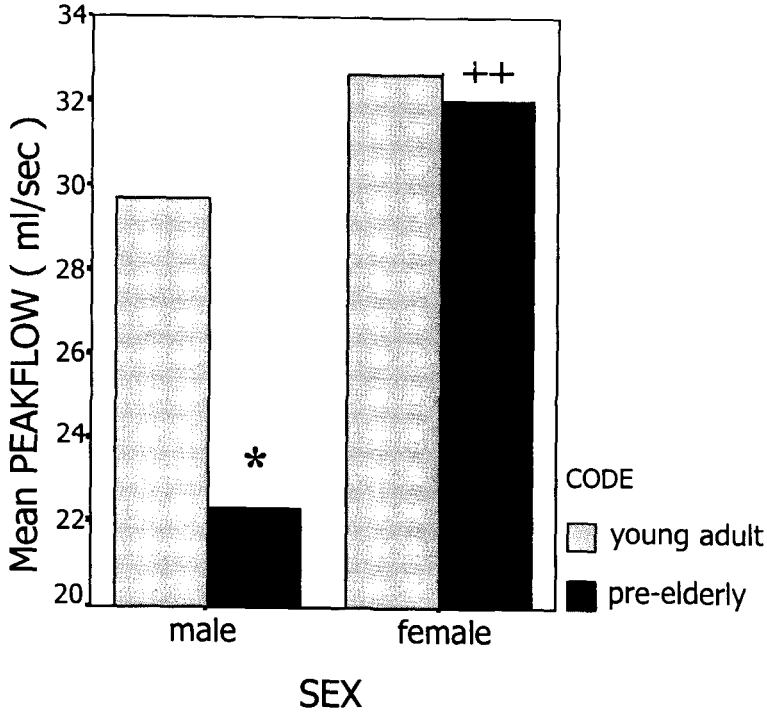

Fig. 3. The peak flow rate in male and female young and pre-elderly subjects.

++ = $p < 0.01$ comparing males to females of the same age.
*** = $p < 0.05$ comparing pre-elderly to young adults of the same sex.**

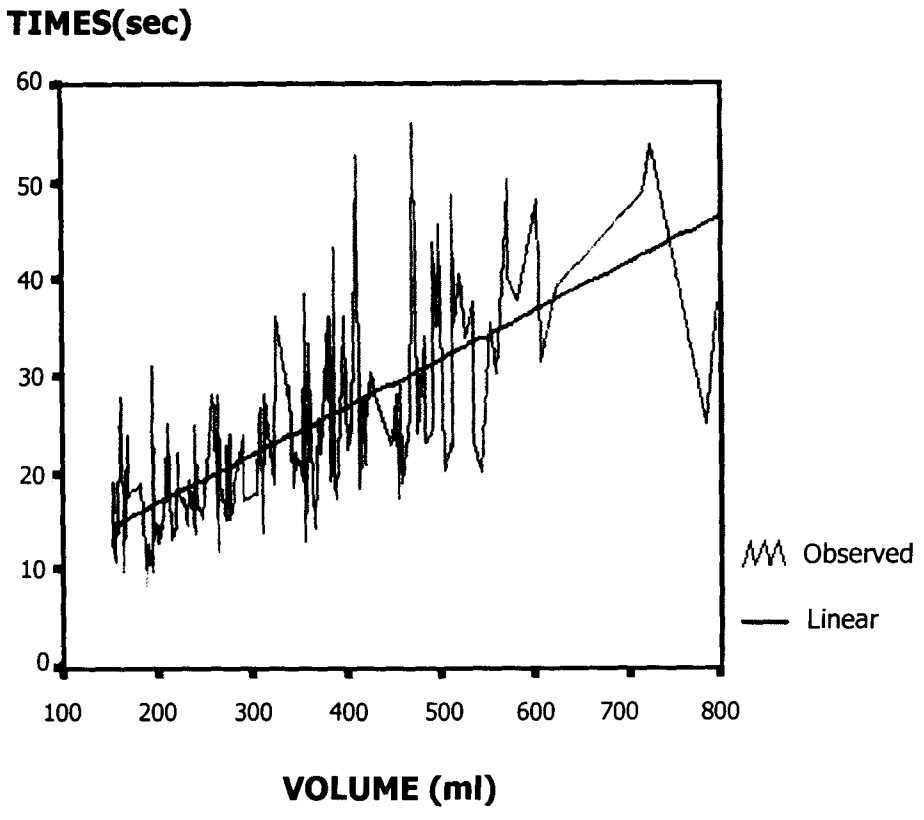

Fig. 4. The relationship between voided volume and voiding time in 140 subjects.

the use of peak flow rate is to detect lower tract obstruction, to predict treatment outcome and to assess treatment efficacy[9].

In the present study the peak flow rate was higher in the young adults than in the pre-elderly subjects. This is most probably due to changing of bladder function with advancing age. In men the urine flow rate is largely controlled by the proximal compressive zone or the membranous urethra. In elderly men, benign prostatic hypertrophy which initiates in the fourth decade of life is the most common cause of bladder outlet obstruction. While in females, the urine flow rate is largely controlled by the last centimeter of the urethra, the distal urethral segment. Estrogen deficiency after menopause can result in atrophic urethral changes. The peak flow rate is decreased due to increased resistance to flow offered by the urethra and bladder neck, more pronounced in males than in females possibly due to the prostate gland and the longer urethra in males (20 *vs* 4 cm long). A distal urethral obstruction tends to produce less decrease in flow rate than a proximal one. The peak flow rate measured in the present study is similar to those in other studies[1,3,10,11].

The peak flow rate correlated well with the voided volume. From the Frank-Starling Law, the energy of contraction is proportional to the initial length of muscle within an optimal limit.

The mean flow rate (QM90) is the voided volume between 5-95 per cent divided by the voiding time between 5-95 per cent. This study demonstrated that the mean flow rate correlated well with the peak flow rate as they were both affected mostly by the same factors. So the mean flow rate can be used to confirm and aid in a more accurate interpretation of the peak flow rate.

In 1979 Siroky et al suggested that the lower limit of the maximal flow rate (mean of Qmax minus

2 times its standard deviation) could be used as a cut-off point to diagnose lower urinary tract obstruction[12]. They also suggested that the maximal flow rate was more meaningful when changes in this flow rate were assessed after medical or surgical therapy.

Does voided volume vary with either age or gender? In the present study the young adults voided at a volume significantly higher than the pre-elderly subjects. This might be due to higher water intake in the young or compliance of the bladder might be lower in the elderly. Incontinence of urine is generally more common in the elderly. The voided volumes were not significantly different among males and females of the younger age group, but the pre-elderly males voided at a lesser volume than the female subjects.

The time elapsed during urination should be approximately less than 10 seconds for each 100 ml of voided volume or about 20-25 seconds for a voided volume of 400 ml. In cases of bladder outlet obstruction the total voiding time is prolonged. In the present study the voiding times were the same in both age groups at the minimum voided volume of 151 ml. while the mean voided volume was slightly higher in the young adults. So the younger group voided a larger volume by the same voiding time as the pre-elderly, probably indicating mild defect in urine propulsion in the latter. However, all subjects could empty their bladder so well that no abnormal residual urine was detected.

SUMMARY

The present study measured main uroflowmetric parameters in urologically asymptomatic subjects. It was found that the peak flow rate was higher in women compared to men and in young adults compared to the pre-elderly. The mean flow rate correlated well with the peak flow rate. Although it is not possible to definitely compare this data in Thai subjects with other data due to some different conditions such as age, measurement techniques, voided volume, etc., nevertheless the parameters obtained are not significantly different from those of other sources. Further study in larger numbers of subjects of various age groups may reveal different physiology of the lower urinary tract at different ages.

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การวัดอัตราการถ่ายปัสสาวะในคนไทยปกติ

ฐิติพร สืบนุการวัฒนา, วทม, สุพัตรา โล่ห์สิริวัฒน์, พบ*,*
เรวิกา ไชยโกมินทร์, พบ, อนุพันธ์ ตันติวงศ์, พบ**, สุชาย สุนทราภา, พบ***

ความเป็นมา : การวัดอัตราการถ่ายปัสสาวะเป็นวิธีหนึ่งในการประเมินการทำงานของกระเพาะปัสสาวะและระบบประสาทที่มาควบคุม ยังไม่เคยมีรายงานค่าปกติต่างๆที่เกี่ยวกับอัตราการถ่ายปัสสาวะในคนไทย

วิธีการ : ศึกษาค่าปกติที่ได้จากการตรวจวัดอัตราการถ่ายปัสสาวะในคนไทยปกติ 140 คน ใช้เครื่อง Dantec Urodyn 1,000 uroflowmeter และตรวจหาปริมาตรปัสสาวะที่เหลือค้างในกระเพาะปัสสาวะด้วยวิธี ultrasonography เปรียบเทียบค่าระหว่างกลุ่มอายุและเพศ ศึกษาความสัมพันธ์ระหว่างปริมาตรปัสสาวะ อัตราการถ่ายปัสสาวะสูงสุด และความจุของกระเพาะปัสสาวะ

ผลการศึกษา : ได้ค่าต่าง ๆ จากการวัดอัตราการถ่ายปัสสาวะดังนี้ กลุ่มหนุ่มสาวอายุ 18–30 ปี มีค่าเฉลี่ยของอัตราสูงสุดของการถ่ายปัสสาวะ (± ค่าเบี่ยงเบนมาตรฐาน) เท่ากับ 31.2 ± 9.0 มล.ต่อวินาที อัตราการถ่ายปัสสาวะเฉลี่ย 22.6 ± 7.4 มล.ต่อวินาที เวลาที่ใช้ในการถ่ายปัสสาวะ 24.7 ± 10.6 วินาที และปริมาตรปัสสาวะเท่ากับ 376.9 ± 147.5 มล ในกลุ่มวัยใกล้สูงอายุ (50–60 ปี) มีอัตราสูงสุดของการถ่ายปัสสาวะ 27.5 ± 9.2 มล.ต่อวินาที อัตราเฉลี่ยของการถ่ายปัสสาวะ 19.1 ± 6.2 มล.ต่อวินาที เวลาในการถ่ายปัสสาวะ 24.4 ± 8.5 วินาที และปริมาตรปัสสาวะ 310.3 ± 107.8 มล กลุ่มหนุ่มสาวมีอัตราสูงสุดของการถ่ายและอัตราเฉลี่ยของการถ่ายสูงกว่ากลุ่มวัยใกล้สูงอายุอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) ปริมาตรปัสสาวะของกลุ่มวัยหนุ่มสาวมีค่าสูงกว่ากลุ่มวัยใกล้สูงอายุ แต่ใช้เวลาในการปัสสาวะนานเท่า ๆ กัน เพศหญิงมีค่าอัตราสูงสุดของการถ่ายและอัตราเฉลี่ยของการถ่ายสูงกว่าเพศชายอย่างมีนัยสำคัญทางสถิติ (32.5 ± 10.0 *vs* 27.8 ± 8.0, $p < 0.05$ และ 23.5 ± 8.1 *vs* 19.8 ± 5.8, $p < 0.05$ ตามลำดับ) แต่ปริมาตรปัสสาวะและเวลาที่ใช้ในการปัสสาวะไม่มีความแตกต่างกัน อัตราสูงสุดของการถ่ายปัสสาวะและปริมาตรปัสสาวะมีความสัมพันธ์กันอย่างมีนัยสำคัญทางสถิติ ($r = 0.382$, $p < 0.01$) แสดงว่าปัสสาวะยิ่งมีปริมาณมากยิ่งถ่ายปัสสาวะออกได้เร็ว ส่วนปริมาตรปัสสาวะที่เหลือค้างในกระเพาะปัสสาวะไม่เกิน 50 มล แสดงว่าอาสาสมัครทุกคนถ่ายปัสสาวะได้อย่างมีประสิทธิภาพ

สรุป : การศึกษานี้ได้ค่าต่าง ๆ ของการวัดอัตราการถ่ายปัสสาวะในคนไทยปกติวัยหนุ่มสาวและวัยใกล้สูงอายุ ค่าเหล่านี้แปรผันตามอายุและเพศ ข้อมูลนี้อาจใช้เป็นแนวทางในการประเมินผู้ป่วยทางระบบปัสสาวะในประเทศไทยต่อไป

คำสำคัญ : การวัดอัตราการถ่ายปัสสาวะ, อายุ, เพศ

ฐิติพร สืบนุการวัฒนา, สุพัตรา โล่ห์สิริวัฒน์,
เรวิกา ไชยโกมินทร์, อนุพันธ์ ตันติวงศ์, สุชาย สุนทราภา
จดหมายเหตุทางแพทย์ ฯ 2546; 86: 353–360

* ภาควิชาสรีรวิทยา,

** ภาควิชาศัลยศาสตร์, คณะแพทยศาสตร์ศิริราชพยาบาล, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10700