Age and Volume Dependent Normal Frequency Volume Charts for Healthy Males

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Abbreviations and Acronyms

FVC = frequency-volume chart

I-PSS = International Prostate Symptom Score

LUTS = lower urinary tract symptoms

PVR = post-void residual urine

Qmax = maximum flow rate

UR = urethral resistance

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Purpose: We report age and voided volume stratified normal values for voiding diary parameters, including urine production, in a uniform, nonreferred population of 935 healthy male volunteers.

Materials and Methods: A total of 935 volunteers kept a 3-day voiding diary and also recorded the time of going to bed and getting up. Additionally, prostate volume was measured using transabdominal ultrasound and the maximum free flow rate was measured with a rotating disc flowmeter. From the diaries we calculated median voided volume and the mean number of voids during the day and night. We also calculated mean urine production in ml per hour during the day and night by assuming constant production between voids.

Results: Volunteers voided a median volume of 220 ml 6 times daily and 0.5 times nightly. They produced 83 ml urine per hour during the day and 48 ml per hour during the night. The median maximum flow rate was 16 ml per second and median prostate volume was 31 ml. All diary parameters, free flow rate and prostate volume depended significantly on International Prostate Symptom Score. However, all parameters except urine production during the day depended significantly on age and all except prostate volume depended significantly on voided volume.

Conclusions: Values in a subgroup of 788 volunteers with an International Prostate Symptom Score of 10 or less may be considered normal for male voiding diary parameters. Age and voided volume stratified normal values were also derived.

Key Words: prostate, prostatic hyperplasia, urodynamics, reference values, urination

FREQUENCY-VOLUME charts record voided volumes as well as the time of each micturition during the day and night for at least 24 hours.[1] Reference values for FVC parameters in a healthy male population may help find and detect abnormalities in patients with LUTS. Despite the frequent use of FVCs normal FVC values are sparse. van Mastrigt and Eijskoot reported an analysis of voided urine volume measured using a small electronic pocket balance.[2] More recently Parsons et al presented normative night and day bladder diary measurements in a small group of patients with mixed pathological conditions.[3]

At the department of urology outpatient clinic at our institution a noninvasive longitudinal study is being conducted to measure changes in bladder function in response to prostatic enlargement.[4–8] A rectangular, age distributed population of 1,020 healthy male volunteers participates in this study. Participants were studied 3 times in 5 years. We analyzed the FVC of 3 consecutive

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days, I-PSS, uroflowmetry and prostate size of the first study round done between November 15, 2001 and December 12, 2003 in this population. The main aim of the current analysis was to establish normal values of frequency-volume parameters and their dependence on I-PSS in this group of healthy males. These values are most likely age dependent and, therefore, they were age stratified. A possible dependence on voided volume was also studied. Daytime and nighttime urine production parameters were derived as previously reported.[2]

MATERIALS AND METHODS

Volunteers

A total of 1,020 male volunteers 38 to 77 years old were included in the longitudinal study from November 15, 2001 to December 12, 2003.[5,6,8] These males were stratified in 8 age groups at 5-year intervals. Eligible and healthy males were studied according to a protocol approved by the medical ethics committee at Erasmus Medical Center, Rotterdam. Most participants were invited by general practitioners in Schiedam, a municipality near Rotterdam. Study inclusion criteria were informed consent and the ability to void in the normal standing position with a minimum free flow rate of 5.4 ml per second. Study exclusion criteria were diabetes mellitus and certain conditions that possibly influence the micturition process, such as a suprapubic catheter, mental and/or sleeping disorders, Parkinsonism, previous surgery or medication of the cerebral nervous system, heart, kidney, bladder and/or prostate, and anticoagulant use. Dormant and/or untreated LUTS were not an exclusion criterion. Additionally, patients on anticoagulants were excluded from analysis because the noninvasive condom method for measuring bladder pressure used in the longitudinal study resulted in slight hematuria in some patients.[5]

Data Collection

All eligible volunteers were requested to complete an FVC for at least 3 consecutive days, including bedtime and awakening times during normal daily circumstances. A disposable 1 l measuring jug was used. Subsequent examination in the hospital included free uroflowmetry. Qmax was assessed with a Dantec® rotating disc flowmeter. Prostate size was measured on transabdominal ultrasound with an Aloka® SSD-1700 device. Earlier we reported that transabdominal and transrectal ultrasonography showed comparable outcomes when estimating prostate size.[9] Additionally, all men completed the I-PSS. Subsequently they underwent 2 noninvasive condom pressure measurements. These results were reported previously.[5–8]

FVC Analysis

Only correctly administered FVCs were selected for further analysis. Urine production was calculated by assuming that the bladder was always completely empty after voiding and urine production was constant between voidings. By linear interpolation of bladder volume between voids production was calculated for each of the 24 hours of each day and averaged for the number of days that FVCs were kept.[2] In this way median urine production per hour was calculated during the awake and asleep periods. Several more straightforward parameters were also calculated (table 1).

Statistics

All statistical calculations were performed using SPSS®, version 10.1. In the current analysis men were subdivided into 2 groups using an I-PSS of 10 as an arbitrary cutoff value. They were also stratified into 5-year age groups and into 5 groups with different median voided volumes. The median, and 25th and 75th percentiles were used as descriptive statistics. The Mann-Whitney U and Kruskal-Wallis tests were used to test for significant differences between 2 or more groups.

RESULTS

Of the 1,020 healthy male volunteers 935 (92%) who properly completed an FVC and an I-PSS, and successfully voided in the flowmeter were included in the current analysis. In 788 men the I-PSS was

Table 1. *Parameters in healthy male volunteers and in groups with I-PSS 10 or less and greater than 10*

	Median (25th–75th percentiles)			
	Healthy	I-PSS 10 or Less	I-PSS Greater Than 10	p Value* (Mann-Whitney U test)
No. pts	935	788	147	
I-PSS	5 (3–8)	4 (2–6)	13 (12–16)	
Age	54 (48–65)	53 (48–64)	59 (50–66)	0.001
Vol (ml)	220 (185–295)	230 (190–300)	200 (158–250)	<0.001
No. voids:				
Day	5.8 (4.8–7.0)	5.7 (4.7–7.0)	6.7 (5.7–8.2)	<0.001
Night	0.5 (0.0–1.0)	0.5 (0.0–1.0)	1.0 (0.5–1.5)	0.001
Urine production (ml/hr):				
Day	83 (60–116)	81 (59–112)	98 (71–128)	0.001
Night	48 (32–73)	47 (31–71)	53 (37–84)	0.010
Qmax (ml/sec)	15.6 (16.3–21.6)	16.1 (11.7–22.4)	12.8 (9.6–19.0)	<0.001
Prostate vol (ml)	31 (23–41)	30 (23–40)	34 (25–48)	0.006

* I-PSS 10 or less vs greater than 10.