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ACCURACY OF ULTRASOUND DETERMINATIONS OF THE BLADDER VOLUME IN THE PATIENTS WITH VOIDING DYSFUNCTION: ARE THEY ACCURATE IN ALL RANGES OF POSSIBLE VOLUME?

Aims of Study

Estimation of postvoid residual urine volume is a very useful tool in the diagnosis and management of the voiding dysfunction. Measurement by urethral catheterization can be complicated by trauma, infection and discomfort. Non-invasive ultrasonographic measurements of the bladder volume have been popularized. However, there is still no agreement on whether the ultrasound measurements are reproducible and reliable in all ranges of possible bladder volume [1]. We investigated the accuracy of both portable 3-D scanner and 2-D conventional ultrasound equipment in estimating the selected bladder volumes.

Methods

The bladder volumes in 50 patients (mean age 53.8 with a range of 17-75 years old; 16 males and 34 females) with voiding dysfunction were measured in supine position during filling cystometry (filling rate 50ml/min) by three methods (two ultrasound measurements and urethral catheterization). Multiple serial ultrasound measurements were done by two trained investigators, where each investigator measured bladder volume three times by a portable hand-held bladder scanner (BS) (BVI-3000, Diagnostic Ultrasound Co.) and three times by a conventional ultrasound (CUS) (Combison 530, Kretz Technik; volume = 0.6 x height x width x depth) when the infused volume reached 100, 200, 300, 400ml. At the end of the cystometry, bladder was catheterized to determine the final true bladder volume. Complete evacuation was confirmed by fluoroscopy. Since the actual urine volume is affected by the urine production from the kidney, true bladder volumes when the infused volume was at 100, 200, 300, 400ml during cystometry were interpolated by using the two end points of 0ml and the final catheterized volume with linearity assumption. Assuming each interpolated volume is a true bladder volume, we comptued percent difference of volume (PDV) at each infused volume and compared it with a mixed linear models (SAS, ver. 8.01), where PDV = (Sonographically measured Vol. – Interpolated Vol.) / Interpolated Vol. Clinical variables including age, sex, waist / hip ratio were analysed with regard to the determined volume.

Results

There were no significant intra-observer or intra-observer variability ($p>0.05$). There was a significant difference in the PDV between the bladder volumes measured by BS and CUS ($p<0.0001$). Bladder volume determined by CUS was significantly underestimated by a mean of 24.2% ($p<0.0001$). The volume measured by BS was also underestimated by a mean of 2.0% but the difference between the interpolated volume and volume measured by BS was not significantly different ($p=0.54$). No significantly different PDV value according to the corresponding interpolated bladder volumes were found in each method of ultrasonographic measurement ($p=0.92$) (Table). The effect of age, sex, waist / hip ratio were not significant in determining the bladder volume in two measured methods ($p>0.05$).

Table. Percent difference of volume (PDV) by two different sonographic measurements (BS, 3-D hand-held bladder scanner; CUS, 2-D conventional ultrasound)

Interpolated volume (ml, ±*S.E.*)	PDV_{BS} (±*S.E.*)	PDV_{CUS} (±*S.E.*)	p-value
120.8(±2.3) (n=50)	+ 0.01 (±0.06)	- 0.24 (±0.04)	$p < 0.001$
239.5(±5.3) (n=46)	- 0.02 (±0.04)	- 0.25 (±0.03)	$p < 0.001$
351.0(±5.0) (n=33)	- 0.08 (±0.03)	- 0.28 (±0.03)	$p < 0.001$
465.3(±7.0) (n=18)	- 0.09 (±0.03)	- 0.29 (±0.03)	$p < 0.001$
Overall	- 0.02 (±0.03)	- 0.24 (±0.03)	$p < 0.001$

Conclusions

Our results demonstrated that a 3-D hand-held scanner measures bladder volume in a reproducible and acurate manner, being superior to the 2-D stationary ultrasound. We concluded a 3-D bladder scanner is reliably applicable in determining the wide range of bladder volume.

References:

1. Arch Phy Med Rehabil 2000;81:18