

VALIDITY OF 3D ULTRASONOGRAPHY FOR MEASURING BLADDER VOLUMES

Hypothesis / aims of study

Examination of noninvasive 3D ultrasonography for measuring bladder volumes, especially in the case of lower bladder volume.

Study design, materials and methods

Using BVI6100 (BladderScan® made by DIAGNOSTIC ULTRASOUND CORPORATION), 3D ultrasonography device, we studied the bladder volume values measured of two groups: one group of patients with bladder volume under 100 ml (32 men and 24 women) and the other group of patients with bladder volume over 100 ml (18 men and 12 women).

For experimental purposes, the BVI 6100 was performed under both male mode and female mode regardless of the patient's gender, 10 readings (totally 20 readings) per patient, immediately followed by in-and-out catheterization.

The themes we studied were as follows:

- 1) Precision between bladder volume obtained by catheterization and that by BVI 6100, its difference (error) rate and Correlation (linearity).
- 2) Tendency of measured values obtained by BVI6100

Consideration of BVI 6100 usage to reduce its error in measurement compared to catheterisation.

Results

1)-a) In cases of bladder volumes lower than 100 ml, a total of 56 cases (including women) were measured in male mode on BVI 6100, and results displayed a difference of $6.6 \pm 44.2\%$ (Average \pm Standard deviation), precision 1.07 ± 0.44 . On the other hand, in cases of measurement in female mode, difference was $53.2 \pm 57.1\%$, precision 0.47 ± 0.57 compared with results in male mode. Furthermore, it appeared in 9 cases (37.5%) of 24 female cases that the scan device misidentified the uterus as the bladder. Looking at linearity, correlation coefficient for male mode is $R=0.974$ [$R^2=0.948$], $p<0.0001$, that for female mode is $R = 0.794$ [$R^2=0.631$], $p<0.0001$.

1)-b) In cases of bladder volumes over 100 ml, a total of 30 cases were measured in male mode, and showed better results than above ones, with a difference $1.1 \pm 13.1\%$, precision 1.01 ± 0.13 . In cases of those measured in female mode, difference turned out to be also significantly better $1.3 \pm 14.6\%$, precision 1.01 ± 0.15 . Correlation coefficient for male mode is $R=0.993$ [$R^2=0.986$], $p<0.0001$, female mode is $R = 0.992$ [$R^2=0.983$], $p<0.0001$.

1)-c) In the total 86 cases in male mode, it showed excellent correlation, difference $4.7 \pm 36.5\%$, precision 1.05 ± 0.37 , correlation coefficient $R = 0.990$ [$R^2=0.980$], $p<0.0001$. In cases of bladder volumes measured in female mode, difference is $34.2 \pm 53.5\%$, precision 0.66 ± 0.54 . Correlation coefficient $R = 0.959$ [$R^2=0.920$], $p<0.0001$.

2)-a) It has been observed that BVI 6100 had a tendency to compute lower value than that of catheterization in its initial measurement. Depending on cases, the difference exceeded over 20-30%, particularly in case of bladder volume lower than 100 ml.

2)-b) In the total 86 cases measured under male mode, the most accurate measurement obtained by BVI 6100 compared to measurements obtained by intermittent catheterization were obtained in 6.2 ± 3.0 attempts. Minimum measurements were obtained in 4.0 ± 2.7 attempts. Maximum measurements were obtained in 7.2 ± 2.6 attempts. Based on this fact, we found an inclination that the measurements' value decreased by repeating the measurements.

3) Regarding the technique to best perform BVI 6100 ultrasound scanning so we may minimize differences of bladder volumes measured, our findings are as follows:

- 1] Minimize both hand movement and the change of contact pressure on abdominal wall by keeping a certain angle with the scanhead.
- 2] Press scanning button at the same time when a patient is holding a deep breathe.
- 3] It is important to operate the probe at the proper contacting pressure with abdomen. In cases with bladder volumes lower than 100 ml, the value tends to be higher if the contact

pressure is too low, and if the pressure is too high, the value tends to be lower. Even with such careful skills, the value, however, will be easily affected by the patient's factors (Adhesion of surrounding tissues of bladder caused by bladder deforming, thicker bladder wall, obesity, abdominal operation, others), so it is not easy to control the variation especially in case of lower bladder volumes (less 100 ml).

Interpretation of results

This study shows much better result than generally reported in regards to BVI measurement. In order to obtain better results like this report, it is necessary to acquire the skill to minimize the human error by considering the correlation with catheterized bladder volume and familiarizing oneself with the BVI operation. Even after becoming familiarized with BVI operation, we should take the median value of several readings (5 or 6 times) due to the variation. For aged patients, we found that male mode basically can work regardless of patient's gender, without scanning under female mode. During assessment of each individual patient's condition--such as the bladder and it's surroundings--by using conventional trans-abdominal ultrasonography, and when the patient has such critical factors as aforementioned which increase the measurement value difference, the BVI should be carefully applied to monitor the bladder volume. With these patients, it is desirable that urologists should implement an initial screening as preparatory research, including checking correlation and comparison with catheterization, before deciding whether it is proper to monitor the bladder volume with BVI.

Concluding message

If we carefully select and maintain the patient cases showing good correlation with BVI, skilled doctors and paramedics will be able to obtain better data and results even in case of lower bladder volume compared with conventional bladder ultrasonography.