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# ULTRASOUND IS NOT RELIABLE FOR THE ESTABLISHMENT OF A NEW NON-INVASIVE CYSTOVOLUMETRIC DEVICE USING ELECTRICAL IMPEDANCE TOMOGRAPHY (EIT)

Hypothesis / aims of study

Although ultrasound measurement is the gold standard for non-invasive bladder volumetry in the clinic there are very limited data in the literature on the accuracy demonstrating large variabilities depending on the user. Therefore the development of new devices for exact and reproducible cystovolumetry, which also could have the potential to be used by the patient himself, is a high aim for the medical engineering. A promising possibility for the determination of the bladder capacity of patients with bladder function disorders is the continuous, non-invasive cystovolumetry via transcoutaneous electrical impedance tomography (EIT). In experiments on animals as well as humans a linear correlation between the changing of impedance and changing of bladder volume could be shown. [1][2]

Study design, materials and methods

The study included eight healthy test persons, four women and four men, with a mean age of 30 ± 2. ECG-electrodes were fixed on the lower abdomen in different patterns for the EIT measurements. At the time point of urgency (BCmax) the test persons underwent ultrasonic investigation (Voluson 730) and bladder scan (CUBEscan Biocon 500) by a professional clinician. Bladder volumetry was calculated by the implemented software formulas ellipsoid (Method I) and length x width x height x 0.62 (Method II). The probands could then empty their bladder in the EIT measurement setup. Validation of the micturition volume was carried out by collection of the voided urine in a measuring pitcher on an electrical scale. Immediately after voiding the determination of residual urine (RU) was performed via ultrasound, bladder scan and collection in the pitcher without EIT measurement. BCmax volume was calculated as micturition volume at the point of urgency plus residual urine and was set 100% for comparison to the volumetric measurements. The RU volume determined by ultrasound and bladder scan too was then compared to the pitcher volume.

Results

In the men´s group BCmax had a mean value of 694.8 ± 216.3 ml and RU of 154.5 ± 98.3 ml. In the women´s group the mean value of BCmax was 671.7 ± 203.0 ml and 161.1 ± 91.3 ml for the RU with no significant gender differences. Results of the electric scale given in grams were converted into a volume by using a conversion factor from the literature which is 1.02 g/ml [3]. Multiplication of the flow data to this factor had a very good correlation of 0.989 ± 0.013 to the pitcher volume.
As can be seen in Fig. 1 BCmax and RU calculated by the ultrasound devices was always lower than the actual volume of BCmax or RU. BCmax correlated only in 68%, 65% and 49% for MII, MI and bladder scan and RU in 56%, 46% and 53% for bladder scan, MI and MII.

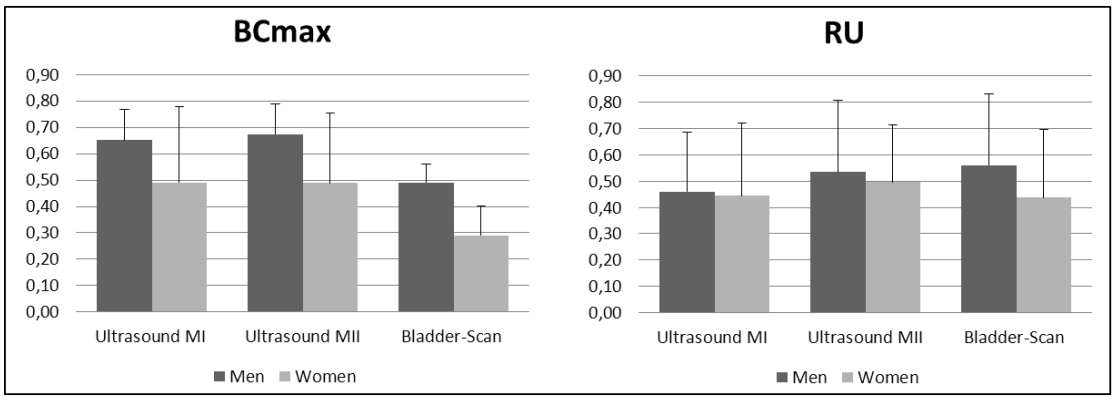


Fig. 1: Dependability of ultrasound method MI, MII and bladder scan for BCmax and RU in the women´s and the men´s group. The actual bladder volume (BCmax or RU) was set 1.0.

Interpretation of results

The ultrasound results – independent from the system and method applied - show a big offset to the actual BCmax respectively RU. Both ultrasound methods had a better correlation for the BCmax volume than the bladder scan. For RU volume the bladder scan was the superior method compared to both ultrasound methods. Although not significant, the correlation to the actual bladder

volume in the women´s group was always worse than compared to the men´s group. This may be due to the influence of the uterus.

Concluding message

The usage of ultrasound as a method of reference for the development of new bladder volume measurement devices has to be seen critically as the correlation to large volumes like BCmax and low volumes like RU shows with an accuracy of 0.62 for BK max and 0.52 for RU a big and inacceptable offset. For our study of EIT bladder volumetry we have to use the measuring pitcher volume, respectively the data from the electric scale to correlate them to our impedance signals.

References


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Disclosures


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