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SHORT REPORTS

Evaluation of Body Composition and Fluid Volume Using a Body Composition Monitor: Does Intraperitoneal Fluid Matter?

Fluid overload is a common finding in patients on peritoneal dialysis (PD) and this condition has been linked to adverse cardiovascular effects and increased mortality (1). The variation of body weight and blood pressure, usually used for clinical evaluation of volume, may not be sufficient for the adjustment of volemia; therefore, regular and precise measurement of hydration and body composition is needed (2). It is believed that volume control in PD patients is harder to achieve compared to hemodialysis patients, as they receive home treatment with monthly monitoring only, and have greater autonomy in their care (3).

Bioimpedance spectroscopy (BIS) is a tool for detecting longitudinal changes in the hydration status of this population. The body composition monitor (BCM) (Fresenius Medical Care, Germany) is a validated and non-invasive method that combines BIS with a physiological tissue model developed for dialysis patients (4). Describing the body composition and hydration profile of PD patients is essential for clinical evaluation; however, the possible interference of dialysate in the intraperitoneal cavity on BCM results is an underexplored question in the literature. Therefore, the aim of this study was to compare body composition and volume variables with the dialysis fluid in the peritoneal cavity and also after its drainage, using BCM methodology.

PATIENTS AND METHODS

A cross-sectional study, approved by the Research Ethics Committee of the Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), enrolled 32 adult patients (>18 years old) on PD for at least 30 days, at the Renal Unit of São Lucas Hospital-PUCRS, Porto Alegre, Brazil. Exclusion criteria: clinical instability, current systemic infection, peritonitis in the last 30 days, active disease diagnosed or acute clinical complication requiring hospitalization; patients with a contraindication for the performance of BIS.

Analysis of body composition and fluid status was carried out using BIS (BCM), which measures the flow of electrical current through the body, resistance and reactance at 50 different frequencies, sampled between 5 kHz and 1 MHz. This provides volume and corporal composition data. Assessments were performed twice, first with the presence of dialysate in the peritoneal cavity – full cavity (FC) – and again after drainage – empty cavity (EC). Dialysate bags were weighed before and after infusion so that the infused volume in the abdominal cavity could be discounted and the scales calibrated, as necessary.

Evaluation of normality and variability was performed using the Kolmogorov-Smirnov test. Comparisons between FC and EC from the same patient were carried out using a paired Student *t*-test or Wilcoxon Signed-Rank test. Correlations were made using Pearson's correlation test. A Bland-Altman plot was used to illustrate the agreement between overhydration (OH) with FC and EC. The level of statistical significance adopted was $p < 0.05$, using the software Statistical Package for the Social Sciences (SPSS), version 20.0 for Windows (Chicago, IL, USA).

RESULTS

Thirty-two patients (20 women and 12 men/mean age 48.9 ± 15 years) on PD (75% continuous ambulatory PD and 25% automated PD) were enrolled. The median time on PD was 15.6 months (range 8.3 – 34.1 months) and population ethnicity was predominantly Caucasian (68.8%). The mean systolic and diastolic blood pressures were 139.7 ± 27.8 mmHg and 83.1 ± 17.8 mmHg, respectively. Among the patients, 24.2% were diabetic and 87.9% hypertensive.

Table 1 shows the comparisons between volume variables of patients with an FC and EC. The data disclosed no statistical difference, except in relation to body weight. In addition, a strong correlation was present between all variables with an FC or EC (Pearson's correlation test, $p < 0.001$). The value for degree of OH was $r = 0.989$ ($p < 0.001$). The determination coefficient ($R^2 = 0.979$) indicates that 97.7% of the OH status variability with an FC is explained by the variability with EC. Agreement between OH with full and EC is illustrated with the Bland-Altman plot (Figure 1).

TABLE 1
Volume Status Assessment by BCM with Full and Empty Cavity

	FC	EC	*p*
Weight (kg)	74.1±14.0	72.6±14.1	<0.001
Overhydration (L)	1.3±2.1	1.3±2.0	0.954
TBW (L)	31.0±5.3	30.7±5.5	0.700
TBW (L)/Weight (kg)	41.1±9.7	43.3±6.8	0.092
EW (L)	15.4±2.9	15.2±3.0	0.332
EW (L)/Weight (kg)	21.4±2.9	21.3±2.8	0.438
EW (L)/TBW (L)	49.9±4.5	49.6±4.7	0.809
OH (L)/EW (%)	0.16 (0.12–0.19)	0.15 (0.12–0.17)	0.163
EW (L)/Height (m)	9.5 ±1.6	9.4±1.7	0.304
IW (L)	15.6±3.1	15.5±3.3	0.608
EW (L)/IW (L)	1.0±0.18	1.0±0.19	0.764

FC = full cavity; EC = empty cavity; TBW = total body water; EW = extracellular water; OH = overhydration; IW = intracellular water.
Data presented as mean ± SD and compared by paired *t*-test or median (25th, 75th percentile) and compared by Wilcoxon Signed-Rank Test.

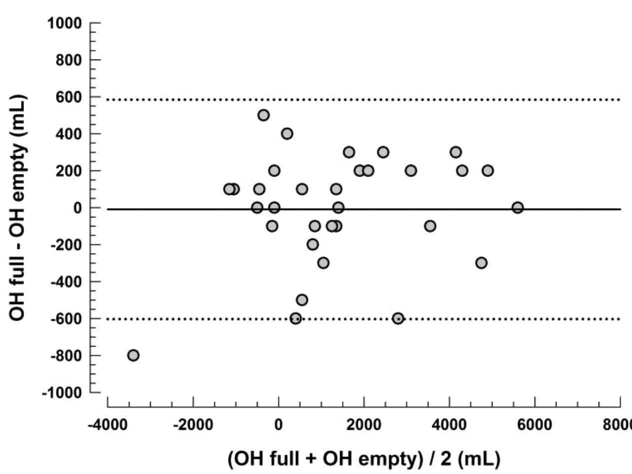

Figure 1 — Bland Altmann plot : OH full and OH empty showing line of bias (-9 mL) and 95% limits of agreement (-603 to 585 mL). OH = overhydration.

No statistical difference was present for the assessment of body composition between the two states (FC and EC), as shown in Table 2, suggesting that the evaluation of both fluid volume and body composition by BCM does not suffer interference from the peritoneal dialysis solution.

DISCUSSION AND CONCLUSION

Maintaining an adequate fluid volume is one of the functions of the kidney. Therefore, ensuring adequate fluid removal is one of the main focuses of PD (1). Hypervolemia is not always accompanied by classic symptoms in PD patients. Thus, it is necessary to use a method of body composition evaluation to give an assessment of volume status.

The effect of the presence of intraperitoneal dialysate during this type of assessment is still a matter of discussion. Some studies have evaluated PD patients using BIS whilst having an FC, or not differentiated between the presence or absence of dialysate solution, increasing the practicality of the assessment (5). According to Kusher *et al.,* because the trunk accounts for just 10% of whole body impedance with the distal tetrapolar technique, any impedance changes restricted to this part of the body have minimal impact on the results (6). Other methods have been used after fluid drainage and, according to Sipahi *et al.,* it is only in this way that it relates with echocardiographic findings (7).

Previous studies have indicated that the presence of intraperitoneal fluid is insignificant when assessing volume status by whole body bioimpedance (8), in agreement with our findings. Nevertheless, some differences have been noted when performing segmental evaluation, in which the trunk and limbs can be assessed separately. Alteration of resistance and reactance values were observed, overestimating body composition, including muscle mass, and making the measurements of body water higher (9). When analyzed separately, the alterations are related to the trunk of the patients.

TABLE 2
Body Composition Assessment by BCM with Full and Empty Cavity

	FC	EC	*p*
Normally hydrated weight by BCM (kg)	70.7±14.5	70.7±14.4	0.739
Body mass index by normally hydrated weight (kg/m²)	27.1±5.5	27.1±5.4	0.707
Lean tissue mass (kg)	28.8±8.2	28.7±8.7	0.639
Fat tissue mass (kg)	31.5±11.9	30.9±12.0	0.167
Lean tissue mass (%)	40.1±13.8	41.2±12.0	0.567
Fat tissue mass (%)	42.4±10.0	41.9±10.4	0.179
Lean body mass index (kg/m²)	11.0±2.9	11.0±3.0	0.544
Total body fat index (kg/m²)	16.5±6.3	16.2±6.4	0.146
Adipose tissue mass (kg)	42.9±16.0	40.4±17.0	0.215
Body cell mass (kg)	14.8±5.6	14.5±5.9	0.451

FC = full cavity; EC = empty cavity.
Data presented as mean ± SD and compared by paired *t*-test.

However, just how much the inclusion of fluid interferes in body composition analysis via BCM – whole body BIS – has still not been reported in the literature. In our study, the variables that determine body composition showed no difference between the two measurements. This finding demonstrates that BCM could be applied without the need for drainage of the dialysis fluid from the abdominal cavity of PD patients. Malnutrition, or purely loss of lean body mass and increased fat mass, is associated with complications and poor prognosis in this population. The routine use of this technology in clinical practice, therefore, is relevant in determining hydration conditions and evaluating nutritional status, as well as for monitoring variations.

DISCLOSURES

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