Original Article

The influence of low dialysate sodium and glucose concentration on volume distributions in body compartments after haemodialysis: a bioimpedance analysis study

Savas Ozturk1, Dilek Guven Taymez1, Gulistan Bahat2, Reyhan Demirel3, Halil Yazici1, Nilgun Aysuna1, Sule Sakar4 and Alaattin Yildiz1

1Division of Nephrology, 2Department of Internal Medicine, 3Hemodialysis Unit and 4Diet Unit, Department of Internal Medicine, Istanbul Medical Faculty, Istanbul University, Istanbul, Turkey

Abstract

Background. Despite the developments in haemodialysis, there are still some difficulties in maintaining the haemodynamic stability. Bioimpedance analysis (BIA) has been proposed for the estimation of dry weight in haemodialysis patients. We aimed to investigate the effects of dialysate sodium and glucose contents on volume distribution in body compartments after haemodialysis by using BIA, a sensitive and reliable method.

Methods. Seventeen chronic haemodialysis patients [11 males, 6 females, mean age: 36.9 (18–64) years] were included in the study. Patients were evaluated in three periods. The patients (period 1-P1) underwent haemodialysis with dialysate of 200 mg/dL glucose and 140 mmol/dL sodium for 4.5 h in the middle session of the first week. At the beginning and the end of the session, haematocrit, vital parameters (blood pressure, pulse), ultrafiltrated volume, plasma osmolarity and plasma renin activity were recorded. Also multi-frequency bioelectric impedance analyses (Bodystat® Quadscan 4000) were applied to all patients at 5, 50, 100 and 200 kHz, including the impedance index (Z200/Z5). In the second midweek session the same procedure was repeated with same glucose concentration and 135 mmol/dL sodium including dialysate (period 2-P2), and in the third week, it was performed with a dialysate that included 140 mmol/dL sodium and no glucose (period 3-P3).

Results. The change of the ratio of the intracellular volume to total body weight (ICV/TBW) at the beginning and the end of the session was same in all periods. However, there were significant differences in the change (after/before session) ratio for the extracellular volume/total body weight (ECV/TBW) in P2 compared to other periods (P1–P2: < 0.001 and P2–P3: 0.007). Likewise, the same was observed in the changes of impedance (P values for P1–P2: 0.08, P1–P3: 0.44 and P2–P3: 0.063). There was a significant increase of hypotensive events in P2 against the other periods (P = 0.001).

Conclusion. Decreasing dialysate sodium concentration results in important haemodynamic changes but the lack of glucose in dialysate does not result in any changes in haemodynamic and inflammatory parameters. The changes in bioimpedance parameters are parallel to haemodynamic changes in the haemodialysis patients.

Keywords: bioimpedance analysis; dialysate glucose; dialysate sodium; haemodialysis; intradialytic hypotension

Introduction

Despite the developments in the dialysis technique, there are still some difficulties in maintaining the haemodynamic stability during a haemodialysis session. Dialysis-induced hypotension may occur in 30% of haemodialysis patients [1]. Sodium and glucose are the major osmotic active components of both the blood and the dialysate. Besides sudden volume removal by ultrafiltration during dialysis, a decrease in plasma osmolarity also contributes to the development of dialysis-induced hypotension. Therefore, high dialysate sodium, individualized dialysate sodium prescription or dialysate sodium modelling, which was based on a quick decrease in sodium concentration during the dialysis session, have been used to prevent this frequent complication [2–7]. Dialysates with different glucose concentrations (or dialysate without containing glucose) are used in routine haemodialysis clinical practice. Although there are some reports regarding the metabolic effect of dialysate glucose [8,9], there is no study assessing its effect on transcompartmental movement of fluids. Bioimpedance analysis (BIA) has been proposed for determining the distribution of volume in the body compartments and estimation of dry weight in haemodialysis patients [10–17]. BIA may estimate extracellular and total body water, and indirectly the intracellular
body water [18]. Impedance is the resistance to the flow of the current in a body. Hence if the resistance increases, the measured impedance value will be higher. At the low frequency of 5 kHz, the impedance will be high since the given current cannot penetrate the cell membrane and it will represent only the extracellular space. On the other hand, if the given current is of as high a frequency as 200 kHz, the current is adequate to penetrate the cell membrane. In this case, the measured impedance will be lower and will measure both the inside and outside of the cells. So it will measure the total body water.

In this study, we aimed to investigate the effects of dialysate sodium and glucose contents on volume distribution in body compartments after haemodialysis by using a sensitive and reliable method, BIA.

Subjects and methods

In this prospective and cross-over study, we included 17 chronic haemodialysis patients (11 males, 6 females, with mean age: 36.9 years, range: 18–64 years). They had been receiving dialysis in our outpatient clinic for >6 months. The mean time for dialysis was 9.3 ± 9 years. All patients were on three times weekly standard haemodialysis programme and had no residual renal function (daily urine output <100 mL). The causes of end-stage renal disease were primary glomerular disease (10 patients), tubulointerstitial nephritis (4 patients) and others (3 patients). None of the patients was diabetic. Patients with heart failure, substantial oedema, uncontrolled hypertension, hypoalbuminaemia (serum albumin level <3.5 g/dL) or ascites due to chronic liver disease were excluded.

Patients were evaluated in three periods. Each study period was executed in the middle session of that week. In other sessions (first and last dialysis sessions of the same week), dialyses were performed with non-glucose-containing dialysate, which contains Na: 140 mmol/L, K: 1 mmol/L, Ca: 1.5 mmol/L, HCO₃: 35 mmol/L. In different three periods, the contents of dialysate were as follows:

- **Period 1**: dialysate contains glucose (200 mg/dL) and normal sodium (140 mmol/L)
- **Period 2**: dialysate contains glucose (200 mg/dL) and low sodium (135 mmol/L).
- **Period 3**: dialysate contains no glucose and normal sodium (140 mmol/L)

No change in drug medications was made during the study period. All blood samples were taken under the fasting condition. Haemodialysis was applied to all patients with standard bicarbonate dialysate for 4.5 h (blood flow rate: 300–350 mL/min, dialysate flow rate: 500 mL/min, membrane: Polysulfone Fx8, Fresenius Medical Care, Germany). Throughout the dialysis, blood pressure and heart rate were monitored with 30-min intervals and ultrafiltration performed during dialysis was recorded. Intradialytic hypotension was defined as systolic blood pressure <100 mmHg with symptoms (nausea, vomiting, dizziness, sweating and muscle cramps).

Blood samples for measurements of serum glucose, sodium, cortisol, CRP levels, complete blood count, plasma osmolarity, and plasma renin and aldosterone activity were obtained both before and after dialysis. The symptoms developing during haemodialysis session such as dizziness, nausea, dyspnea, abdominal pain and cramps were recorded, and medical interventions were performed appropriately. All procedures were performed by trained dialysis nurses and were recorded to study follow-up forms.

The informed consents were taken and behaved according to Helsinki Declaration during the study.

**BIA analysis**

The multi-frequency bioelectric impedance analyses (Bodystat® Quadsan 4000) were applied to all the patients at 5, 50, 100 and 200 kHz, including the impedance index (Z200/Z5). Each measurement was carried out 15 min before and after the dialysis session by keeping all patients lying down during the measurement. The each BIA values (as litre) of ICV (intracellular volume) and ECV (extracellular volume) and ratio of ICV and ECV to total body weight (TBW) were recorded.

**Statistics**

The statistical analysis was carried out with Statistical Package for Social Sciences for Windows version 10.0 (SPSS Inc., Chicago, IL, USA). Numerical variables were given as mean ± standard deviation. Two groups were compared with paired Student’s t-test or Mann–Whitney U-tests when necessary. The chi-square test with Yates correction and Fisher’s exact test were used for 2 × 2 contingency tables when appropriate for non-numerical data. Correlations between numerical parameters were analysed with Spearman’s rho correlation test. Groups were compared with Student’s t-test or analysis of variance (ANOVA) as necessary. Comparisons in more than two groups were made by Kruskal Wallis-H analysis of variance when the distribution was abnormal. Tukey HSD was used for post hoc comparisons. P values <0.05 were accepted as significant.

**Results**

Demographic features and baseline biochemical parameters of the study group are given in Table 1. The mean ultrafiltration volume of all study periods were similar among the study periods (2561 ± 1078 mL for period 1, 2572 ± 1089 mL for period 2 and 2633 ± 952 mL for period 3, P > 0.05). Symptomatic hypotension, cramp and saline infusion rates of Period 2 were more prominent (Table 2 and Figure 1). Values of intracellular water, extracellular water, total body water volume, total body weight and impedance index obtained during the study are presented in Table 3. The results of the laboratory parameters (biochemical and hormonal analyses) during the study periods are given in Table 4.

Although values of ICV and TBW did not show significant changes between periods during the study, the changes in ECV, total body water volume (TBW) and impedance
index between period 1–period 2 and period 2–period 3 were significant (Table 3). The results of the volume estimations of BIA were also presented as change in the volume ratios. The lessening ratio of intracellular volume to total body weight (ICV/TBW), before and after dialysis, was very similar between all periods (Figure 2). On the other hand, the ratio of change in extracellular volume to change in body weight (ECV/TBW), before and after dialysis, in period 2 was much less compared to that in periods 1 and 3 (Figure 2). The same changes were found in the ratio of the impedance index (before/after dialysis) as well, but were not statistically significant (period 1: 0.951, period 2: 0.943, period 3: 0.960; P values: period 1–period 2: 0.08, period 1–period 3: 0.44, period 2–period 3: 0.063) (Figure 2). In addition, in periods 1 and 2, the level of serum sodium showed a statistical significant decrease at the end of the dialysis compared to entering. Nevertheless, in period 3 this drop was unimportant (serum sodium levels, before/after dialysis: period 1; 139.7 ± 2.8/135.8 ± 2.88, period 2; 140.3 ± 1.8/134.4 ± 1.7, period 3; 139.7 ± 2/138.7 ± 2.2) (Figure 2). Furthermore, comparing the periods in terms of the ratio of changes in serum sodium (before/after dialysis), the following values were found: period 1–period 2: P = 0.066, period 1–period 3: P = 0.762, period 2–period 3: P = 0.23. Serum osmolality, before and after dialysis, was checked. The before/after dialysis ratio of these values is shown in Table 4. The change of osmolality in period 2 was more prominent than period 3 (P = 0.010) and the change of cortisol in period 2 was prominent than period 1 (P = 0.011).

**Discussion**

In this study, we observed a significant decrease in ECV in the low dialysate sodium group, which is consistent with clinical findings of hypotension. However, there were no significant changes in ECV in the low dialysate glucose group albeit via measurement with BIA.

On the other hand, no change in ICV was found in the whole study periods (Table 3 and Figure 2). The study was performed in three periods. As shown in Table 2, ultrafiltration amounts were almost same in all periods. Nevertheless, in period 2, symptomatic intradialytic hypotension, need of saline infusion and muscle cramps were significantly higher than the other periods (Table 2 and Figure 1). In addition, the serum sodium concentration, which is the essential solute showing the tonicity of extracellular fluid, decreased more in period 2 (low sodium including dialysate period) at the end of the session (Table 4 and Figure 2). As a matter of fact, the changes of before/after dialysis volume for ICV were similar in all periods; ECV was measured clearly lower after dialysis in

---

**Table 1.** Patients’ baseline demographic and biochemical parameters

<table>
<thead>
<tr>
<th>Number</th>
<th>Age (year)</th>
<th>Gender (male/female)</th>
<th>Duration of HD (year)</th>
<th>Weight (kg)</th>
<th>BMI (kg/m²)</th>
<th>URR (%)</th>
<th>Mean Kt/V urea</th>
<th>Glucose (mg/dL)</th>
<th>Na (mmol/L)</th>
<th>K (mmol/L)</th>
<th>BUN (mg/dL)</th>
<th>Creatinine (mg/dL)</th>
<th>Systolic BP (mmHg)</th>
<th>Diastolic BP (mmHg)</th>
<th>Pulse (per min)</th>
<th>Haemotocrit (%)</th>
<th>Primary renal disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>36.9 ± 12.3</td>
<td>11/6</td>
<td>9.3 ± 9</td>
<td>63.1 ± 14.7</td>
<td>21.2 ± 3.7</td>
<td>72.4 ± 6</td>
<td>1.57 ± 0.32</td>
<td>78.8 ± 7</td>
<td>138.6 ± 2.6</td>
<td>4.8 ± 0.6</td>
<td>55.4 ± 10.4</td>
<td>6.8 ± 2.4</td>
<td>128 ± 18</td>
<td>74 ± 15</td>
<td>76 ± 12</td>
<td>35.4 ± 5.2</td>
<td>GN (10), TIN (4), Other (3)</td>
</tr>
</tbody>
</table>

HD: haemodialysis; BMI: body mass index; URR: urea reduction rate; BP: blood pressure; GN: glomerulonephritis; TIN: tubulointerstitial nephritis.

**Table 2.** The haemodynamic changes seen in this study

<table>
<thead>
<tr>
<th></th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 3</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP (mmHg)</td>
<td>Before dialysis 128 ± 18</td>
<td>123 ± 17</td>
<td>122 ± 18</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>After dialysis 119 ± 23</td>
<td>121 ± 22</td>
<td>120 ± 20</td>
<td>NS</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>Before dialysis 74 ± 15</td>
<td>71 ± 13</td>
<td>65 ± 17</td>
<td>0.013a</td>
</tr>
<tr>
<td></td>
<td>After dialysis 61 ± 15</td>
<td>58 ± 17</td>
<td>70 ± 15</td>
<td>NS</td>
</tr>
<tr>
<td>Pulse rate (/min)</td>
<td>Before dialysis 76 ± 12</td>
<td>76 ± 11</td>
<td>76 ± 13</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>After dialysis 75 ± 15</td>
<td>79 ± 10</td>
<td>76 ± 17</td>
<td>NS</td>
</tr>
<tr>
<td>Kt/V</td>
<td>Before dialysis 1.57 ± 0.32</td>
<td>1.52 ± 0.41</td>
<td>1.54 ± 0.37</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>After dialysis 2561 ± 1078</td>
<td>2572 ± 1089</td>
<td>2633 ± 952</td>
<td>NS</td>
</tr>
<tr>
<td>Ultrafiltration (mL)</td>
<td>Before dialysis 17</td>
<td>55</td>
<td>13</td>
<td>0.038b, 0.013c</td>
</tr>
<tr>
<td></td>
<td>After dialysis 11</td>
<td>63</td>
<td>29</td>
<td>0.016b</td>
</tr>
</tbody>
</table>

aPeriod 1–Period 3; bPeriod 1–Period 2; cPeriod 2–Period 3. NS: not significant.
was the only portion of body composition that decreased
dialysis complications still had excessive ECV% and ECV.
Furthermore, some hypertensive patients with symptoms of
hypertension, but none of the normotensive patients had ECV excess.
patients with excessive ECV% had hypertension, but fluid changes, Chen all of body fluid [19].
ultrafiltration to pull out from ECV most likely, instead of
increases, fluid in this area moves to intracellular area which
period 2 (Table 3 and Figure 2). This is an expected finding;
while extracellular (it means intravascular) sodium decreases,
fluid in this area moves to intracellular area which remains relatively hypertonic, and thus it probably caused ultrafiltration to pull out from ECV most likely, instead of all of body fluid [19].
In a study, in which BIA was used for showing body fluid changes, Chen et al. [17] demonstrated that all patients with excessive ECV% had hypertension, but none of the normotensive patients had ECV excess. Furthermore, some hypertensive patients with symptoms of dialysis complications still had excessive ECV% and ECV was the only portion of body composition that decreased (P < 0.001) after decreasing dry weight, without changes in ICC/TBW. But they did not use low dialysate sodium. In our study, the percent decrease in the ECV/TBW ratio after the haemodialysis session was significantly higher in the period with low sodium (period 2) compared to other periods with 140 mmol/L dialysate sodium (P values: period 1–2: <0.001; period 1–3: 0.73; period 2–3: 0.007). Despite this, changes in the ICC/TBW ratio have not shown considerable differences in any periods (P values: period 1–2: 0.18, period 1–3: 0.37, period 2–3: 0.37) (Table 3 and Figure 2). At this point, the question is why the ratio ICC/TBW did not increase considerably in period 2 in which hypoosmolar dialysates were applied. Because ICC is much higher than intravascular volume, the amount of volume shifting from compartments might be just enough to make considerable changes in ICC, but not for ICC. It might be, also, caused by low number of the patients to reach the statistical significance. The decrease in ICC with the use of a dialysis solution with low sodium content has been shown with BIA first time in the present study.
In addition to sodium, another major factor for the toxicity of body fluid is glucose. In our study, in period 3, there was no glucose in the dialysate. Mean serum glucose concentration after dialysis in period 3 was lower than in period 1, which contains the same level of Na but also 200 mg/dL glucose (P = 0.023). However, it was shown that there were no haemodynamically important changes in blood pressure, incidence of cramps and the BIA measurement (ICC, ECV, impedance index) among these periods (Table 2 and 3, and Figure 1). There was an ~20 mg/dL difference in the mean serum glucose levels between these two periods after dialysis. This creates ~1–1.2 mmol (mg glucose/18 = mmol glucose) discrepancy in serum osmolarity. This small decrease in osmolality could explain no significant effect of dialysate glucose concentration on ECV in haemodialysis patients. In addition, recent studies [20,21] showed that serum potassium, BUN, phosphate increase in the post-dialysis period up to 120 min. They showed that the increase is different with low or high Na-dialysate as the percent and timing. This might also contribute to the development haemodynamic alterations observed in our study.
The quantitative comments on results of bioimpedance analysis are often very difficult. By evaluation of body fluid with BIA, it is clearly defined that the rates and changes of impedance results are more useful than the absolute value of impedance [22,23]. Moreover, there are conflicting data regarding the value or accuracy of BIA in showing the acute volume changes, like ultrafiltration in haemodialysis. [23–28]. In our study, we could demonstrate the BIA is able to show the acute ECV changes in haemodialysis patients during the hypotonic dialysate application. On the other hand, this study demonstrates that when dialyzing patients with a low sodium concentration fluid, patients are more prone to hypotension and extracellular volume decreases more, with a similar total ultrafiltration (~2.6 kg), while the mean decrease in total body water ranges approximately from 3 to 3.4 kg. The discrepancy between total ultrafiltration and decrease in total body water is important. Hence, these data raise a doubt on the validity of BIA measurements in haemodialysis population.
Although the need of interventions with isotonic saline, incidence of cramps and hypotension was clearly much frequent in period 2 (Table 2 and Figure 1), there was no change in the mean systolic and diastolic blood pressure and pulse rate at the end of the session, compared to other periods. Furthermore, with regard to Table 4, it was found that the serum aldosterone and PRA levels before/after dialysis were not different in period 2, compared to that of other periods. It was thought that interventions for patients with symptomatic hypotension to recover blood pressure might obscure the determination of probable haemodynamic and biochemical changes. However, serum cortisol levels at the end of the dialysis with low Na dialysate were statistically higher than those of period 1 (P = 0.011) suggesting adrenal stress due to hypotension. In addition, we did not find any changes in serum CRP levels after haemodialysis. These findings suggested no influence of dialysate glucose on

**Table 3.** Values of intracellular volume (ICC), extracellular volume (ECV), total body water volume (TBV), total body weight (TBW) and impedance index obtained during the study

<table>
<thead>
<tr>
<th></th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
<th>% Change</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
<th>% Change</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC (L)</td>
<td>20.4 ± 4.4</td>
<td>19.6 ± 4.5</td>
<td>−3.8 ± 0.6</td>
<td>20.4 ± 4.7</td>
<td>19.1 ± 4.7</td>
<td>−6.6 ± 0.2</td>
<td>20.6 ± 4.6</td>
<td>19.5 ± 4.6</td>
<td>−5.6 ± 0.3</td>
</tr>
<tr>
<td>ECV (L)a</td>
<td>16.4 ± 2.6</td>
<td>14.9 ± 2.5</td>
<td>−9.2 ± 0.4</td>
<td>16.7 ± 2.8</td>
<td>14.6 ± 2.6</td>
<td>−12.7 ± 0.2</td>
<td>16.3 ± 2.7</td>
<td>14.7 ± 2.6</td>
<td>−9.0 ± 0.3</td>
</tr>
<tr>
<td>TBV (L)b</td>
<td>37.6 ± 6.8</td>
<td>34.6 ± 6.7</td>
<td>−8.2 ± 0.4</td>
<td>37.9 ± 7.3</td>
<td>33.5 ± 7.1</td>
<td>−11.6 ± 0.2</td>
<td>37.7 ± 7.1</td>
<td>34.3 ± 6.9</td>
<td>−9.1 ± 0.3</td>
</tr>
<tr>
<td>TBW (kg)</td>
<td>63.8 ± 15.3</td>
<td>61.0 ± 14.8</td>
<td>−3.5 ± 1.5</td>
<td>64.32 ± 15.0</td>
<td>62.1 ± 14.7</td>
<td>−3.3 ± 0.6</td>
<td>62.5 ± 14.7</td>
<td>60.4 ± 16.4</td>
<td>−3.9 ± 1.6</td>
</tr>
<tr>
<td>Impedance indexc</td>
<td>0.810 ± 0.04</td>
<td>0.770 ± 0.03</td>
<td>−4.8 ± 0.4</td>
<td>0.818 ± 0.03</td>
<td>0.772 ± 0.03</td>
<td>−5.6 ± 0.1</td>
<td>0.840 ± 0.02</td>
<td>0.772 ± 0.03</td>
<td>−4.0 ± 0.2</td>
</tr>
</tbody>
</table>

*aSignificant difference in % change between period 1 and period 2 (P < 0.001) and between period 2 and period 3 (P = 0.025).
*bSignificant difference in % change between period 1 and period 2 (P < 0.001) and between period 2 and period 3 (P = 0.045).
*cSignificant difference in % change between period 1 and period 2 (P = 0.033) and between period 2 and period 3 (P = 0.046).
Table 4. Some important biochemical and hormonal data given (pre-dialysis, post-dialysis and % change)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose (mg/dL)</td>
<td>78.8±7.6</td>
<td>89.3±11.6</td>
<td>+42.2±20.2</td>
</tr>
<tr>
<td>Na (mmol/L)</td>
<td>138.6±2.88</td>
<td>140.0±1.8</td>
<td>+1.4±1.8</td>
</tr>
<tr>
<td>Hct (%)</td>
<td>35.4±5.2</td>
<td>35.2±6.4</td>
<td>+1.0±1.6</td>
</tr>
<tr>
<td>CRP (mg/L)</td>
<td>4.2±4.0</td>
<td>4.6±5.0</td>
<td>+4.6±2.1</td>
</tr>
<tr>
<td>Osmolarity (mosm/kg)</td>
<td>299±33</td>
<td>287±22</td>
<td>−12±11</td>
</tr>
<tr>
<td>Aldosterone (pg/mL)</td>
<td>268±35</td>
<td>259±25</td>
<td>−4±10</td>
</tr>
</tbody>
</table>
| Serum glucose and Na changes were statistically significant within Period 1 and 2. All serum potassium levels significantly decreased after the sessions. The change of cortisol in period 2 was more prominent than period 1 (P = 0.011) and the change of osmolarity in period 2 was more prominent than period 3 (P = 0.37). Period 2 showed a more prominent change of serum glucose (P = 0.011) than period 1. The change of Os was significantly decreased after the sessions. The change of cortisol in period 2 was more prominent than period 1 (P = 0.011) and the change of osmolarity in period 2 was more prominent than period 3 (P = 0.37).

Fig. 2. The change of the ratio of some parameters (intracellular, extracellular volume and total body water volume, impedance indexes and serum sodium concentrations) before and at the end of the session. The values of changes were given in the 1/1000 ratio. ICW: intracellular volume; TBV: total body water volume; ECV: extracellular volume; IMPIND: impedance index. (ICW/TBV: period 1 versus 2, P = 0.18; period 1 versus 3, P = 0.37; period 2 versus 3, P = 0.30; ECV/TBV: period 1 versus 2, P < 0.001; period 1 versus 3, P = 0.73; period 2 versus 3, P = 0.007, IMPIND: period 1 versus period 2, P = 0.08; period 1 versus period 3, P = 0.44; period 2 versus period 3, P = 0.063; Serum sodium: period 1 versus period 2, P = 0.066; period 1 versus period 3, P = 0.762; period 2 versus period 3, P = 0.25).

Conclusion

Decreasing dialysate sodium concentration results in important haemodynamic changes. On the other hand, the lack of glucose in dialysate does not result in any changes in haemodynamic and inflammatory parameters. The changes in bioimpedance parameters are parallel to haemodynamic changes in the haemodialysis patients. The bioimpedance analysis is a practicable, easy and reliable method for defining the changes in body fluid compartments in the haemodialysis patients.

Conflict of interest statement. None declared.

References

24. Thompson CM, Kong CH, Lewis CA et al. Can bio-electrical impedance be used to measure total body water in dialysis patients? Physiol Meas 1993; 14: 455–456

Received for publication: 3.9.07
Accepted in revised form: 18.4.08