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Effect of acetate and bicarbonate dialysate on whole body bioimpedance (BIS) and segmental (thoracic) bioimpedance in hemodialysed (HD) patients

Physiology of fluid distribution during hemodialysis (HD) is still of great importance. The most rapid change in volemic state occurs during haemodialysis and ultrafiltration, where – ideally – hypervolemia is being changed to normovolemia (14). One of methods of body fluid control is bioimpedance measurement, the non-invasive method of body water measurement (11). The whole body impedance can be not accurate, because 80% of the whole resistance is caused by extremities, and the trunk, which contains the majority of water, causes only 20% of resistance (15). Thorax is one of fluid containers (3) – thoracic impedance has been shown to correlate with the weight of dialysis patients (2) and it has been demonstrated that during HD thoracic impedance changes parallel with whole body impedance, indicating a simultaneous and unidirectional changes in total body fluid as well as in thoracic fluid (13). Our own data support these findings (12). A measure of thoracic fluid volume might be of help by better understanding of the hemodynamic side of hemodialysis. The influence of dialysis itself on bioimpedance parameters is still poorly known.

The aim of this study was to evaluate the influence of dialysis without ultrafiltration, on bioimpedance measurement.

MATERIAL AND METHODS

A group of 8 patients was studied – 5 male and 3 female, aged from 45 to 76 years (mean 65.25 ±10.36). The characteristics of the studied group is presented in Table 1. During the first hour of dialysis there was no ultrafiltration (isovolemic dialysis) and, for the first time, the bicarbonate buffer was used. During the next 3 h a normal

Table 1. Characteristics of the studied patients

Patient	Age (year)	Length of dialysis therapy (months)	Cause of chronic renal failure	Hipotensive medication	Urea (mg/dl)	Creatinine (mg/dl)	KT/V	Hemoglobin (g/dl)	Albumin (g/dl)	Transferrin (mg/dl)
G.A.	76	62	Interstitial nephropathy	-	89	9.8	1.16	10.1	4.6	189
H.H.	66	55	Interstitial nephropathy	ACE inhibitor	85	6.6	1.20	10.0	4.3	139
S.L.	69	33	Unclear	Ca channel blocker	127	8.8	1.90	10.2	3.5	208
S.F.	63	26	Chronic glomerulo-nephritis	alpha-2 mimetic	128	8.8	1.01	9.9	3.8	202
B.A.	70	92	Chronic glomerulo-nephritis	-	78	5.6	1.59	9.3	3.1	179
M.R.	76	24	Interstitial nephropathy	-	101	6.7	1.16	10.1	4.8	233
D.U.	57	62	Chronic glomerulo-nephritis	-	150	10.3	1.63	12.0	4.3	304
S.W.	45	12	Toxic nephropathy	ACE inhibitor	111	5.82	1.37	10.7	3.8	186

dialysis procedure was performed. During the first hour of the next dialysis session, isovolemic dialysis using acetate buffer was performed. All these patients had small intradialytic weight gain, so 1 hour of isovolemic haemodialysis had no negative influence on their therapy. Before and after isovolemic dialysis measurements of whole body bioimpedance (R), thoracic impedance (Zo), blood pressure, blood density, hematocrit and blood density were obtained. The sodium level in dialysis fluid was set according to plasma sodium level. Thoracic bioimpedance was measured using Kardio-Com (Diefenbach Elektromedizin, Frankfurt/M) Total body bioimpedance was measured using device of RJL-Systems (Detroit, Michigan USA). Blood density was obtained by measuring with Chempro PAAR DMA 46.

All data are expressed as means ± standard deviation (x ± SD). The statistical analysis was performed using paired Student t-test. Every patient served as his own control. Differences were considered significant when P value was <0.05.

RESULTS

After bicarbonate dialysis significant Zo values were significantly lower than before dialysis (30.05 ± 5.33 Ω; 30.55 ± 5.18 Ω respectively) ($p=0.011$). Though such significant

differences were not observed in dialysis with acetate fluid (30.26 ± 5.13 Ω; 30.05 ± 5.30 Ω respectively) – Figure 1.

There was noticed a significant blood density lowering after bicarbonate hemodialysis (1.0445 ± 0.0025 g/cm^3) in comparison with the state before it (1.0409 ± 0.0026) *

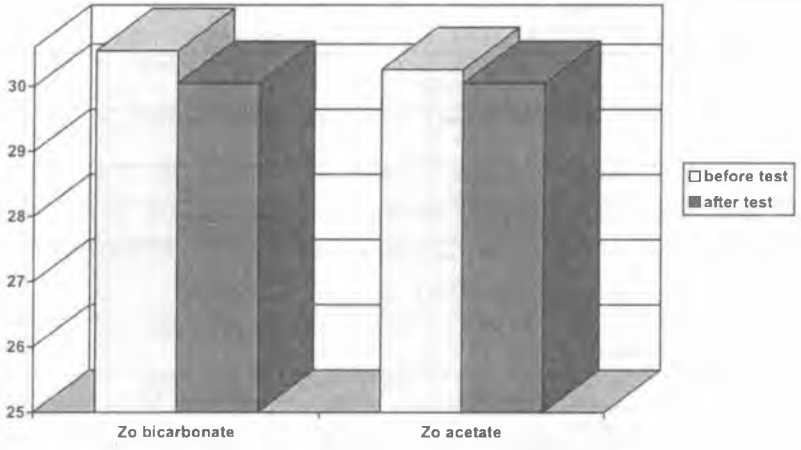

Fig. 1. Thoracic bioimpedance values using bicarbonate and acetate fluid
* Statistically significant $p<0.05$

($p=0.001$). There were no significant differences in blood density before and after acetate dialysis (1.0439 ± 0.0029; 1.0416 ± 0.0045 Ω respectively) – Figure 2.

*

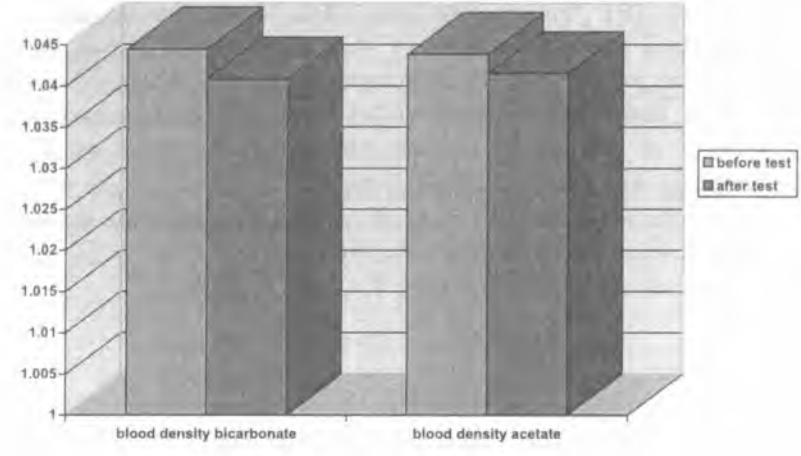

Fig. 2. Blood density values during dialysis with bicarbonate and acetate fluid
* Satistically significant $p<0.05$

A significant increase of R values was observed after both – bicarbonate and acetate hemodialyses (576.62 ± 181.62; 594 ±173.24 Ω , p=0.014 and 569.88 ± 162.18; 580 ± 156.34, p=0.017 respectively) – Figure 3.

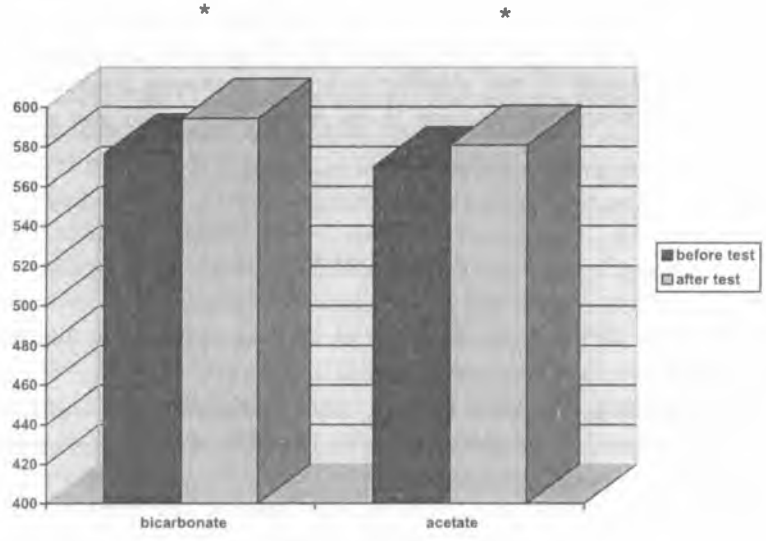

Fig. 3. Whole body bioimpedance before and after dialysis using bicarbonate and acetate dialysis

* Statistically significant $p<0.05$

DISCUSSION

The relationship between Zo values and body fluid changes during HD was observed by Vonk Noordegraaf et al. (1995)(13) and Graziani et al. (2). In total body bioimpedance the electrodes are placed on the hand and foot. Because extremities cause the majority of resistance (15), a more accurate method of bioimpedance measurement had to be found. Patterson et al. (7, 8) tried to apply the multisite bioimpedance measurement in hemodialysed patients. Patterson suggested that the most accurate is multisite measurement, followed by bioimpedance of thorax.

The amount of fluid in thorax also depends on body position (10) and haemodynamic state of the patient (5). That is why we decided to compare these two methods. It is known that using of acetate fluid can lead to more frequent episodes of intradialytic hypotension (4, 9). Acetate is metabolised in muscles, and can cause vasodilatation (1).

It is possible that Zo lowering was caused by backfiltration of dialysis fluid in haemodialyser (the dialysis was led without ultrafiltration) and that is why we could have decreased Zo values and decreased blood density. It is difficult to explain, however, why it did not happen while using acetate and why in both tests the total body

bioimpedance rose significantly. Significant changes in Zo and blood density with the opposite reaction of whole body bioimpedance suggest that dialysis itself without ultrafiltration has an influence on bioimpedance parameters probably by causing fluid shifts or ionic/osmolality changes (10). Zhu et al. (15) suggest that during hemodialysis centralization of circulating blood takes place. The observed less pronounced change in Zo using acetate dialysis in this situation is a very interesting observation. Probably segmental multifrequency bioimpedance of the whole body would give more information.

CONCLUSIONS

1. Significant changes in Zo and R during isovolemic haemodialysis were observed.
2. The influence of other factors, not only hydration status changes, must be considered in interpretation of bioimpedance measurement analysis. Further investigation is needed.

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SUMMARY

There are sparse data about the influence of dialysis itself on bioimpedance measurement. The aim of this study was to evaluate the influence of dialysis without ultrafiltration on bioimpedance of thorax and bioimpedance of the whole body in hemodialysed patients. Isovolemic HD was performed during the first hour of dialysis session, using bicarbonate and then acetate dialysate. Thoracic impedance, whole body bioimpedance, blood pressure and blood density were measured. After bicarbonate dialysis significant TI lowering was observed with simultaneous R increase. There was a significant blood density lowering. Acetate hemodialysis caused no significant changes in TI but significant increase in R values. Blood density did not change after acetate HD. The influence of other factors, not only hydration status changes, must be considered in interpretation of bioimpedance measurement analysis.

Wpływ płynu dializacyjnego octanowego i dwuwęglanowego na bioimpedancję całego ciała (BIS) i bioimpedancję segmentalną (klatki piersiowej) u pacjentów hemodializowanych (HD)

Niewiele jest danych mówiących o wpływie zjawiska hemodializy na pomiar zawartości płynu w ludzkim ciele metodą bioimpedancji. Celem pracy było sprawdzenie wpływu samej dializy, bez ultrafiltracji, na zmiany wartości bioimpedancji klatki piersiowej i bioimpedancji całego ciała u pacjentów hemodializowanych. Zbadano pacjentów podczas dializy zarówno przy użyciu płynu dwuwęglanowego, jak i octanowego, mierząc bioimpedancję klatki piersiowej i całego ciała. Zaobserwowano spadek wartości bioimpedancji klatki piersiowej, który był istotny jedynie przy użyciu płynu dwuwęglanowego. W obu przypadkach gęstość krwi zmalała, ale istotność była obserwowana również jedynie w przypadku dializy z użyciem płynu dwuwęglanowego. Jednocześnie zaobserwowano istotny wzrost wartości bioimpedancji całego ciała w obu przypadkach. Należy podkreślić złożoność czynników kształtujących pomiary bioimpedancji, dokonywane przy monitorowaniu zmian nawodnienia u pacjentów hemodializowanych.