Usefulness of a Body Composition Analyzer, InBody 2.0, in Chronic Hemodialysis Patients

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The objective of the present study was to investigate whether InBody 2.0 might be useful in measuring the dry weight of chronic hemodialysis (HD) patients. Thirty-five HD patients (22 males and 13 females; mean age 62.6 ± 14.0 years; mean HD duration 101.0 ± 118.06 months) were examined. Multifrequency bioelectric impedance analysis was used to estimate the ratio of extracellular water (ECW) to total body water (TBW). The body resistance was measured at frequencies ranging from 1 kHz to 1 MHz. The impedance index was determined at a low frequency (5 kHz) and correlated closely with ECW, using sodium bromide dilution as standard comparison. The levels of serum albumin, prealbumin, total cholesterol (TC), triglycerides (TG), transferrin, and human atrial natriuretic peptide (hANP) were measured by routine methods in our hospital. The ECW/TBW ratio was significantly associated with the levels of hANP ($p < 0.05$). However, no associations between the levels of serum albumin, TC, TG, or transferrin and the ECW/TBW were observed. It appears that the body composition analyzer, InBody 2.0, may be useful for estimating the dry weight in chronic HD patients.

Key Words: chronic hemodialysis, body composition analyzer
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An accurate measurement of total body fluid status is extremely important in patients having hemodialysis (HD). The "dry weight" is the post-dialysis weight after excess body fluid has been removed by HD [1]. Patients who have hypervolemic status develop hypertension, edema, pulmonary congestion, and cardiovascular instability. In contrast, patients who have hypovolemic status often have general malaise, washed-out feeling, cramps, dizziness, and shock after HD. Also, the dry weight often periodically changes secondarily to a change of nutritional status and/or additional catabolic disease. Therefore, the dry weight of HD patients should frequently be evaluated. Traditionally, the dry weight has been evaluated by high-quality clinical assessments based on diagnostic skills and experience. To address these problems, several methods for estimating the dry weight are used, such as plasma cyclic 3′,5′-guanosine monophosphate (cGMP), infrared light reflection method, inferior vena cava diameter, chest radiography, and clinical parameters including blood pressure, intradialytic symptoms of volume depletion and edema. The plasma levels of human atrial natriuretic peptide (hANP) may be useful as a basis for adjusting the dry weight, in addition to clinical judgment and chest radiography [2–4].

Bioelectric impedance analysis (BIA) is a newly developed, noninvasive, easy, and reproducible technique to estimate the body fluid volume status [5]. In the present study, the usefulness of BIA was compared with plasma hANP levels for prediction of the dry weight in HD patients.

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Materials and Methods

Thirty-five stable HD patients participated in this study after giving informed consent. The study was performed 30–60 minutes after the first dialysis session of the week (Monday or Tuesday) at the outpatient HD center at Juntendo University Hospital, Tokyo, Japan. Venous blood samples were drawn at the beginning and end of each HD session. Serum albumin, prealbumin, total cholesterol (TC), triglycerides (TG), and transferrin were measured by routine methods of the hospital central laboratory. Plasma hANP levels were measured by the Eiken RIA Kit (Eiken Chemical Co. Ltd, Tokyo, Japan). Body composition measurements of postdialysis patients were carried out by segmental bioelectric impedance, using eight tractile electrodes according to the manufacturer's instructions (InBody 2.0, Biospace Co. Ltd, Seoul, Korea). A pair of electrodes was placed on the surface of the thumb, palm, and fingers of the hand, and ball of the foot and heel. With these electrodes, microprocessor-controlled switches and impedance analyzer were operated and segmental resistance was measured at four frequencies (5, 50, 250, and 500 kHz). Thus, a set of 20 segmental resistances was measured for each individual. With these data, extracellular water (ECW), total body water (TBW) and the ECW/TBW were calculated from the sum of each segment, using the equations in the BIA software [6,7].

According to the normal range of the ECW/TBW provided by the manufacturer, patients were divided into two groups: the edema group ($n = 16$), with ECW/TBW more than or equal to 0.35; and the nonedema group ($n = 19$), with ECW/TBW less than 0.34.

Statistical analysis

Data are expressed as mean ± SD and compared with unpaired Student's *t*-test. The level of significance used in all statistical analyses was 0.05.

Results

The profiles of patients with or without edema are shown in Table 1. There were no significant differences in gender, age, and HD duration between the two groups. There were no significant differences in the serum levels of prealbumin, TC, TG, and transferrin between the edema and nonedema groups (Table 2). There are no correlations between ECW/TBW and hANP. Levels of plasma hANP in the edema and nonedema groups are shown in Figure 1. The levels of hANP in the edema group (ECW/TBW ≥ 0.35) were significantly higher than those in the nonedema group (ECW/TBW < 0.34) ($p < 0.05$). However, there was no significant difference in the levels of serum albumin between these two groups (Figure 2).

Table 1. Patient profile

	Edema group	Nonedema group	Statistical significance
Patient number	16	19	ns
Gender (M/F)	9/7	13/6	ns
Age (yr)	71.0 ± 8.7	58.9 ± 15.5	ns
HD duration (months)	112.8 ± 159.8	81.2 ± 65.8	ns

HD = hemodialysis; ns = not significant.

Table 2. Relationship of extracellular water/total body water ratio (edema level) and laboratory data in post-hemodialysis patients

	Prealbumin (mg/dL)	Total cholesterol (mg/dL)	Triglyceride (mg/dL)	Transferrin (mg/dL)
Edema group	38.99 ± 4.75	202.94 ± 39.67	127.88 ± 80.39	224.19 ± 37.86
Nonedema group	36.44 ± 6.98	197.13 ± 43.45	130.13 ± 83.17	249.44 ± 68.84
Statistical significance	ns	ns	ns	ns

ns = not significant.

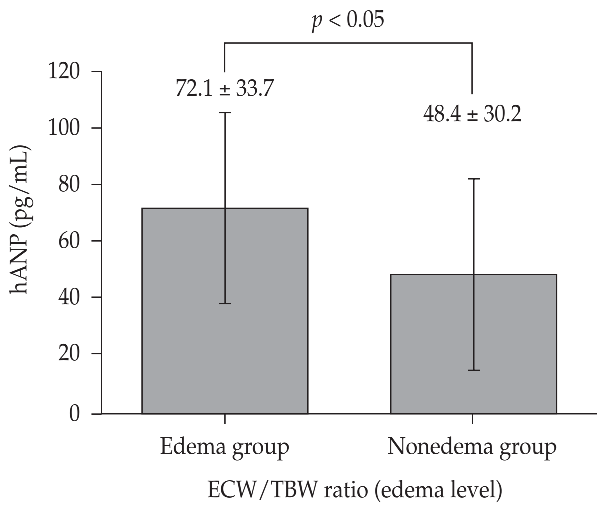

Figure 1. *Relationship of extracellular water/total body water ratio (edema level) and human atrial natriuretic peptide in post-hemodialysis patients.*

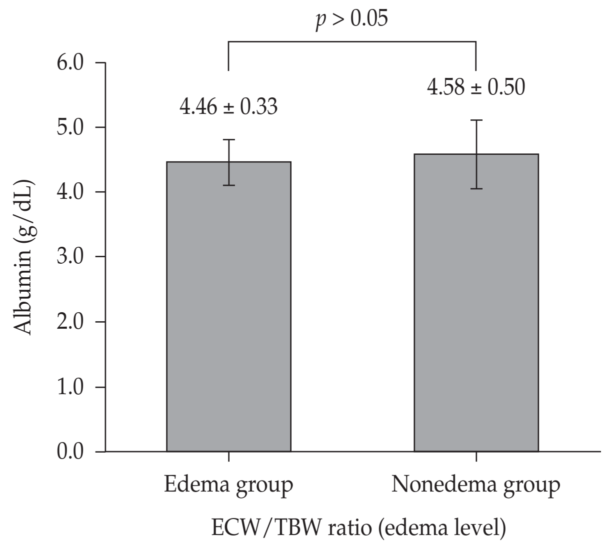

Figure 2. *Relationship of extracellular water/total body water ratio (edema level) and albumin in post-hemodialysis patients*

Discussion

Ideally, the fluid status returns to normal extracellular volume after HD treatment. In clinical practice, the dry weight is defined as the post-dialysis weight at which all or most excess body fluid has been removed. There are several methods of estimating dry weight, including inferior vena cava diameter, chest radiography, and clinical parameters (e.g. blood pressure and intradialytic symptoms of volume depletion and edema). However, these methods lack reliable endpoints. Interobserver errors and the cost of echocardiography obviate more widespread application of measurement of inferior vena cava diameter [3]. Some markers also proposed for assessment of dry weight in HD patients are hANP and its second messenger cGMP, and the infrared light reflection method [8], but the infrared light reflection method cannot be evaluated in several patients simultaneously. The clinical parameters depend on the time at which ultrafiltration is performed in the dialysis strategy, the predialysis body fluid status, and concomitant drug treatment, such as antihypertensive drugs [5].

BIA is a newly developed, noninvasive, easy, and reproducible method for estimating the TBW in normal adults. However, it is still controversial whether this method can be used to estimate the dry weight of HD patients. de Fijiter et al [9] and Kong et al [10] reported that BIA was inaccurate in the assessment of TBW in HD patients. Their studies were based on single-frequency BIA, however, whereas multifrequency (MF) BIA was used in this study [5]. Tsai et al reported that there were significant differences of ECW/TBW and the ratio of intracellular fluid to extracellular fluid between the edematous group and nonedematous group [11]. They also pointed out that BIA measurement of TBW may overestimate the actual volume of ultrafiltration as a result of drinking or eating during HD, or the body impedance during HD could be a consequence of loss of conductive molecules.

In the present study, we showed that the ECW/TBW was significantly associated with the levels of hANP in HD patients. We have provided strong evidence that the fall in plasma hANP levels in HD patients is mainly due to the reduction in circulating plasma volume [4]. Zoccali et al reported that plasma levels of hANP may be useful in addition to clinical judgment and chest radiography as a basis for adjusting dry weight [5]. Wann et al reported that cGMP, the second messenger of hANP, could help predict dry weight and avoid hypotension in HD patients [8]. However, the cost and complexity of the assays of hANP limit their possible application. These findings suggest that measurement of BIA is also useful for prediction of dry weight in HD patients. This speculation is compatible with other reports that MF BIA is a new method for prediction of dry weight [5,12].

In summary, the levels of hANP in the edematous group (ECW/TBW ≥ 0.35) were significantly higher than those in the nonedematous group (ECW/TBW < 0.34) in HD patients. It appears that BIA is a useful method to evaluate the dry weight in HD patients.

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References

1. Daugirdas J, Kjellstrand CM. Chronic hemodialysis prescription: a urea kinetic approach. In: Daugirdas JT, Blake PG, Ing TS, eds. *Handbook of Dialysis*, 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2001:140–1.
2. Groll J, Hagemann J, Rohrich B, Schaefer K. Atrial natriuretic peptide plasma levels during hemodialysis and hemofiltration in patients with end-stage renal disease. *Int J Artif Organs* 1989;12:284–8.
3. Chemney PW, Kramer M, Rode C, et al. A new technique for establishing dry weight in hemodialysis patients via whole body bioimpedance. *Kidney Int* 2002;61:2250–8.
4. Shiota J, Kubota M, Hamada C, et al. Plasma atrial natriuretic peptide during hemodialysis with or without fluid removal. *Nephron* 1990;55:283–6.
5. Zoccali C, Dunea G. Hypertension. In: Daugirdas JT, Blake PG, Ing TS, eds. *Handbook of Dialysis*, 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2001:468–9.
6. Cha K, Chertow GM, Gonzalez J, et al. Multifrequency bioelectrical impedance estimates the distribution of body water. *J Appl Physiol* 1995;79:1316–9.
7. Lee SW, Song JH, Kim GA, et al. Assessment of total body water from anthropometry-based equation using bioelectrical inpedance as reference in Korea adult control and hemodialysis subjects. *Nephron Dial Transplant* 2002;16: 91–7.
8. Wann GL, Tsai CS, Lin SH, et al. Prediction of dry weight through change in blood volume and plasma cyclic 3′,5′-guanosine monophosphate in patients under maintenance hemodialysis. *ASAIO J* 1998;44:M569–73.
9. de Fijiter WM, de Fijiter CWH, Oe PL, et al. Assessment of total body water and lean body mass from anthropometry, Watson formula, creatinine kinetics on peritoneal dialysis patients. *Nephron Dial Transplant* 1997;12:151–6.
10. Kong Ch, Thompson CM, Lewis CA, et al. Determination of total body water in uremic patients by bioelectrical impedance. *Nephron Dial Transplant* 1993;8:716–9.
11. Tsai WS, Wu CC, Lin SH, et al. Evaluation of ideal body weight in dialysis patients though bioelectrical impedence analysis. *Acta Nephrol* 2002;16:119–24.
12. Spiegel DM, Bashir K, Fisch B. Bioimpedance resistance ratios for the evaluation of dry weight in hemodialysis. *Clin Nephrol* 2000;53:108–14.