Original Article

Comparison of experimental and bioelectrical impedance analysis methods in calculation of dry weight in peritoneal dialysis patients

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Abstract

Background: To optimize dialysis prescription and fluid balance of the peritoneal dialysis (PD) patients, it is important to assess their dry weight accurately. The experimental evaluation is the method which is widely used in PD centers which needs continuous and controlled reduction of the postdialysis weight down to the point where patient does not show any signs of hypotension and volume overload. This study intends to indicate that the bioelectrical impedance analysis (BIA) method can be used as an alternative method to evaluate the dry weight.

Materials and Methods: The demographic data of 101 continuous ambulatory peritoneal dialysis (CAPD) patients of Alzahra and Noor hospitals of Isfahan University (50 males and 51 females) who had been referred for periodical examinations from April 2009 to April 2010 were extracted from their files. The normal body volume was selected as the inclusion criteria and identified by an examiner group (a nephrologist, a general practitioner and a PD nurse). The patients' dry weights were calculated based on both methods. The bioelectrical impedance analysis method was done by the Maltron Bioscan ver916 and data were analyzed by SPSS program ver18.

Results: There were 49.5% males and 50.5% females with the mean age of 54.6±17 years. The mean dry weight in the experimental method was 63.4±13.3 kg in comparison to the other (61.5± 13.7 kg). There was a significant difference between the results (*P* value <0.001) depended on the gender t-test, but there was a 98% correlation between the results by two methods. No correlation observed between the patient's age, body mass index, blood pressure, previous hemodialysis history, PD duration time, and underlying disease.

Conclusion: The study showed that there is significant difference between the two methods. However, there was 98% direct correlation between them. It is concluded that bioelectrical impedance analysis could be a better alternative for accurate evaluation of dry weight in PD patients because it is a fast and cheap method and does not depend on examiner's capability. Further studies based on the results of this method are recommended to consider this method as the gold standard.

Key Words: Bioelectrical impedance, dry weight, peritoneal dialysis

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INTRODUCTION

Dry weight in a peritoneal dialysis patient is an estimate of the body weight without any sign of excess volume (high blood pressure, dyspnea, extremities edema, jugular vein distention, and respiratory rales) and any sign of volume depletion (low blood pressure, dizziness, cramp and malaise). One of the most important issues in the proper quality of peritoneal dialysis is to measure the patients' body dry weight. Assessment of the patients' dry weight is important because it is from this assessment that the patient's fluid overload is calculated at each dialysis session. The excessive drainage of this fluid will lead to fall in blood pressure, muscle cramps, and hemodynamic disorders. Also, inadequate drainage of this fluid will lead to pulmonary edema and poor heart function. Another important matter due to an inaccurate estimation of dry weight can lead to the negligence of malnutrition caused by over weighing despite to losing fat and building muscle mass as well as reduction of peritoneal membrane permeability in PD patients. There is still a dispute about dialysis adequacy in PD patients.[1]

Several methods have been developed to estimate body mass index[2] but the assessment of dry weight in patients is largely made empirically on a trial and error basis. Dry weight calculation in an empirical method requires the patient to reach a weight at which despite having edema and effusion in the third space, there is patient's hemodynamic stability as well as no fall in blood pressure. A method, which may be used in fluid-overloaded dialysis patients, is the study of their blood pressure.

But there is still no secure noninvasive method in the patients with normal blood pressure despite fluid overload in their body.[3]

Bioelectrical impedance analysis is a method used in dialysis patients and in general in subjects whose body mass should undergo a medical examination. This method determines the opposition to the flow of a weak electric current by means of two electrodes through body tissues which can be employed to calculate an estimate of intracellular and extracellular water, muscles, and fat mass. In addition to providing an accurate measure of body composition, BIA is a noninvasive method to be used more frequently. Moreover, many of the early research studies have proven that the use of this method for the assessment of body composition both in healthy subjects, hemodialysis patients, and peritoneal dialysis patients is more efficient than other methods such as experimental method.[4-8]

MATERIALS AND METHODS

This is a cross-sectional study made from April 2009 to April 2010 on the all eligible patients under peritoneal dialysis in the hospitals affiliated with Isfahan University of Medical Sciences. The criteria to enter into the study were as follows: (1) patient's consent to participate in this study; (2) patient's stability with no record of hospitalization and peritonitis in the preceding month; (3) no obvious edema and effusion in the patient in order to empirically determine the dry weight in a faster manner; (4) examination of the women volunteered to participate in the study in terms of regular menstrual periods in the mid-cycle (for the minimum fluid congestion in body).

A total of 101 patients were studied in the present survey. They were randomly selected from the dialysis patients of the hospitals affiliated with Isfahan University of Medical Sciences and entered into in the study.

Having been volunteered to participate after being examined by the experienced nurse of the dialysis center and the nephrologist, the study patients were entered into the trial after giving explanations, if desired. For each patient the two methods were conducted simultaneously at the same day.

On the study day, the fasting patients came to the peritoneal dialysis center of the hospital in the morning.

Upon the patient's entry into the study, a form containing patient's demographic data including age, gender, height, and weight at time of referral, underlying disease, time the patient's dialysis treatment started, weight at the beginning of dialysis, blood creatinin, and dialysis instructions including the number of dialysis sessions, the type of dialysate solution, and the duration of each dialysis session was filled by the research team.

After dialysate fluid had been drained out, if the patient had no edema and effusion so that no obvious pulmonary crackle, pitting edema, and ascitis were observed at the reexamination made by the project execution physician on the same day and also JVP and blood pressure were normal, the patient would be weighted and his/her weight would be considered as dry weight on the basis of the empirical method. Thereafter, the patient lied in bed and the electrodes of Malton bioscan ver916 were attached.

During BIA, the wrist electrode pair is placed on the dorsal surface of the third metacarpal joint. The

electrode pair for the ankle is placed on the dorsal surface of the second metatarsal bone. The electrodes should not be connected to an amputated or fistulated hand. Then, the patient's dry weight is inferred on the basis of a manufacturer formula that considers the subject's height, weight, age, gender, and race.[6]

After the data were collected, they were entered into a computer and analyzed using SPSS-ver18. For data analysis, a variety of statistical tests including the chi-Square, Fischer's exact test, Student *t*-test, Paired *t*-test, pearson's correlation, and a one-way analysis of variance (ANOVA) were performed.

RESULTS

In this study, 101 dialysis patients from the hospitals affiliated with Isfahan University of Medical Sciences were studied. The mean age of patients was 54.6±17 years.

Out of the total 101 patients 49.5% (n=50) were males and the rest 50.5% (n=51) were females. The mean age of the studied patients was 58.4±15.3 years in males and 51±17.8 years in females, respectively.

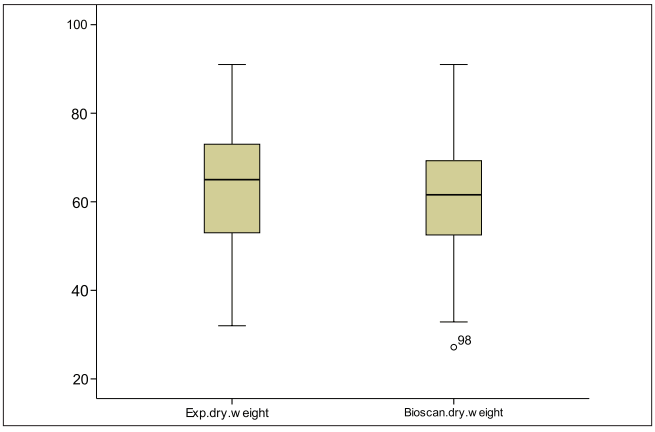

Figure 1: Comparison between the mean and the confidence interval for the patients' dry weight by the experimental and BIA methods

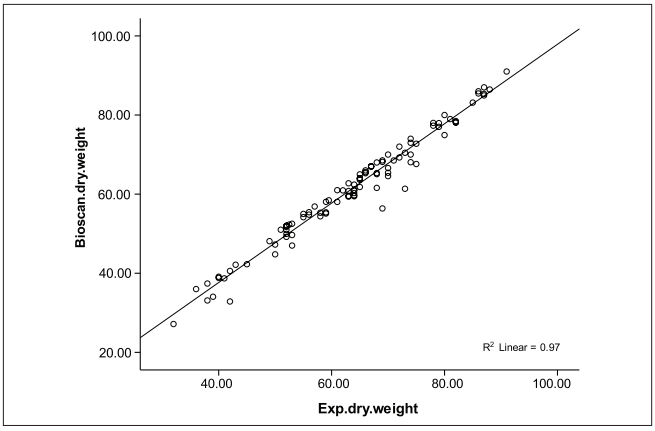

Figure 2: Correlation between the estimated dry weight by the experimental method and BIA (using Maltron Bioscan ver916) methods

The mean body mass index (BMI) of these patients was 24.13 ± 5 kg/m^2. Results showed that 11 patients (10.9%) were underweight (BMI<18.5), 51 patients (50.5%) had normal weight (18.5<BMI<24.99), 26 patients (25.7%) were overweight, and 26 were (25.7%) were obese (BMI≥ 30).

The cause of renal failure in 39 patients was diabetes, in 35 patients was high blood pressure, in four patients was polycystic kidney disease, in two patients was lupus and in 21 patients was renal failure of unknown etiology.

The mean systolic blood pressure was 128±25 mmHg and mean diastolic blood pressure was 81±17 mmHg in patients. According to the obtained results, a direct coordination of 0.17 existed between systolic blood pressure and the difference of patients' dry weight by two methods, but the Pearson correlation test indicated that it was not significant (P=0.09). Also, there was no significant relationship between diastolic blood pressure and weight difference by two methods (P=0.48).

The study of the difference in patients' dry weight by these two methods also showed that in 19 patients (19%) no difference existed between the two methods in determining the patient's dry weight and in 82 patients (82%) the dry weight data values obtained from the BIA method were lower.

The mean dry weight in the experimental method was 63.7±13.8 kg in comparison to 61.5±13.7 kg obtained from BIA evaluation and the difference in mean weight between the two groups was significant according to the paired *t*-test (P<0.001). That means that the patient's dry weight estimated by the experimental method differs from that obtained by instrumental evaluation. Figure 1 illustrates the patients' dry weight distribution by the two methods.

The study of the correlation between the patient's dry weight obtained by the experimental method and BIA evaluation showed that there is a direct correlation of 0.99 between the patient's dry weight through the two methods which is statistically significant (P<0.001). Figure 2 depicts the correlation between these two methods in the calculation of the patient's dry weight.

Mean difference of patients' dry weight by the two methods was 2.2±2.4 kg. The minimum difference observed was zero and the maximum was 12.6 kg.

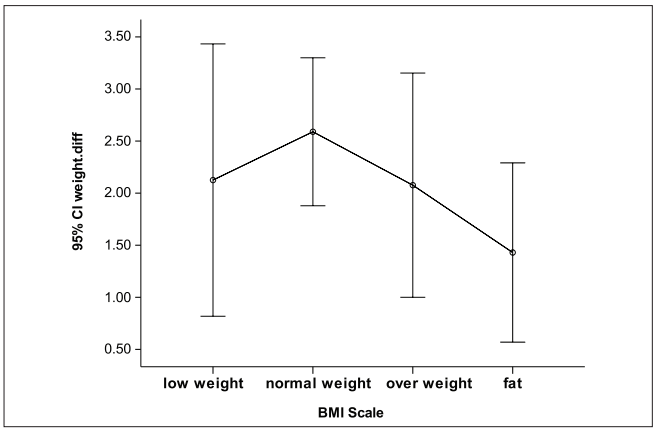

Figure 3: The patients' dry weight difference in the two experimental and BIA methods based on the BMI scale

Mean weight difference in the males and females under study was 3±2.7 and 1.5±1.8 and according to the Student *t*-test there is significant difference in the dry weight of the females and males (P=0.002).

Dry weight difference calculated by the two methods for underweight patients was 1.2±1.9, for patients with normal weight was 2.6±2.5, for overweight patients was 2±2.7 and in the obese ones was 1.4±1.4 and, also, according to the analysis of variance (ANOVA), no relationship existed between BMI and weight difference in the two methods (P=0.44). The results are as shown in Figure 3.

No correlation observed between the patients' dry weight difference by the two methods and the patient's age, body mass index, blood pressure, previous hemodialysis history, PD duration time, and underlying disease.

DISCUSSION AND CONCLUSION

The general objective of this study was to compare the dry weight in peritoneal dialysis patiens with using the experimental method and BIA evaluation. According to obtained results, the reliability of the gravimetric method by BIA has been proven in different age groups and, in fact, no significant difference existed between the age groups. Regarding different gender groups, these two methods gave significantly different values for males and females which can be justified with considering the difference in males' and females' body fat percentage and body water as well as the impact of these parameters on the results obtained by instrument.

Despite all these findings as well as the significant difference between the two methods, BIA can be a proper method to determine body dry weight as a result of high correlation of these two methods (98%). Therefore when one of these methods is available, the body dry weight can be calculated with considering a total approximation through the other method. Consequently, in conditions where the patient has signs of fluid overload it may even be possible to use BIA for the preestimation of the patients' dry weight.

Although the current study and similar studies[9-11] prove the efficiency of the dry weight evaluation method with using bioelectrical impedance analysis, introducing this evaluation as a gold standard method requires further studies and the survey on clinical trials results, which are based on dry weights which are calculated by the same analysis.

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