Section: Obstetrics & Gynaecology

Original Research Article

ASSESSMENT OF TOTAL BODY WATER DISTRIBUTION IN PREECLAMPSIA COMPARED TO NORMOTENSIVE PREGNANT FEMALES BY BIOELECTRICAL IMPEDANCE ANALYSIS.

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ABSTRACT

Gestational hypertension and preeclampsia are common disorders of pregnancy and remain a major health issue for women and their infants worldwide. The body undergoes dynamic changes in composition during pregnancy in order to support the growing fetus as it develops from conceptus to live born infant. The progressive fluid retention during pregnancy causes subsequent increase in TBW (total body water) and in plasma volume. The assessment of extracellular, intracellular and total body water (ECW, ICW, TBW) is important in many clinical situations. The studies regarding assessment of TBW distribution in pregnancy, especially, high risk pregnancies are scarce. Present study was a prospective study which included 140 pregnant women (70 cases and 70 controls) admitted at Padmashri Dr D. Y. Patil Hospital and Research Institute, Kolhapur. Total body water and its distribution were measured using impedance analyzer (TRANSTEK Bluetooth Body Fat Scale BF-1256-B).Bioelectrical impedance was measured at a specified frequency, viz., 50 kHz (Z1=50) after 24 weeks of gestational age.

Mean of total body water among cases(n=70) was 30.30±5.76%,control (n=70) was 29.37±2.87% and among severe preeclamptic population(n=36)was48.55±4.46%.(P<0.0001, r =0.38, 95%CI=0.14 – 0.57,r2 = 0.14).Mean of extracellular body water among cases(n=70) was 22.46±2.89% , control(n=70) was 22.47±2.70,and among severe preeclamptic population(n=36)was 22.24±3.12.(P< 0.0001, r =0.63, 95% CI=0.44 – 0.77, r2 = 0.40).Mean of intracellular water among cases(n=70) was 25.87±2.83%, controls(n=70) was 24.74±4.29 , and among severe preeclamptic population(n=36) was 26.30±3.40%.(P< 0.0001, r =0.76, 95% CI=0.62 – 0.85,r2 = 0.58).Positive correlation was found between total body water distribution with severity of disease using bioelectrical impedance analysis. The results of the present study gives insight that Bioelectrical Impedance Analysis can be used to diagnose preeclampsia in incipient stages, which can be quite useful in the care provision of women at a higher risk for pregnancy induced hypertension. BIA can also be used to stratify patients with a higher risk for progression to severe preeclampsia, which might result into more vigilant and better management.

Keywords: Pregnancy, Preeclampsia, Bioelectrical Impedance Analysis, Total body water, Extracellular body water, Intracellular body water.

INTRODUCTION

Pregnancy induced hypertension, preeclampsia and eclampsia accounts for 24% of all maternal deaths in India.[1] Hypertensive disorders are the most common medical disorders complicating around 12-22% of all pregnancies.[2] The body undergoes dynamic changes in composition during pregnancy in order to support the growing fetus as it develops from conceptus to live born infant.[3] The progressive fluid retention during pregnancy causes subsequent increase in total body water (TBW) and in plasma volume.[4] The changes in body composition during pregnancy and its effects on pregnancy outcome is important as it represent a field of major interest in perinatal medicine. Only few studies of changes in body fluids during pregnancy have been conducted due to accompanying difficulties, i.e., such studies are too difficult and invasive for pregnant women. So,important advances in the development of non-invasive techniques for assessing TBW have been made.Some of these techniques include Single frequency Bioelectrical Impedance analysis (SF-BIA) andMultiple frequency Bioelectrical Impedance analysis (MF-BIA).[5] Classic methods of assessing body water (e.g., isotope dilution with deuterium or oxygen−18) are too expensive and complicated and subsequently have low patient compliance. Multiple frequency bioelectrical impedance analysis (MF-BIA) allows the determination of body composition, i.e., total body water (TBW), fat mass, and fat-free mass. MF-BIA is based on the body's conduction of one single frequency (multiple frequency) to electrical current to determine total conductor volume of the body. Because water and electrolytes are the determinants of electrical conduction in the body, TBW is easily evaluated by BIA.[5] Of note, studies regarding assessment of TBW distribution in high risk pregnancies especially in Indian population are scarce. Therefore, we designed this study to assess total body water distribution in preeclampsia compared to normotensive pregnant females by bioelectrical impedance analysis (BIA). It may play a potential role in recognising those pregnant females who are at risk for developing preeclampsia and may serve as a supplementary indicator of maternal health in our population where malnutrition and adverse pregnancy outcomes are prevalent.

Aims and Objectives

The present study was planned with the aim to assess total body water distribution in preeclampsia compared to normotensive pregnant females by bioelectrical impedance analysis (BIA) after 24 weeks. The main objectives of the present study were comparing the changes in total body water during normal pregnancy and pregnancy complicated by preeclampsia and to study the correlation between severity of preeclampsia and total body fluid water using Bioelectrical Impedance Analysis (BIA).

MATERIALS AND METHODS

The present study was a prospective study. 140 pregnant women attending the outpatient Department of Obstetrics & Gynaecology of tertiary care hospital, Padamshri Dr D.Y. Patil Hospital and Research Institute, Kolhapurwere registered when admitted under Department of Obstetrics & Gynaecology. At the time of registration the baseline information was taken especially with respect to socio-demographic factors, Total body water, and other investigations. Thus each & every patient was followed up in the department of Obstetrics & Gynaecology till discharge. The data thus collected was analyzed to assess total body water in preeclampsia compared to normotensive pregnant females by bioelectrical impedance analysis (BIA) after 24 weeks of gestational age. Total body water and its distribution were measured using impedance analyzer (TRANSTEK Bluetooth Body Fat Scale BF-1256-B).Bioelectrical impedance was measured at a specified frequency, viz., 50 kHz (Z1=50). Bioelectrical impedance analysis (BIA) was done after 24 weeks of gestational age.A total of 70 well proven preeclamptic patients and 70 normotensive pregnant females of more than 24 weeks gestational age were compared. On the admission day, Single frequency Bioelectrical Impedance Analysis (SF-BIA) was performed with use of a standard method and instrumentation in normotensive women, while it was done in the preeclamptic patients on admission and then every 2 days until childbirth. TBW was calculated by using the prediction formula of Lukaski et al, ECW by using the prediction formula of Segal et al, and intracellular water (ICW) as the difference between the latter 2 quantities. [4,6-8]

Operational Formulas

- TBW=0.737 x FFM(fat free mass)
- EBW(kg)=0.24253 x H 2 /Z1+4.1
- Fat free mass=Weight – fat mass
- Fat mass= Body fat%/100 x weight
- W=Weight in kg
- H = Height in cm
- $Z1=\sqrt{(R^2 + Xc^2)}$
- R (Resistance)=963.477-10.465 x BMI (kg/m^2) - 0.471 x gestational age(days)
- Xc (Reactance)=99.630-0.297 x weight (kg) - 0.074 x gestational age(days)

The collected data was compiled in Microsoft Excel 2010. Qualitative data was analyzed by proportions and statistical significance was calculated using student ‘t’ test and for quantitative data analyzed by mean and SD and statistical significance was calculated using student Chi Square test. P value <0.05 was considered statistically significant. Analysis was done using SPSS (Statistical

Programme for Social Sciences) software 23version, Open Epi Software Version 2.3.1.

RESULTS

The present study was conducted in the Department of Obstetrics and Gynaecology from May 2014 to August 2016. It included a total of 70 well proven preeclamptic patient and 70 normotensive pregnant females >24 weeks were compared. Case group (70) consisted of 34 mild preeclamptic females and 36 severe preeclamptic females while control Group included 70 normotensive pregnant patients. Mean of total body water among cases(n=70) was 30.30±5.76%,control(n=70) was 29.37±2.87% and among severe preeclamptic population(n=36)was48.55±4.46%.(P<0.0001, r =0.38, 95%CI=0.14 – 0.57,r2 = 0.14). [Table – 1 and Fig. - 1]Mean of extracellular body water among cases(n=70) was 22.46±2.89% , control(n=70) was 22.47±2.70% among severe preeclamptic population(n=36)was 22.24±3.12%.(P< 0.0001, r =0.63, 95% CI=0.44 – 0.77, r2 = 0.40).[Table – 2and Fig. - 2] Mean of intracellular water among cases(n=70) was 25.87±2.83%, controls(n=70) 24.74±4.29% , and among severe preeclamptic population(n=36) was 26.30±3.40%.(P< 0.0001, r =0.76, 95% CI=0.62 – 0.85,r2 = 0.58). [Table – 3and Fig. - 3] Positive correlation was found between total body water distribution with severity of disease using bioelectrical impedance analysis.

Table 1: Association of Total body water among study population

TBW	Case (n=70)	Control (n=70)	Severe preeclamptic (n=36)
Mean ± SD	30.30±5.76	29.37±2.87	48.55±4.46
P value	<0.0001		<0.0001

Table 2: Association of ECW among study population

ECW (%)	Case (n=70)	Control (n=70)	Severe preeclamptic (n=36)
Mean ± SD	22.46±2.89	22.47±2.70	22.24±3.12
P value	<0.0001		<0.0001

Table 3: Association of ICW among study population

ICW	Case (n=70)	Control (n=70)	Severe Preeclamtic (n=36)
Mean ±SD	25.87±2.83	24.74±4.29	26.30±3.40
P value	<0.0001*		<0.0001*

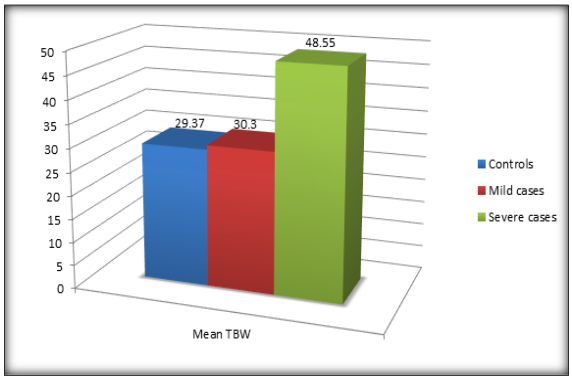

Figure 1: Association of Total body water among study population

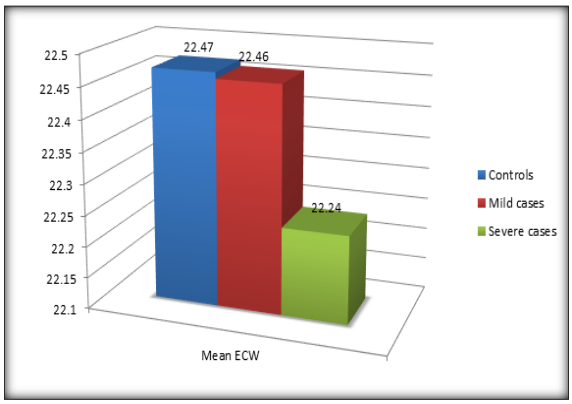

Figure 2: Association of ECW among study population

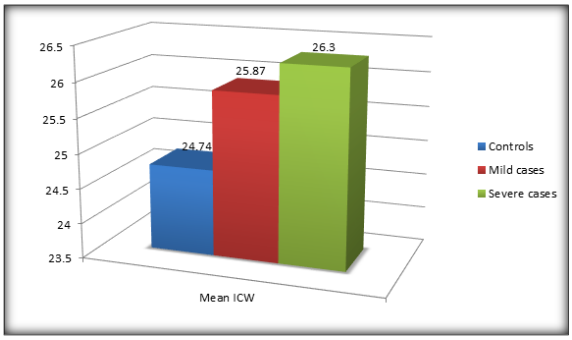

Figure 3: Association of ICW among study population

DISCUSSION

Gestational hypertension and preeclampsia are common disorders of pregnancy and remain a major health issue for women and their infants worldwide. Obstetricians are experts at diagnosing acute conditions and their management but they do not commonly cross-examine women about their long-term risks. The body undergoes dynamic changes in composition during pregnancy in order to support the growing fetus as it develops from conceptus to live born infant. The progressive fluid retention during pregnancy causes subsequent increase in TBW (total body water) and in plasma volume. This increase in TBW is responsible for the maximum proportion of weight gain during pregnancy. The studies regarding assessment of TBW distribution in

pregnancy, especially, high risk pregnancies are scarce. We found only one study till date in South Asia by Saijuddin Shaikh et al comparing normative cross-sectional distributions of bioelectrical impedance properties in early pregnancy, late pregnancy, and at three months postpartum in a cohort of women with viable pregnancies or live infants at the time of analysis in a typical rural setting in northern Bangladesh. (9) However, there is still no study in this subject in the Indian population. Considering preeclampsia as a major cause of perinatal morbidity and mortality in our population, it becomes quite prudent to manage it before complication arises making it mandatory to diagnose this disease as early as possible. Not surprisingly, search for a non-invasive marker to diagnose preeclampsia in incipient stages still continues.

Therefore, the present study was planned with the main objective of comparing the changes in total body water during normal pregnancy and pregnancy complicated by pre-eclampsia and to study the correlation between severity of pre-eclampsia and total body fluid water using Bioelectrical Impedance Analysis (BIA).

Our study population included a total of 70 well proven preeclamptic women of more than 24 weeks gestational age who were compared with 70 normotensive pregnant controls of more than 24 weeks gestational age. Among cases, 34 were diagnosed to be suffering from mild preeclampsia while remaining 36 were grouped into severe preeclamptic group.

During pregnancy, Total body water (TBW) changes are highly variable. Several studies have reported TB Waccretion of approximately 5–8 litres over the course of pregnancy. In this study, mean total body water was 30.30±5.76 among cases and in the control group, mean was 29.37±2.87, while in severe preeclamptic women, mean was 48.55±4.46. Positive correlation was seen between the total body water and severity of the disease. (Correlation coefficient (r) =0.38, 95% CI=0.14 – 0.57, Coefficient of determination (r2) = 0.14), which states that as TBW increases, the severity of the disease also increases. Lukaski et al (10) studied 15 women before, during and after pregnancy and similar measurements were made once in a group of 50 non pregnant women which showed that TBW was 30.3±1.2 and even showed statistically significant difference. They also showed that TBW increased significantly during pregnancy and then decreased during postpartum. EG da Silva et al,[11] observed in their study that among cases, total body water mean was 47.2±3.8 while that in controls was 49.7±4.48 and p value was statistically significant. Study states that in pregnancy complicated with preeclampsia, a bad distribution of body water occurs due to generalized vasoconstriction, increased capillary permeability and decreased renal sodium excretion. Similar results were seen in the study done by Gernand et al,[12] which showed that mean TBW was 25.6±2.5kg and TBW showed positive correlation (r = 0.65; P < 0.001)with severity of the disease. Corresponding findings were observed in the present study.

Varying degrees of edema has been commonly reported in pregnancy signifying an increase in Extracellular water (ECW). In the present study, mean ECW among cases was 22.46±2.89compared to controls with mean ECW value of 22.47±2.70 and this difference in the group reached statistical significance. Also, the mean value of ECW was significantly decreasedin the severe preeclamptic group with the value of 22.24±3.12. Significant correlation was observed between the extracellular body water and severity of the disease (Correlation coefficient (r) =0.63, 95% CI=0.44 – 0.77, Coefficient of determination (r2) = 0.40). Study by da Silva et al (11) showed that among cases, mean value of ECW was 47.9±2.56 while that in controls was significantly higher with value of 50.04±4.35. The mean ECW was lower among the present study population as compared to da Silva study. Similar study by Gernand et al,[12] was carried out in 2010 to find the maternal weight and body composition during pregnancy associated with placental and birth weight, where they showed that mean ECW was 11.4±1. Similar correlation with ECW as compared to the present study was observed in their study (r = 0.61; P < 0.001).

The intra cellular body water (ICW)analysis showed statistically significant difference among cases and controls and also severe preeclamptic women with observed mean values of ICW as 25.87±2.83, 24.74±4.29 and 26.30±3.40 respectively. A positive correlation between ICW and severity of disease was also observed (Correlation coefficient (r) =0.76, 95% CI = 0.62 – 0.85, Coefficient of determination (r2) = 0.58). Similar study by E.G. da Silva et al,[11] showed that among cases mean intra cellular body water was 51.5±4.83 and among controls mean intra cellular body water was 49.45±3.17 and even they showed statistically significant difference.

This way, it is evident that the present study represents a contribution by filling gaps in the knowledge on water-related body alterations in pregnant women with preeclampsia. The results of the present study support other previous studies done till date in this subject, indicating that pregnant women with preeclampsia present a bad distribution of body fluids and reduced plasma volume, increased interstitial volume and decreased water excretion, which are well-known characteristics of preeclampsia.

CONCLUSION

The present study was designed as a longitudinal prospective study to evaluate and compare the total body water distribution among preeclamptic women with normotensive pregnant females. Our study highlights the differences between pregnant women

with preeclampsia and healthy pregnant women with regards to body water distribution. Total body water and intracellular body water was significantly greater in the preeclampsia group, whereas the percentage of extracellular body water was lower in the patients of preeclampsia. Also, there was positive correlation between the severity of the disease and indices of Bioelectrical Impedance Analysis. Thus, Bioelectrical Impedance Analysis can be used to diagnose preeclampsia in incipient stages, which can be quite useful in the care provision of women at a higher risk for pregnancy induced hypertension. BIA can also be used to stratify patients with a higher risk for progression to severe preeclampsia, which might result into more vigilant and better management. No wonders, diagnosing preeclampsia earlier in the course of pregnancy can commensurate into better outcomes for both mother and baby thereby decreasing both maternal and perinatal morbidity.

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