Analysis of Mass Distribution in Dengue Patients Using Bioelectrical Impedance

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Abstract-This paper describes the mass distribution in healthy subjects and dengue patients on the day of defervescence of fever using bioelectrical impedance analysis. A total of 223 healthy subjects (65 males and 158 females) and 210 dengue patients (119 males and 91 females) were studied. The ages for healthy subjects vary between 14 and 60 years old with mean age of 26.05 years while the ages for the dengue patients vary between 12 and 83 years old with mean age of 30.14 years. The parameters of mass distribution investigated were body cell mass (BCM) and extracellular mass (ECM). There were significant difference between healthy subjects and dengue patients for female in BCM and ECM beginning on fever day 0 till fever day 4 ($p<0.001$). There were also significant difference between healthy subjects and dengue patients for male in BCM for fever day 1 till fever day 3 and in ECM for all fever days ($p<0.05$). On the other hand, both the mean BCM and ECM for healthy and dengue groups for male were higher than female. Bioelectrical Impedance Analysis is a useful method to assess the changes of mass distribution in dengue patients.

1. Introduction

Analysis of body composition is important aspect of clinical research to assess the pathophysiology of human health and diseases. Bioelectrical impedance is a noninvasive, inexpensive, portable method of body composition analysis, which is appealing for both research and clinical practice [1]. Although bioelectrical impedance has been validated in healthy populations and certain disease states [2-5], it has not been tested in evaluating mass distribution of the dengue patients. This is important because previous studies have shown that bioelectrical impedance is sensitive in predicting and monitoring body cell mass in HIV patients [6].

Bioelectrical impedance application in evaluating mass distribution of the dengue patients is relatively new. To date, no known literature describe the mass distribution in Malaysian population.

In this study, we focused on the measurement of mass distribution in bioelectrical impedance analysis (BIA) for Malaysian healthy subjects and dengue patients. The parameters for the mass distribution investigated are body cell mass (BCM) and extracellular mass (ECM).

2. Subjects and Methods

2.1. Subjects

The subjects are divided into 2 groups: Group 0 is the control healthy subjects while Group 1 is the dengue patients. Group 0 consists of a total of 223 volunteers with no past medical history. Subjects were non-randomly volunteers, recruited through advertisement in the University Malaya's monthly news bulletin 'BERITA UM', internal posters circulation, and internal University Malaya's email. Some of the volunteers were from general public during the University Malaya convocation exposition 2002 and the University Malaya Second College Creative Week Open day 2002. On the other hand, Group 1 consists of a total of 210 dengue patients aged 12 years old and above, serologically confirmed dengue patients during their hospitalization in University Kebangsaan Malaysia (HUKM) in the years of 2001 and 2002 [7].

2.2. Method

For each subject, informed consent form was obtained and anthropometrics measurements (height and weight) were taken at admission. Demographic data were recorded using standardized questionnaire data collection forms designed for the study. All subjects were abstained from eating and drinking for 4 hours and physical exercise for 12 hours prior to the BIA measurement. These protocols were implemented to ensure an accurate body composition result [8]. The BIA safety measurements procedure and other safety precautions were made known to the subjects.

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2.3 BIA Measurement

Subjects were asked to lie supine on their bed and two electrodes were placed on the right hand, one at the base of knuckles and another slightly above the wrist joint. Another two electrodes were placed on the right foot, one near the base of the toes and the other slightly above the ankle joint. A constant current less than 1mA at a single frequency of 50kHz [8] was injected to the base of the toes and the signal was pick-up by the other two sensor electrodes (slightly above the ankle and wrist joint).

Each measurement took approximately 3 minutes. Bioelectrical impedance measurement was performed with a biodynamic Model 450 bioimpedance analyzer, from Biodynamic Corporation USA. The subject's profile such as age, sex, height and weight were entered to the BIA 450 analyzer. The analyzer directly measures bioelectrical tissue conductivity and uses regression analysis to compute the mass distribution (BCM and ECM) and water compartments.

3. Statistical Analysis

The statistical analysis was performed using SPSS statistical package version 12 for WINDOWS XP. The clustered error bar chart displaying 95% confidence interval of mass distribution was drawn. Univariate Analysis of Variance (ANOVA) was used to assess whether the mass distribution are significantly different between the healthy subject and dengue patients.

4. Results and Discussions

The BIA measurements have been conducted to 223 healthy subjects (65 males and 158 females) while 210 dengue patients (119 males and 91 females). The subjects' distribution with gender and groups is illustrated in Figure 1.

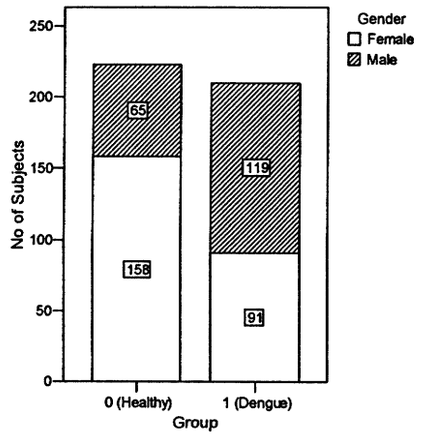

Figure 1: The subject's distribution with gender and groups.

For the healthy subjects, in the racial distribution, the Malay contributes to 63.68% followed by Chinese 30.04%, Indian 2.24% and others 4.04% while for the dengue patients, the Malay contributes to 55.24% followed by Chinese 28.57%, Indian 7.14% and others 9.05%. The subjects' distribution with race and group is illustrated in Figure 2. The ages of healthy subjects vary between 14 and 60 years old with mean age of 26.05 years while the ages of the dengue patients vary between 12 and 83 years old with mean age of 30.14 years.

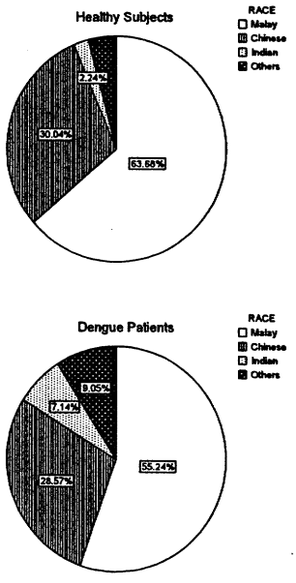

Figure 2 : The subject's distribution with race and groups.

The clustered error bar chart displaying 95% confidence interval of BCM and ECM for day after fever defervesence with gender and groups were drawn as shown in Figures 3 and 4, respectively. Univariate Analysis of Variance (ANOVA) was used to estimate the significantly different of mean value for mass distribution between dengue and healthy subjects. From in Figures 3 and 4, the overall significant value for BCM and ECM between healthy and dengue groups for female was $p<0.001$ while for male was $p<0.05$.

From Figure 3, the mean BCM of dengue patients for both gender were lower than the normal healthy subjects beginning from fever day 0 till day 4. For example, the mean ± standard errors of BCM for female dengue patient on fever day 1 was 32.90±0.28 % which is lower than the control healthy subjects 35.53±0.19% ($p<0.001$). At the same time, the mean value of both groups was higher in male than in

female. The mean ± standard error of BCM for male on fever day 1 was 42.01±0.43% which is higher than in female (32.90±0.28%). There was no specific trend of day effect in BCM for female dengue patient. However, the mean value was increasing from fever day 0 till day 2 while decreasing after fever day 2 for male dengue patient (See table I).

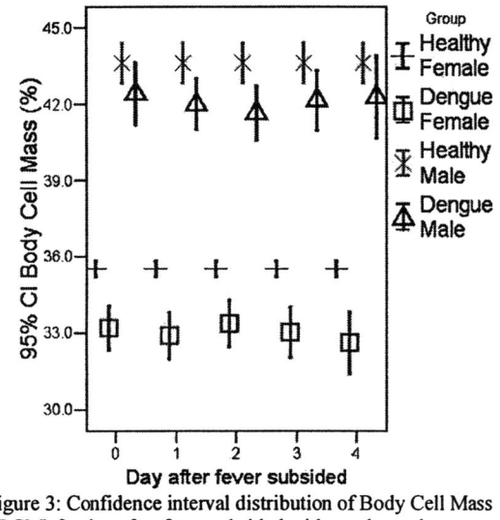

Figure 3: Confidence interval distribution of Body Cell Mass (BCM) for day after fever subsided with gender and groups.

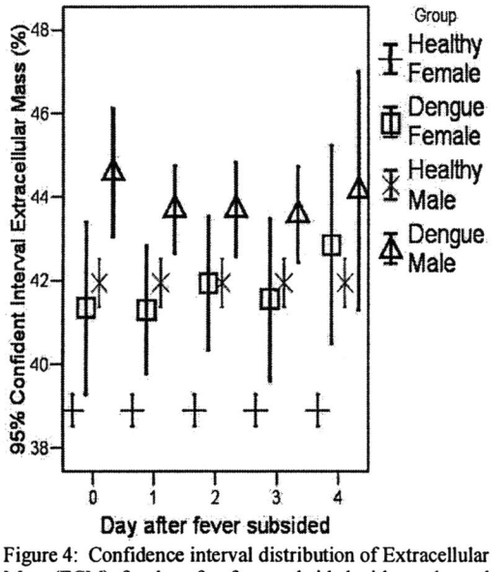

Figure 4: Confidence interval distribution of Extracellular Mass (ECM) for day after fever subsided with gender and groups.

On the other hand, the mean ECM of dengue patients for both female and male were higher than the normal healthy subjects beginning from fever day 0 till day 4 (Figure 4). However, the mean ECM for both groups were higher in male than in female, e.g. the mean ± standard error for healthy male was 41.95±0.53% which is higher than the female mean value (38.90±0.31%). The mean ± standard errors of ECM for male dengue patient on fever day 2 was 43.70±0.45 % which is higher than the control healthy subjects 41.95±0.53 % (p<0.05). There was no specific trend of day effect in ECM for female dengue patient. However, the mean value was decreasing from fever day 0 till day 3 (See table 1).

The ability to measure BCM would provide a reference basis for the measurement of oxygen consumption, caloric requirement, basal metabolic rate and work performance [9]. This study showed that the mean value of BCM in dengue patients was lower than the healthy subjects. The results obtained were in agreement with the depletion of BCM in HIV infection and critical level of BCM must be maintained [10].

Table 1: The Body Cell Mass and Extracellular Mass mean Classification Results for Gender and Groups (Gender Coding; FEMALE=0, MALE=1)

Days	No of Sample	Gender	Mean ± Standard Error	
			BCM (%)	ECM (%)
0	45	0	33.20±0.35	41.35±0.58
1	71	0	32.90±0.28	41.30±0.46
2	63	0	33.37±0.30	41.93±0.49
3	52	0	33.04±0.33	41.56±0.54
4	28	0	32.63±0.45	42.85±0.73
Control	158	0	35.53±0.19	38.90±0.31
0	62	1	42.42±0.51	44.58±0.54
1	89	1	42.01±0.43	43.70±0.45
2	90	1	41.66±0.43	43.70±0.45
3	63	1	42.16±0.51	43.58±0.53
4	29	1	42.28±0.75	44.15±0.79
Control	65	1	43.63±0.50	41.95±0.53

5. Conclusion

The BIA technique provides a non-invasive, simple to use, and reliable method to accurately monitor the changes in mass distribution of dengue patients. The finding indicates that dengue patients were affected in their mass distribution. The mean BCM values of dengue patients were lower than the normal healthy subjects while the mean ECM values of dengue patients were higher than the healthy subjects. These values can be used as an indicator to monitor the daily progress of the pathphysiology changes of the dengue fever and other diseases.

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