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State of Body Bioimpedance Parameters after Massage Therapy

Mohd Riduan Mohamad[1,2]*, Wan Mohd Azhar Wan Ibrahim[2]

[1]School of Biomedical Engineering & Health Sciences, Faculty of Engineering,
Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, MALAYSIA

[2]Department of Biomedical Engineering, Faculty of Engineering,
Universiti Malaya, 50603 Kuala Lumpur, MALAYSIA

*Corresponding Author

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Abstract: Massage therapy is commonly non-invasive, non-harmful, economical, pleasant, and greatly appreciated by the recipients. The Bioelectrical Impedance Analysis (BIA) method has been identified as one of the fastest, simple, and safest non-invasive techniques for measuring the body bioimpedance parameters after the massage therapy. This study aims to evaluate massage therapy's effect on the body bioimpedance parameters of the subject using the Bioelectrical Impedance method. The male bioimpedance parameters were measured before and after massage therapy by using the Microtest 6378 Impedance Analyzer. The measured bioimpedance parameters were capacitance (C), phase angle (θ), impedance (Z), resistance (R), and reactance (X). The other body composition parameters were then calculated, including basal metabolic rate (BMR), fat mass (FM), fat free mass (FFM), total body water (TBW) intracellular water (ICW), and extracellular water (ECW). The measurements of bioimpedance and body composition parameters were significantly different before and after the massage therapy. In addition, the massage therapy increased the capacitance, phase angle, impedance, resistance, reactance, fat mass, and intracellular water. However, the massage therapy decreased the BMR, FFM, TBW, and ECW. The study findings show that massage therapy has a significant impact on bioimpedance and body composition parameters in maintaining good health.

Keywords: Bioimpedance parameters, bioelectrical impedance analysis, body compositions, non-invasive, massage therapy

1. Introduction

The number of people in the United States (U.S.) who had used massage therapy in the earlier year increased from just more than 1 million to more than 1.8 million from 2002 to 2007 [1]. It has been discovered that 36% of adults in the U.S. had used complementary and alternative medicine (CAM) in the previous year based on 31,044 adults aged 18 and older [1]. This data was described in the 2002 National Health Interview Survey [1]. The massage was proven as the top ten frequently-used therapies [2]. In addition, massage therapy could be seen in cultures worldwide for a quite long history [2]. Nowadays, many dissimilar types of massage therapy are used by people for different health-related objectives. Massage therapy has resulted in a wide number of clinical trials and has shown that it can improve pain, muscle tension, and anxiety [3]. However, the study of body bioimpedance parameters that related to massage therapy is rarely discovered and more importantly, the study of body compositions can lead to detect the body fat that is related to blood pressure and other cardiovascular disease risk factors [3], glucose intolerance [4] and also insulin resistance [5]. Thus, this study will provide a general overview of the effects of massage therapy in term of bioimpedance study.

The study was conducted in order to obtain whether massage therapy can affect the body bioimpedance parameters of the subject using the Bioelectrical Impedance method. The objectives of this study were i) to measure the

*Corresponding author: mohd.riduan@utm.my

Bioimpedance (BI) parameters of male subjects before and after 1 hour of massage therapy, ii) to calculate the body composition parameters using the measured BI parameters, iii) to analyze and compare between BI parameters of male subjects before and after 1 hour of massage therapy, and iv) to analyze and compare between body compositions parameters of male subjects before and after 1 hour of massage therapy. The hypothesis of this study was that the bioimpedance and body composition parameters of the subject were not significantly different before and after undergoing massage therapy.

2. Methodology

2.1 Subjects/ participants

A total of 35 male subjects which the age range of 19 – 62 years old was recruited. The subjects were picked up randomly amongst the population in Muar, Johor. The details of subjects were requested in terms of their age, status, weight, height, occupation, place of living, and purpose of having massage therapy. Body mass index (BMI) was then calculated. All subjects completed the consent form before the experiment was conducted. All bioimpedance parameters such as Capacitance; Phase Angle, Impedance; Resistance, and Reactance were measured using the Microtest 6378 Impedance Analyzer. Meanwhile, the body composition parameters such as Basal Metabolic Rate, Fat Mass, Fat Free Mass, Total Body Water, Intracellular Water, and Extracellular Water were derived using the formulas and equations.

2.2 Anthropometry

The baseline procedures of standing height and weight for the subjects were determined before the measurement was conducted whereby the standing height and weight (in light clothing) of the subject were determined without shoes, in duplicate to the nearest 0.5 m and 0.5 kg, respectively. The BMI (kg/m^2) was then calculated after obtaining the standing height and weight.

2.3 Subject Test Position and the Placement of the Sensor Pads

In order to ensure accurate body composition results, the subjects were required to follow the specific guidelines during the measurement. All measurements and the placement of sensor pads were also positioned on the body of the subject based on the standard guidelines from the manufacturers, as shown in Fig. 1.

2.4 Microtest 6378 Impedance Analyzer

The used Microtest 6378 in this study is a non battery-powered bioimpedance analyzer and requires the power of input voltage 90~132 Vac or 198~264 Vac (selectable). With a weight of 9 kg, this analyzer can measure all the well-known measurement parameters, including impedance, phase angle, reactance, resistance, capacitance, and so on. Other than that, it provides a continuous variable frequency from 20 Hz to 5 MHz.

2.5 Statistical Analysis

The data were analyzed based on the statistical analysis using the SPSS version 16.0 for Windows (SPSS Inc., Chicago U.S.A) and Microsoft Office Excel version 2003. Microsoft Office Excel 2003 is a mutual application for Windows that is easy to use as well, as it can give variety of graph structures and presentations.

3. Results

3.1 Demographic Data

There were 22 out of 35 subjects (or 62.85%) who were single. The other 13 subjects (or 37.14%) were married. Most of the subjects were students (49%) and workers (48%), while retired subjects contributed only 3%. The subjects were aged from 19 to 62 years old. The age was classified into three groups as 19–29 years old, 30–39 years old, and 40 and above years old. The subjects were aged between 19 to 29 years old (66%), followed by the range of 30 to 39 (20%) and 40 and above years old (14%). Most of the subjects have an ideal BMI (51.43%). The percentage of overweight and obese subjects was 31.43% and 17.14%, respectively. Most subjects tended to do massage therapy to reduce stress and increase relaxation (53%). Meanwhile, the other purposes of massage therapy were to relieve pain (37%); rehabilitation sports injuries (8%); and others (2%).

3.2 Descriptive Data

The five bioimpedance parameters of the subjects were measured in this study. Those parameters were *C, θ, Z, R*, and *X*. The body composition parameters were derived by using the formulas and equations based on the measured bioimpedance parameters. Body composition parameters under consideration in this study were BMR, FM, FFM,

TBW, ICW, and ECW. All these descriptive data were measured and calculated at the following stages, i.e., before and after the massage therapy.

3.3 Mean Comparison Before and After Massage Therapy

The mean and standard deviation results of bioimpedance parameters were performed in Table 1. Meanwhile, the mean and standard deviation results of body composition parameters were shown in Table 2.

Table 1 - The mean and standard deviation of bioimpedance parameters

	Stage	50 Hz		5 kHz		50 kHz	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
X	Before	16625.46	16018.43	2338.20	8475.01	83.42	76.30
	After	14644.67	12726.98	2531.08	8637.29	102.34	127.28
R	Before	13089.20	10767.75	2094.75	5895.70	449.67	241.26
	After	12128.07	11791.55	2387.75	7041.16	506.65	182.99
Z	Before	25017.92	18334.35	38.52	3094.13	479.47	179.28
	After	21317.53	17648.74	35.45	9178.61	529.81	197.64
θ	Before	1038.57	24.43	33.64	27.56	10.76	25.51
	After	3741.08	24.53	31.92	15.76	11.85	10.74
C	Before	2.86E11	2.95E12	117204.62	87622.61	14570.07	2.11E5
	After	1.24E11	1.42E12	148059.25	99706.08	58365.60	1.36E5

	Stage	100 kHz		200 kHz		500 kHz	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
X	Before	70.01	90.09	100.10	122.93	246.34	199.77
	After	88.07	128.36	118.69	130.85	277.50	166.97
R	Before	443.81	253.37	456.15	261.91	382.72	207.73
	After	495.07	192.76	507.15	210.50	420.94	184.97
Z	Before	467.29	206.95	491.44	241.87	483.70	235.68
	After	514.01	207.96	531.84	217.49	520.68	209.66
θ	Before	7.71	24.32	8.63	24.52	27.29	26.08
	After	10.67	10.80	12.94	12.72	32.33	15.58
C	Before	15203.82	1.56E5	14766.97	93925.75	2003.82	2792.50
	After	88794.53	5.28E5	995.54	33556.43	1661.29	1737.60

Table 2 - The mean and standard deviation of body composition parameters

Frequency	Stage	TBW (kg)		FFM (kg)		FM (kg)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
50 kHz	**Before**	41.54	28.35	56.91	38.84	15.14	36.15
	After	35.85	13.96	49.10	19.13	22.94	20.40

Frequency	Stage	BMR (cals/day)		ICW (kg)		ECW (kg)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
50 kHz	**Before**	1775.60	1211.82	1.56	27.50	43.10	54.54
	After	1532.02	596.73	4.21	13.51	31.64	26.08

4. Discussions

From the results in Table 1, most of the reactance (X) and resistance (C) increased after massage therapy except at 50 Hz. It seems that all measurements of X and R were significantly different before and after the massage therapy. By undergoing massage therapy, the subject's reactance will increase due to the existence of capacitance and energy storage characteristics of the body that intact cell membranes [6]. With the reactance, it is also possible to obtain the body's capacitance and the size and strength of the body cell mass compartment [6]. Meanwhile, a low resistance before massage therapy indicates large amounts of fat-free mass, while a high resistance after massage therapy

indicates low amounts of fat-free mass. Additionally, impedances (Z) increased at different frequencies after massage therapy except at the lowest frequency of 50 Hz and 5 kHz. This shows that all measurements were significantly different before and after the massage therapy. In fact, the value of Z depends on both X and C values.

The results also show that the changes in phase angle (θ) at different frequencies. Mainly, the phase angle increased after massage therapy except at 5 kHz. It seems that all measurements were significantly different before and after the massage therapy. A low phase angle in most frequencies before massage therapy indicates the low reactance in which the cells cannot store energy and sign of failure in the selective permeability of cell membranes [7]. By doing massage therapy, the phase angle increased, and it indicates high reactance, which comprises large quantities of body cell mass and intact cell membranes [7]. It seems that phase angle was proportional to cellular health regardless of subject's weight, either weight increased or decreased.

In terms of capacitance (C), there were some changes in capacitance before and after the massage therapy. It increased at 5 kHz, 50 kHz, and 100 kHz after the massage therapy. However, it decreased at other frequencies such as 50 Hz, 200 kHz, and 500 kHz. Somehow, the measurements seem inconsistent. The errors might cause it during the measurement taken and due to subjects' instability condition after the massage therapy. However, it shows that all measurements were significantly different before and after the massage therapy. A high capacitance reflects great amounts of intact cellular membranes, while a low capacitance reflects poor amounts of intact cellular membranes [6]. It can be stated that capacitance is directly proportional to the size of the body cell mass compartment. Increased capacitance represents the increased number of cells and the quality of cells; or both. However, decreased capacitance represents the reduced body cell mass associated with the patient's health or weight loss [6].

Based on Table 2, all measurements of body composition parameters were significantly different before and after the massage therapy. In fact, the measurements were only conducted at 50 kHz as it is practical for body composition studies [1, 8-9]. The fat-free mass (FFM) and total body weight (TBW) decreased while the fat mass (FM) increased after the massage therapy. Hence, it seems that all measurements of body composition parameters were significantly different before and after the massage therapy. Total body water may be low when dehydrated or losing a lot of fluid. But if it retains fluid or has an infection, TBW may be elevated compared to ideal. It appears that massage therapy will cause some fluids dehydrated in the subject's body [10]. Massage therapy caused the FFM decreased due to the total amount of nonfat (lean) parts of the body reduced. FFM comprises nearly all the metabolically active tissues and all the body's water. Therefore, FFM becomes the source of all metabolic caloric expenditure. Muscle tissue and specific factors can differ the individual's body fat measurement since BIA is based on the fluid levels of FFM [8]. The result also shows increased FM and other extractable lipids from adipose or other tissues in the body after massage therapy.

The results also showed a significantly different basal metabolic rate (BMR) before and after the massage therapy. The measurements of BMR decreased after the massage therapy. The number of calories consumed after having massage therapy decreased, and it seems proportional to the fat-free mass of subjects. If the fat-free mass decreased, the basal metabolic rate also decreased and vice versa [9]. Intracellular water (ICW) measurements were also different after undergoing massage therapy as it seems drastically increased after the massage therapy. Massage therapy caused the fluid inside all body's cells to increase. This is due to the muscle cells and organs such as the liver, kidney, and brain that comprise more water than fat cells [11-13]. Moreover, the measurements of extracellular water (ECW) also changed after the massage therapy. It means that the measurements of ECW as the fluid that circulates outside the cells and all over the body (consisting of blood, extracellular mass, and lymphatic tissue) decreased after massage therapy [11].

5. Conclusion

The statistical data performs the significant result. The measurements before and after massage therapy were significantly different, so the null hypothesis, *Ho* is rejected. Most of the results that consist of bioimpedance and body composition parameters showed significantly different before and after undergoing massage therapy. Therefore, the study has proven that massage therapy can significantly affect bioimpedance and body composition parameters in maintaining a good state of health. The basis finding of this study might be beneficial for the professional massage therapists to describe the advantages of massage therapy.

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