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Original Article

Determination of changes in the basal metabolic rate and body composition of patients with chronic active and inactive hepatitis B infection using bioelectrical impedance analysis*

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Aim: To examine changes in the basal metabolic rate and body composition of patients with chronic inactive and active hepatitis B (HBV) infection as measured using single frequency bioelectrical impedance analysis (BIA) and to investigate the convenience of this method for follow-up with these patients.

Materials and methods: Twenty patients with chronic inactive HBV infection, 22 with chronic active HBV infection, and 43 healthy subjects were enrolled in the study. Using single frequency BIA and basal metabolic rate (BMR), the resistance and body composition of all participants were measured.

Results: A total of 85 subjects (31 female and 54 male) with a mean age of 35.1 ± 11.4 years were enrolled. There was no significant difference between the groups in terms of mean age, height, or body weight ($P > 0.05$). The mean body mass index (BMI) of the participants was 26.55 kg/m². While the BMR was found to be lower, resistance was higher in patients in the inactive group ($P < 0.05$ for both). The body fat index was higher in the inactive group than in the active group, but the difference was not statistically significant ($P > 0.05$). A strong negative correlation was found between BMR and resistance, and the body fat index (rho = –0.804, $P < 0.01$; rho = –0.337, $P < 0.01$, respectively). There was a positive correlation between BMR and BMI (rho = 0.408, $P < 0.05$). There was no significant difference between the groups BMI, phase angle, and other body components ($P > 0.05$).

Conclusion: This study suggests that single frequency BIA is less useful in the follow-up with the aforementioned group of patients.

Key words: Chronic hepatitis B, bioelectric impedance, body composition

Kronik aktif ve inaktif hepatit B enfeksiyonlu hastalarda biyoelektrik empedans analizi ile bazal metabolik hız ve vücut kompozisyonu değişimi

Amaç: Çalışmada, kronik inaktif ve aktif hepatit B enfeksiyonlu hastalarda tek frekans Biyoelektrik Empedans Analiz (BIA) yöntemiyle bazal metabolik hızın ve vücut kompozisyonunun değişiminin saptanması ve bu yöntemin bu grup hastaların takibinde uygulanabilirliğinin araştırılması amaçlandı.

Yöntem ve gereç: Çalışmaya, kronik inaktif HBV enfeksiyonlu 20 hasta ve kronik aktif HBV enfeksiyonlu 22 hasta ile 43 sağlıklı kontrol kişi dahil edildi. BIA yöntemi ile her gruptaki katılımcıların, bazal metabolik hız (BMR), rezistans ve vücut kompozisyonları ölçüldü.

Bulgular: Çalışmaya yaş ortalaması 35,1 ± 11,4 yıl olan toplam 85 kişi (31'i kadın ve 54'ü erkek) katıldı. Çalışma grupları yaş, boy ve vücut ağırlıkları açısından karşılaştırıldığında istatistiksel olarak farklılık yoktu ($P > 0,05$). Katılımcıların

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ortalama vücut kitle indeksi (VKİ) 26,55 kg/m² idi. Kronik inaktif hastalarda BMR düşük iken rezistans yüksek bulundu (ikisi için P < 0,05). Kronik inaktif hastalarda vücut yağ oranı daha yüksek olmakla beraber aradaki fark istatistiksel olarak anlamlı değildi (P > 0,05). BMR ile rezistans ve beden yağ indeksi arasında negatif yönde güçlü bir korelasyon bulundu (sırasıyla, rho = –0,804, P < 0,01; rho = –0,337, P < 0,01). BMR ile VKİ arasında pozitif yönde bir korelasyon vardı (rho = 0,408, P < 0.05). Gruplar VKİ, faz açısı ve diğer ölçülen vücut kompozisyonları açısından karşılaştırıldığında anlamlı bir farklılık görülmedi (P > 0,05).

Sonuç: Sonuç olarak, çalışmamızın sonuçları bu grup hastalarda kullanılan tek frekans BİA yönteminin kronik hepatit B enfeksiyonu olan hastaların izleminde daha az yararlı olduğu düşünülmektedir.

Anahtar sözcükler: Kronik hepatit B, biyoelektrik empedans, vücut kompozisyonu

Introduction

Hepatitis B virus (HBV) is one of the most common causes of acute/chronic hepatitis, cirrhosis, and hepatocellular carcinoma. It is known that 400 million people worldwide have chronic HBV infection, and 1-2 million people die annually because of HBV infection and its complications (1).

Currently, HBV infection rates are decreasing as a result of effective vaccines, but the incidence of obesity is steadily increasing worldwide (2). Symptoms of metabolic syndrome, including fatty liver and hepatic cell damage, are frequently observed in obese people (3). Obesity, in conjunction with chronic viral hepatitis, affects 100 million people. In the presence of a disease that has a synergistic effect with obesity, like HBV infection, the risk of fibrosis, cirrhosis, and hepatocellular carcinoma increases (4,5). Therefore, investigators have tried to find a quick, reliable, and practical way of measuring the body composition of individuals while investigating the correlation of these 2 public health issues using biochemical, viral, and histopathological methods. One method that is being evaluated is single frequency bioelectric impedance analysis (BIA), which involves applying a stimulating low level current to the body at a frequency of 50 kHz and measuring the resistance (bioimpedance) against this current. This is a non-invasive, easy, inexpensive, portable, and effective method for establishing body composition (6,7). The aim of the present study was to determine changes in the basal metabolic rate and body composition of patients with chronic active and inactive hepatitis B infection using single frequency BIA and, furthermore, to investigate the convenience of this method for follow-up with patients.

Materials and methods

Twenty-two patients with chronic inactive HBV (CIHB) infection and 20 patients with chronic active HBV (CAHB) infection presented to the Harran University Medical Faculty in the Infectious Diseases and Clinical Microbiology Department between October 2008 and April 2009 and were enrolled in the study. As a control group, 43 subjects with no known cardiovascular, haematological, endocrinological, or any other chronic diseases were also enrolled in the study. Harran University Medical Faculty Ethical Committee's approval was obtained before starting the study.

Patients who left the study; patients under the age of 18 and over 60 years of age; patients using anti-lipid medications or steroids; pregnant women; patients with other concomitant liver disease (alcohol use, hepatitis D infection, hepatitis C infection), hepatic decomposition, or metal implants (prosthesis and pacemakers); and immunosuppressed patients (HIV infection, medicines, malignancies) were excluded from the study.

The patients were diagnosed as having either chronic inactive hepatitis B infection or chronic active hepatitis B infection according to the guidelines (1). Body weight was measured with a bascule, while the patients wore the least clothes possible and no shoes. Height was measured while the patients were barefoot, with their legs together in an upright position using a height measuring scale. Body mass index (BMI) was calculated using the following formula: BMI = [weight (kg)/height (m^2)]. BMI levels below 18.5 kg/m^2 were defined as underweight, 18.5-24.9 kg/m^2 as normal weight, 25-29.9 kg/m^2 as overweight, 30-39.9 kg/m^2 as obese, and 40 kg/m^2 and above as morbidly obese (8).

The BIA method was used in this study to calculate the components of the body. BIA relies on measuring a vectorial magnitude called impedance (Z), following the application of alternative current to the body (9). Resistance is the defence the body exerts against the conduction of electric current and is exerted by extracellular cells (10). Reactance, on the other hand, is the property of storing electric load for a certain period of time. High reactance values depend on the number of intact cell membranes and can be used as an indirect measurement of body cell mass (6). Bioelectric impedance analysis was performed on all participants following 8 h of rest, and with an empty stomach and bladder. The bio-dynamics BIA 450 (USA Bioimpedance Analyser) was used. The participants were told to drink 7-8 glasses of water the day before the measurement and were advised to avoid tea, coffee, and smoking. Before measurement, metal accessories (belts, cell phones etc.) were removed. Each participant was asked to lie on his or her back on the examination table, without clothes. Standard tetrapolar electrodes were used for measurement. A total of 4 electrodes were utilised; 2 of the electrodes were placed 1 on the right hand, 1 on the right hand wrist, and the 2 other electrodes on the right foot and right ankle. The device was turned on following the placement of electrodes; patient data such as body weight and height were recorded, and the measurement was performed. Body composition parameters [body fat index (BFI), lean body mass (LBM), total body water (TBW), and basal metabolic rate (BMR)] as measured with BIA were matched (age, weight, BMI) with the study group of patients with chronic hepatitis B and were compared to the control group.

When evaluating the data, the percentage, mean, and standard deviation were calculated and used as descriptive statistics. Since the groups in the study did not comply with normal distribution and the variances were not homogeneous, a non-parametric test (Kruskal-Wallis) was used for comparison between groups. The Bonferroni corrected Kruskal-Wallis test was used to compare groups and the Mann-Whitney U test was used to determine which group was different. A P value < 0.05 was considered significant. SPSS (Statistical Package for the Social Sciences) software version 11.5 was used for the statistical analysis.

Results

A total of 85 subjects (31 female and 54 male) with a mean age of 35.1 ± 11.4 (min 18, max 60) years were enrolled in the study including CIHB patients (n = 20, 12 male/8 female; mean age 35.2 ± 14.5 years), CAHB patients (n = 22, 13 male/9 female; mean age 35.2 ± 11.2 years), and control patients (n = 43, 29 male/14 female; 35.0 ± 10.2 years). No significant difference was observed when the study groups' age, gender, weight, or height was compared (P > 0.05) (Table 1).

Table 1. Comparison of groups for age, height, and weight.

	N	Mean value ± S.D.	Chi square*	df	P
Age (year)					
Inactive	20	35.2 ± 14.5	0.084	2	0.959
Active	22	35.2 ± 11.2			
Control	43	35.0 ± 10.2			
Height (cm)					
Inactive	20	168.3 ± 7.3	0.98	2	0.952
Active	22	168.1 ± 6.0			
Control	43	167.5 ± 9.5			
Weight (kg)					
Inactive	20	72.3 ± 11.3	1.974	2	0.353
Active	22	77.5 ± 12.9			
Control	43	74.8 ± 14.8			

* Kruskal-Wallis test was used

The mean body mass index of the participants was 26.5 ± 4.3 kg/m^2; 47.6% of them were overweight and 21.4% were obese. The BMIs in CIHB, CAHB, and control patients were 25.6 ± 4.3, 27.4 ± 4.4, and 26.4 ± 4.1, respectively. The difference between the groups' BMIs was not statistically significant (P > 0.05). A statistically significant difference and positive correlation was observed between the BMI and BMR, as well as between the BFI and age (rho = 0.408, P < 0.01; rho = 0.580, P < 0.01 and rho = 0.551, P < 0.01, respectively).

No significant difference was observed regarding the BMI and body fat indexes between CAHB patients, CIHB patients, and controls.

The basal metabolic rate was lower in CIHB patients. The difference was statistically significant and this difference was due to the inactive hepatitis B group (P < 0.05) (Table 2). A strong negative correlation was found between BMR and resistance, and the body fat index (rho = –0.804, P < 0.01; rho = –0.337, P < 0.01, respectively). There was a positive correlation between BMR and BMI (rho = 0.408, P < 0.05). Resistance was significantly higher in patients with inactive HBV (P < 0.01) (Table 2). We found a negative correlation between BMR and BMI (rho = –0.804, P < 0.01; rho = –0.417, P < 0.01, respectively) and a positive correlation with BFI (rho = 0.337, P < 0.01).

The phase angle was measured as 7.6° in the CIHB patient group, 8.2° in the CAHB patient group, and 6.6° in the control group. There was no significant difference between the groups (P > 0.05). However, there was a negative correlation between the phase angle and extracellular mass (ECM) (rho = –0.469, P < 0.01), and a strong positive correlation between body cell mass (BCM) and intracellular water (ICW) (rho = 0.636, P < 0.01; rho = 0.930, P < 0.01, respectively). There was no significant difference between the phase angle and age, BMR, BMI, resistance, or BFI (P > 0.05).

There was no significant difference in the BCM, ECM, BFI, or ICW between the groups (P > 0.05) (Table 3).

Discussion

Almost one third of the world's population has been infected with HBV (1). Turkey has an intermediate prevalence of HBV infection (11). While the overall incidence of HBV infection is decreasing because of successful vaccination campaigns, the incidence of obesity has been increasing worldwide. According to data from the WHO, there are over 400 million obese and approximately 1.6 billion overweight individuals in the world (2).

Table 2. Comparison of groups for BMR and resistance.

	N	Mean value ± S.D.	Chi square*	df	P
BMR (calories)					
CIHB patients	20	1560.0 ± 269.5			
CAHB patients	22	1776.8 ± 248.4	6.38	2	0.041
Controls	43	1724.9 ± 362.1			
Resistance (ohms)					
CIHB patients	20	638.0 ± 164.9			
CAHB patients	22	512.0 ± 79.1	10.03	2	0.007
Controls	43	533.2 ± 98.8			

* Kruskal-Wallis test was used

Table 3. Comparison of groups with regard to BCM, ECM, BFI, and ICW.

		N	Mean value ± S.D.	Chi square*	df	P
BCM (kg)	*CIHB patients*	20	34.2 ± 9.7			
	CAHB patients	22	38.1 ± 5.4	2.67	2	0.263
	Controls	43	35.7 ± 5.2			
ECM (kg)	*CIHB patients*	20	33.6 ± 8.1			
	CAHB patients	22	35.8 ± 7.6	4.16	2	0.125
	Controls	43	38.1 ± 3.5			
BFI (%)	*CIHB patients*	20	32.0 ± 14.3			
	CAHB patients	22	26.0 ± 8.9	2.50	2	0.286
	Controls	43	26.0 ± 6.9			
ICW (litre)	*CIHB patients*	20	57.4 ± 9.3			
	CAHB patients	22	59.8 ± 9.1	1.56	2	0.457
	Controls	43	56.5 ± 4.9			

* Kruskal-Wallis test was used

In studies performed in Turkey regarding the prevalence of obesity, the rates were found to be 18.6% in 1990, 22% in 2000, and 25.2% in 2002. These figures suggest that the obesity rate is increasing in Turkey (12,13). In the present study, the percentage of obese participants was lower than the prevalence in Turkey (25.2%) (12). The lower rate seen in this study may be due to regional differences or to the small size of the study group. Nevertheless, almost half of the patients were within the limits of obesity. Chronic hepatitis B cases are not exempt from the increasing rate of obesity. These rates were calculated using the BMI classification standardised by the WHO. It is known that people with the same BMI can have different muscle, bone, water, and fat ratios (14,15). In defining obesity as a risk factor for metabolic disorders, the excess fat ratio in the body is taken into consideration (14). In our study, a positive and statistically significant correlation was found between BMI and the body fat index as calculated by the single frequency BIA method.

In obese people, the metabolic syndrome characteristics of fatty liver and liver cell damage are frequently observed (3). While only fatty liver was observed in some of the obese patients, necroinflammation, fibrosis, and cirrhosis may be seen in others. The reason for this is not fully understood; however, alcohol consumption and diseases that synergistically enhance the effects, such as chronic hepatitis B or C infection, are likely candidates (5,16). In Taiwan, patients with chronic hepatitis B and chronic hepatitis C were followed for 14 years, and it was established that diabetes mellitus and obesity had a synergistic effect with viral infection and that these patients had an increased risk of developing hepatocellular cancer (HCC) that was 100 times greater than that of the normal population (4). In a study by Chen et al., performed with anti-HCV positive individuals, the obesity rate was higher in the HCV RNA positive group than it was in the HCV RNA negative group (32.1% versus 18.8%) (4). In the present study, there was no significant difference between the BMI and body fat index in patients with chronically active HBV and high levels of HBV DNA. In the literature, similar studies to this have been performed for HCV infection. As our study was performed with HBV infected patients, the observed differences may be attributable to the differences between viruses.

Altiparmak et al. performed a study wherein they evaluated the role of fat deposition on liver damage in patients with chronic hepatitis B infection and determined which viral and host factors cause fatty liver. They found that metabolic factors in the host, rather than the virus, affected fat deposition in these patients (17). In our study, fat deposition was not significantly different in CAHB patients whose viral load was high. A negative correlation between the phase angle measured by BIA and extracellular water was observed; however, a strong positive correlation was found between the body mass index and intracellular water levels. There were no statistically significant differences between phase angle and age, basal metabolic rate, BMI, resistance, and the body fat index in this study. On the other hand, Guida et al. previously showed a correlation between high phase angle and high BMI (18). While a decrease in phase angle with an increase in age has been established, Barbosa-Silva et al. have stated that the fat tissue resistance may account for this correlation (19). Selberg et al. found that a phase angle below 5.4° in patients with liver cirrhosis is associated with a shorter survival time (20). In contrast to previous studies, no significant correlation was established between phase angle and age or between BMI and body fat index in our study.

When comparing bedside methods that are used to measure the nutritional status of patients with cirrhosis, the determination of body cell mass or phase angle is considered to be superior to anthropometric methods (21). On the other hand, in cirrhosis patients with ascites, the single frequency BIA method is not recommended for evaluation of the nutritional status, for measurement of intra-abdominal ascites or for follow-up (22).

Two recent publications disagreed about whether BIA should be used to evaluate patients with hepatitis C. Antaki et al. found that single frequency BIA did not distinguish between minimal and advanced degrees of hepatic fibrosis in patients with chronic HCV infection (23). As in the present study, they excluded patients with decompensated cirrhosis. The study was designed as a pilot study with a small group of patients. In contrast, Kahraman et al. found that BIA offered a sophisticated analysis of body composition including body fat, body cell mass, and total body water for HCV patients following antiviral therapy (24). In our study, the patients were examined before and after antiviral treatment and compared to untreated HCV patients. Antiviral treatment for HCV is often associated with fatigue, weight loss, and anorexia (25). Therefore, single frequency BIA detects some changes in body composition during therapy.

In the present study, high phase angle values were obtained in CIHB subjects, CAHB subjects, and the control group. Our opinion, which is supported by the literature, is that serious liver damage had not yet developed in the patients included in the study group because cirrhosis was an exclusion criterion; therefore, we cannot draw conclusions regarding serious liver damage.

Studies have shown that the results obtained by single frequency BIA are similar to those obtained by more complicated methods (densitometer, calculation of total body water, etc.) (26, 27). However, measurements performed at different times of day, the electrodes and their position, skin heat, exercise, eating/drinking, and postural changes can affect single frequency BIA (28,29). In our study, to minimise the margin of error the patients were prepared the day before and the measurement was performed at the same time of the day by the same person. However, further studies are needed to determine the sources of error before the method can be used as a reference test.

In Turkey, millions of people have chronic hepatitis B infection and/or obesity. Today, the long-term health risks of these diseases are well defined. There is a need for methods that produce reliable results and that can be used to establish and follow changes in body composition. The development of models that can perform automatic calculations and the marketing of cheaper, smaller, and lighter devices would increase their use in outpatient health care and in field studies. This study and other literature suggest that this method is less useful for follow-up of the aforementioned group of patients.

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