Resting metabolic rate analysis in chronic hemiparesis patients

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Abstract

The objective of the present study was to compare resting metabolic rate (RMR) of chronic hemiparetic patients to sedentary health individuals. The sample was composed of 16 individuals, that were divided into two groups. The first group had eight hemiparetic patients and the second group was formed by eight sedentary individuals. To access and analyze the gases information a VO2000 analyzer was used. The following variables were measured: VO_2, VCO_2, VE, QR, grams of fat (GrFAT), grams of carbohydrate. RMR was calculated based on Weir's equation. There was a significant shift on ventilation variables: VE ($P<0.0003$), VO_2 ($P<0.0004$) and VCO_2 ($P<0.0001$) on hemiparetic individuals group when compared to control group. When the energetic substrate used behavior is observed, it shows that fat consumption (represented by GrFAT) is higher on the hemiparetic group when compared to controls ($P<0.0001$) significant differences were observed for RMR between groups ($P<0.0001$). RMR showed a correlation to VO_2 on the hemiparetic group ($r=0.9277$, $P=0.0022$). To sum up, it was observed through the results that individuals with hemiparesis as a sequel of stroke showed a RMR larger than normal individuals.

Introduction

Metabolism can be defined as a set of chemical reactions that occur in the organisms, including anabolism and catabolism to provide energy for organic functions.[1,2]

Every biological work depends, basically, on the continuous energy delivery. Therefore, for homeostasis maintenance, there must be a constant energy production so that it can be consumed.[3]

The total energetic expenditure (TEE) is composed by: resting metabolic rate (RMR); food thermogenesis, which represents the macronutrients digestion, absorption, and assimilation energetic expenditure and physical activity. The basal metabolic rate (BMR) is the major component of TEE and can be defined as the energetic need for the maintenance of basic vital processes.[4] However, it's difficult to calculate the BMR, once it's measurement should be done during sleep. In this context, RMR is usually used, once it presents a very small difference compared to BMR (about 3%) and it's measurement is easier to obtain because it is done with a resting awake individual on a thermo-neutral and comfortable environment.[4,5]

The RMR is mostly related to the individual's lean mass but is also influenced by the body surface area, fat mass, age, gender and genetics.[6] To determine the RMR, some methods are described on the literature, such as double labeled water, prediction equations like Harris-Benedict formula,[7-9] besides direct and indirect calorimetries.[10] Indirect calorimetry (IC) is held through a calorimeter that has gas collectors and, through an unidirectional valve, the inspired and expired air volumes are measured. This data is used to calculate the RMR and the most used formula is the one proposed by Weir.[10] The IC is a practical, safe and noninvasive method to determine the RMR through gases exchange measurements (VO_2 and VO_2). It allows the determination of respiratory quocient (RQ), which reflects the relationship between produced CO_2 and consumption O_2, indicating the oxidation of the major energetic substrates.[8,11] Some authors have been investigating clinical conditions that alter the RMR.[12-14] However, the literature about RMR is scarce on patients that suffered a stroke, in spite of its high incidence.[15-17] Through the functional musculoskeletal sequels, metabolic alterations haven't been attracting substantial interest from researchers. One of the dysfunctions provoked by stroke, hemiparesis, is highlighted with high prevalence and incidence.[15-18]

About metabolic modifications, there are few papers regarding RMR, specially in chronic hemiparetic patients. We hypothesize that chronic hemiparetic patients would present a higher RMR when compared to healthy individuals. Based on this, the objective of the present study was to compare RMR of chronic hemiparetic patients (due to stroke) to sedentary healthy individuals.

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Key words: energy metabolism, calorimetry, stroke, respiratory muscles, rehabilitation.

Contributions: the authors contributed equally.

Conflict of interests: the authors declare no potential conflict of interests.

Received for publication: 16 April 2014.
Revision received: 13 August 2014.
Accepted for publication: 2 September 2014.

Neurology International 2014; 6:5442
doi:10.4081/ni.2014.5442

Materials and Methods

This is a study with cross-sectional design with a sample of 16 individuals (male and female), that were divided into two groups. The first group had eight hemiparetic patients (1F/7M) that underwent treatment at Plínio Leite University Center Clinic School (Brazil) and the second group was formed by eight sedentary individuals (1F/7M). The sample was characterized and paired according to age, genre, weight, height and body mass index (BMI). This is a transversal study. All participants signed an informed consent, according to resolution 196/96 of Brazilian National Health Council and approved by Research Ethical Committee.

Experimental protocol

The evaluation of body mass was done using a scale with bioimpedence (Welmy, Santa Bárbara d'Oeste, São Paulo, Brazil). The experimental protocol was performed at a evaluation room with controlled temperature (21.6±1.0°C, range: 19-22°C) and with verifi-

cation of barometric pressure and relative air humidity (62.5±4.1%, range: 50-70%).[6] The individuals were evaluated with a four-hour fasting. The subjects stayed at rest on supine with head elevation at 30 degrees for 20 minutes. After this period, vital signs were measured (heart rate, breathe rate and arterial pressure). To access and analyze gas information, VO2000 analyzer was used (Medical Graphics, Saint Louis, MO, USA) and it was linked to a low flow pneumotach (Medical Graphics).[11] All individuals were coupled to a mouthpiece and used a nasal clip. The data collection was made at breath-by-breath for 20 minutes. The following variables were measured: VO_2, VCO_2, VE, QR, grams of fat (GrFAT) and grams of carbohydrate (GrCHO). RMR was calculated based on Weir's equation: $RMR=[3.941(VO_2)+1.106(VCO_2)]\times1140$ and the results expressed as kcal/day.[10]

Data analysis

The sample size was calculated adjusting the statistical power to 80% and the alfa error to 0.05. To analyze the results and plot the graphs, SigmaStat 3.1 (Jandel Scientific, San Rafael, CA, USA) and SigmaPlot 9.01 (Jandel Scientific) programs were used, respectively. The normal distribution of the data was verified using Kolmogorov-Smirnov test (Lilliefors correction) and the variance homogeneity through Levene's test. To compare the groups, Mann Whitney test was used and differences equal to or smaller than 0.05 were considered significant.

Results

Anthropometric and hemodynamic characteristics and age means were similar between groups (Table 1). There was a significant shift on ventilation variables: VE ($P<0.0003$), VO_2 ($P<0.0004$) and VCO_2 ($P<0.0001$) on hemiparetic individuals group when compared to control group. However, there was no difference on the RQ ($P=0.0830$), as shown in Figure 1. When the energetic substrate used behavior is observed, it shows that fat consumption (represented by GrFAT) is higher on the hemiparetic group when compared to controls ($P<0.0001$). There were no significant differences on carbohydrate consumption (represented by Gr CHO) between groups. Significant differences were observed for RMR between groups ($P<0.0001$), as shown in Figure 2. RMR showed a correlation to VO_2 on the on the hemiparetic group ($r=0.9277$, $P=0.0022$), but this behavior was not observed on control group ($r=0.2395$, $P=0.5821$). There were no correlation between Ashworth scale and BMR ($r=-0.03280$, $P=0.4279$).

Discussion and Conclusions

Basal metabolic rate comprises 60-75% of an

Table 1. Anthropometric and hemodynamic characteristics.

Variable	Hemiparetic (mean±SD)	Health (mean±SD)	P
Age (years)	51.6±21.4	51.1±21.1	0.7111
Body mass (kg)	74.1±17.3	73.5±14.1	0.9591
Height (cm)	171.3±5.8	169.6±4.5	0.5054
BMI (kg/cm²)	23.9±5.2	25.5±4.6	0.4266
SBP (mmHg)	126.2±5.1	128.7±9.9	0.8566
DBP (mmHg)	86.2±5.1	85.0±5.3	0.3558
HR (bpm)	78.9±7.0	73.1±7.4	0.2469

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

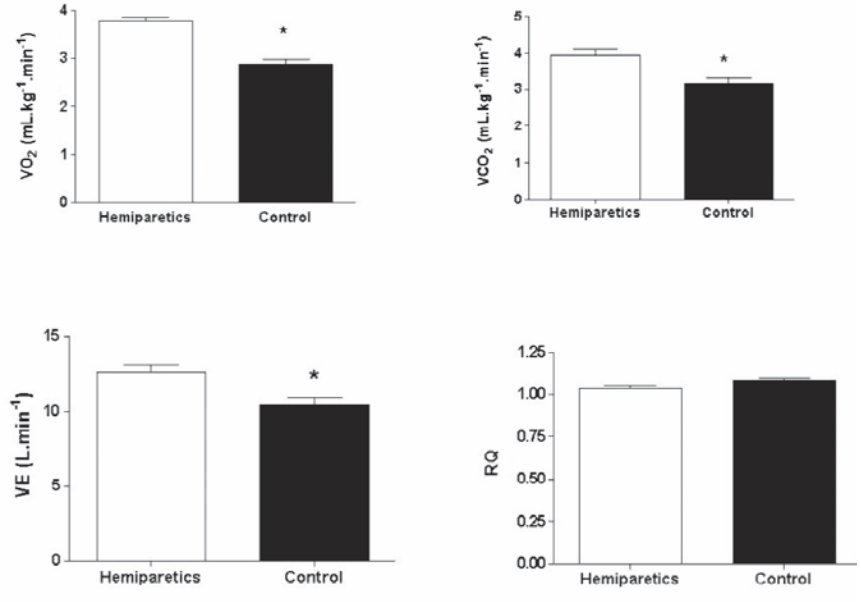

Figure 1. Comparison between hemiparetic and control groups for ventilation variables (VO_2, volume of oxygen; VCO_2, volume of carbon dioxide; VE, ventilation; RQ, respiratory quotient).

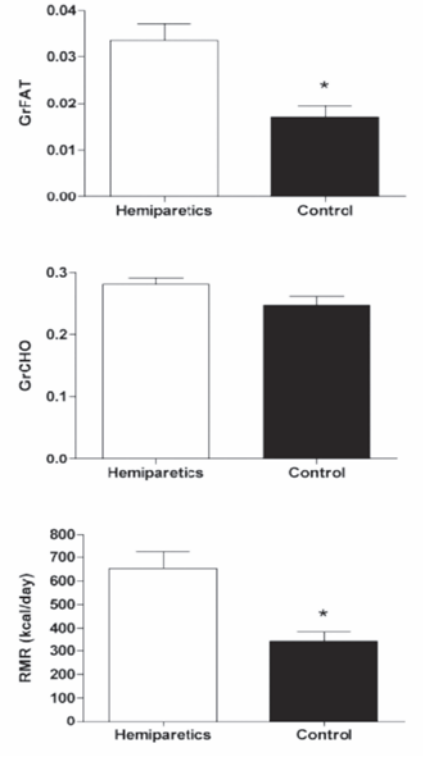

Figure 2. Comparison between hemiparetic and control groups for metabolic variables (RMR, resting metabolic rate; Gr FAT, grams of fat; Gr CHO, grams of carbohydrate).

individual's daily energetic expenditure and many factors may contribute to its elevation as well as age, genre, body composition, food induced thermogenesis, exercise's thermal effect, hormonal status, climate, caffeine and tobacco consumption.[14]

In this study, we observed higher BMR values for hemiparetic individuals when compared to controls, and the highest values were obtained from the youngest individuals of the sample. These findings are not according to the description of Van Pelt *et al.*[19] study in which they investigated physical activity effects on health individuals BMR and concluded that younger individuals presented smaller BMR. Finestone *et al.*[20] realized a study involving male and female hemiparetic patients, mean age 69±11.3 years, and demonstrated BMR behavior as well as the energetic substrate used by these patients, through indirect calorimetry method. The evaluation was made at the moment of stroke diagnosis (admission) and at the 7th, 11th, 14th, 21th and 90th days after admission. They observed that for the 7th, 11th and 90th days, BMR was higher when compared to admission, however, on days 14 and 21, it was lower than admission. At the 90th day, BMR of hemiparetic group was similar to the control group. In our sample, we have chronic patients (more than 6 months since stroke) and we found a higher BMR in the hemiparetic group when compared to control group. In this study, we observed no significant difference between the mean carbohydrate consumption on both groups, but when fat consumption was analyzed, it showed a significant difference between groups, what suggests that this is the major substrate to generate energy to maintain the high energetic expenditure of hemiparetic patients. Body fat is the most abundant potential energetic source and its production is almost unlimited. It represents about 90,000 to 110,000 kcal. The body energy reserve in the form of carbohydrates comprehends less than 2000 kcal. The shift on striate skeletal muscle work leads to lipolysis, which shifts the fat use to produce energy.[21] This could justify our findings, specially due to the possibility of respiratory muscles' work intensification. We believe that differences found on BMR, VE, VO_2 and VCO_2 of hemiparetic patients when compared to control individuals are due to functional alterations that happen to these individuals, especially in respect to diaphragmatic function. This hypothesis corroborates the study of Fugi-Meyer *et al.*,[22] which developed a experimental protocol to evaluate the respiratory function of 54 hemiplegic or hemiparetic stroke patients. They described an alteration on diaphragmatic function shown through ultrasound when compared to healthy individuals and the authors correlated this phenomenon to spasticity graduation. Neurological sequels due to stroke are known to alter diaphragmatic muscle function, both in acute and chronic conditions,[23-25] and it directly affects diaphragmatic mobility and range of movement. We believe that these important functional alterations on the major ventilation musculature leads to a greater VO_2 in special like hemiparesis (in normal conditions, in consumption 1-3% VO_2 to play its role).[23] This could justify one of our findings about a greater fat substrate utilization on the hemiparetic group when compared to control and also the greater BMR.

Besides that, neurological commitment can compromise diaphragmatic function, once during normal ventilation the hemidiaphragm of paretic side has a normal mobility,[24] however, on forced inspiration, diaphragmatic excursion is shorter. A bigger excursion on the non-affected side may result from a compensatory shift on neural activity on the correspondent hemisphere or from a reduction on impedance of diaphragm movement on that side.[26] As a result, we would have a greater energetic expenditure and a bigger BMR. In conclusion it was observed through the results that individuals with hemiparesis showed a RMR larger than normal individuals. We suggest that a new study addressing the theme should be carried.

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