ROLE OF BODY BIOELECTRICAL IMPEDANCE ANALYSIS IN THE ASSESSMENT OF THE NUTRITIONAL STATUS OF PATIENTS WITH INFLAMMATORY BOWEL DISEASE AND METABOLIC SYNDROME

Article *in* Proceedings of the Latvian Academy of Sciences Section B Natural Exact and Applied Sciences · January 2012

CITATIONS
0

READS
86

1 author:

Edgars Bodnieks
Paula Stradiņa Klīniskā Universitātes Slimnīca
4 PUBLICATIONS **0** CITATIONS

SEE PROFILE

PROCEEDINGS OF THE LATVIAN ACADEMY OF SCIENCES. Section B, Vol. 66 (2012), No. 3 (678), pp. 20–30.

Short Communication

ROLE OF BODY BIOELECTRICAL IMPEDANCE ANALYSIS IN THE ASSESSMENT OF THE NUTRITIONAL STATUS OF PATIENTS WITH INFLAMMATORY BOWEL DISEASE AND METABOLIC SYNDROME

Edgars Bodnieks*, Aldis Puķītis**, and Juris Pokrotnieks*

* Gastroenterology Centre, Pauls Stradiņš Clinical University Hospital, Pilsonu iela 13 , Rīga, LV-1002, LATVIA

** Faculty of Medicine, University of Latvia, Šarlotes iela 1a, Rīga, LV-1001, LATVIA
bodnieks@e-apollo.lv

Nutrition has an important role in the management of inflammatory bowel disease (IBD) and metabolic syndrome (MS). The goal of this study was to assess the nutritive status of patients treated with IBD and metabolic syndrome in the Gastroenterology Centre, Pauls Stradiņš Clinical University Hospital. Body bioelectrical impedance analysis (BIA) using GENIUS 220 PLUS (Jawon Medical) was used to determine Body Mass Index (BMI) kg/m², Metabolic Body Fat (MBF) kg, Soft Lean Mass (SLM) kg, Total Body Water (TBW) kg, body composition, metabolic type, Basal Metabolic Rate (BMR) kcal, and total Energy Expenditure (TEE) kcal in patients with IBD and metabolic syndrome and in a similarly aged control group. The obtained data showed that BMI was not correlated with MBF, BTW and body lean mass. Patients with Crohn's disease (CD) had normal value of BMI (M 24.3 kg/m²; F 20.2kg/m²), but we found variety-specific differences in body composition that confirmed deficiency or increase of specific body parameters. The performed prospective study confirmed the importance of the more precise nutritional status analysis, as it was clinically useful for the nutritional management of IBD. Patients with CD had expressed nutrient deficiency, sarcopenia, and reduced amount of proteins and minerals. For patients with MS, sarcopenia was present despite obesity.

Key words: *bioelectrical impedance, inflammatory bowel disease, nutritional status.*

Body composition reflects nutritional intake, which is correlated with the development of diseases, their clinical outcomes and human quality of life. Assessment of human body composition includes the measurement of body fat, fat-free mass (FFM), and total body water (TBW). FFM can be further separated into lean soft tissue, including water, and bone. Excesses or depletions of fat and FFM are associated with an increased risk of some chronic diseases. The amount of FFM is considered to be directly correlated with health and longevity (Hartman *et al*., 2009). FFM is an important predictor of survival in some critical illnesses and malignancies. A significant component of the change in body weight with aging is attributable to an increase in body fat or a decrease in TBW secondary to a decrease in muscle or body cell mass (Steen *et al.,* 1997*;* Chumlea *et al.,* 1999). An alternative method for body-composition assessment is bioelectrical impedance analysis (BIA). This method has practical features similar to anthropometry (e.g., safety, cost effectiveness, convenience for the patient, and ease of use), and it has been used in large-scale studies of body composition and assessment of body fluid status and malnutrition (Thibault *et al.,* 2012). Malnutrition is common in patients with inflammatory bowel disease (IBD), especially in active Chron's disease (CD). Several studies have documented weight loss in 70–80% of hospitalised IBD patients and in 20–40% of outpatients with CD. The prevalence of malnutrition is lower in patients with ulcerative colitis (UC), but nutritional deficiencies can develop fast in these patients during periods of active phase of the disease (Hartman *et al*., 2009). Evaluation of malnutrition in the early stage for long-term management of autoimmune diseases like IBD, which affects the treatment and complication rate, was the main goal of our study.

The retrospective pilot study was carried out on patients treated with IBD in the Pauls Stradiņš Clinical University Hospital. The group used was those patients evaluated in a three-year period from 2003 to 2006 when the hospital had the highest number of in-hospital patients with IBD. Anthropometric data, inflammatory activity, biochemistry rates and types of complications for 376 patients (116 patients with CD and 260 with UC) were analysed. In the study group, the incidence of UC was more than two times higher than CD. The highest malnutrition rate was found (80%) in the group of patients with CD. This group of patients was selected for targeted examination of the data from archives, grouped by disease registry codes. To assess the biochemical differences in CD and UC, we used data from

the year 2006, when the total number of patients was 83 (UC 51, CD 32). Total protein, albumin, hemoglobin, serum iron, c-reactive protein, height and weight were determined in a set of ten randomly selected patients from each group. On the basis of the obtained data, a prospective study included 28 persons for body bioelectrical impedance analysis (BIA). Body composition analysis in the study group (seven females, seven males) and the same age control group (ten females, four males) was performed. Eight patients with metabolic syndrome (four males, four females), and six patients with IBD (CD three females, one male and UC two males) were included for determination of body mass index (BMI) kg/m², metabolic body fat (MBF) kg, soft lean mass (SLM) kg, total body water (TBW) kg, body composition, metabolic type, basal metabolic rate (BMR) kcal, total energy expenditure (TEE) kcal, protein (kg), and minerals (kg) using bioelectrical impedance technology GENIUS 220 PLUS (Jawon Medical, Korea). Specification: Measuring method BIA via tetra-polar electrode method using eight touch electrodes. Frequency range: 5, 50, 250 kHz. Measuring site: whole body. Main items: protein mass, mineral mass, mass of body fat, total body water, soft lean mass, lean body mass, weight, BMI, age matched of body, basal metabolic rate, TEE, waist to hip ratio analysis. Power consumption: 30VA. Measuring range: 100~950 ?. Measuring time: within 30 seconds. Input height: 100~200 cm. Measuring weight: 10~250 kg. Applicable age: 5~89 years old. Operation ambient: temperature 10~40 ^{o}C, humidity 30 ~ 75% (non condensing). Humidity lower than 95% (non condensing).

Statistical processing was conducted using MS Excel 2007 and SPSS 20.0 software. Three patients with CD had body fat mass less than 8%. As the BI analyzer fails to register such low body composition parameters, these patients were not included in the statistical analysis.

The main mechanisms responsible for malnutrition in IBD are related with autoimmune response. Active disease may cause malnutrition. The most important causes of malnutrition are due to reduced food intake, presence of active inflammation and enteric loss of nutrients during periods of disease activity and remission. Anorexia, secondary to abdominal pain, increased levels of pro-inflammatory cytokines (tumour necrosis factor-α, interleukin IL-1 and IL-6), adipokines (leptin, adiponectin, resistin) and suspected alterations in hypothalamic serotonin levels are considered the main causes of reduced food intake. Our retrospective data showed that BMI was not correlates with body fat mass MBF, BTW and BLM. The mean values for of CD vs. UC groups, respectively, were: BMI (kg/m²) 17.3 ± 2.0 vs. 23.5 ± 3.1; Tot. Protein (g/l) 61.2 ± 4.7vs. 73.2 ± 6.2; Albumin (g/l)36 ± 6.9 vs. 42.7 ± 8.4; Hb (g/l) 118.2 ± 11.3 vs. 121.2 ± 14.3, Fe (mkmol/l) 11.2 ± 2.8 vs. 12.46 ± 3.1, CRO (mg/l) 19.47 ± 4.2 vs.15.54 ± 4.1. CD patients had reduced BMI (mean 17.31kg/m²) and had more frequent complications (mainly surgical: small bowel obstruction, stenosis, and fistulas). Our data showed mainly reduced BMI, in comparison with the study conducted by Valentini (Valentini *et al.,* 2008), where 32% of patients with CD had BMI 25 kg/m^2. Diet analysis showed that patients had lower fat free mass and significantly lower adjusted mean daily intakes of carbohydrates, monounsaturated fat, fibre, calcium, and vitamins C, D, E, and K. Muscle mass depletion was detected in more than half of CD and UC patients, even in the absence of malnutrition. BMI, arm muscle area and triceps plus subscapular skin fold thickness values were significantly lower, but only in the active phase of CD (Valentini *et al.,* 2008). Bioelectrical impedance analysis is a more precise method for body composition assessment to determine basal metabolic rate and total energy expenditure. Our data confirmed that patients with CD had a normal mean value of BMI (male 24.3 kg/m²; female 20.2 kg/m²), but the body composition analysis showed variety-specific differences in body structure, which indicated deficiency or increased specific body parameters (see Table 1). Measurement of bioelectrical impedance was calculated with an average reliability of 95%. The calculated mean values by the analyzer (BMI and BMR) were determined with deviation.

So far studies on energy metabolism in patients with CD have been contradictory. Energy expenditure has been reported to be increased, normal, or even reduced in IBD patients, compared with healthy individuals. This is because patients with different disease extension, inflammatory activity, and nutritional status have been grouped together. However, when adjusted for body composition, increased resting energy expenditure (REE) has generally been disclosed (Hartman *et al*., 2009).

Assessment of human body FFM may be further separated into lean soft tissue, including water, and bone. Excesses or depletions of fat and FFM are associated with an increased risk of development of chronic diseases. A prospective, controlled, multicentre study evaluating the nutritional sta-

Table 1

STUDY RESULTS OF BIOELECTRICAL IMPEDANCE DATA TO ASSESS PATIENTS' BODY COMPOSITION

Average value	Controle group		IBD			Metabolic steatosis		Norma	
			CD		UK				
	M n=4	F n=10	M n=1	F n=3	M n=2	M n=4	F n=4	M	F
TBW %	**57,4**	**52,8**	↓54,7	**56,6**	**57,6**	↓51,9	↓43,9	**55 - 65**	**45 – 60**
Protein %	**16,5**	**14,8**	↓15,5	**16,2**	**16,6**	↓14,5	↓11,4	**16 - 18**	**14 - 16**
Mineral %	**5,8**	**5,8**	↓5,7	**5,8**	**5,8**	↓5,7	**5,6**	**5,8 - 6**	**5,5 - 6**
MBF %	**20,3**	**26,8**	↑24,0	**21,4**	**20,0**	↑27,8	↑39,1	**15 - 20**	**20 - 30**
SLM %	↓73,9	**67,5**	↓70,3	**72,8**	**74,2**	↓66,4	↓55,3	**74 - 80**	**64 - 80**
LBM %	↓73,6	↓68,4	↓76,0	**78,6**	**80,0**	↓72,2	↓60,9	**80 - 85**	**70 - 80**
BMI kg/m²	20,7	22,6	24,3	20,2	24,6	**↑31,0**	**↑32,2**	**18,5 - 24,9**	
BMR kcal	1493,5	1213,3	1660	1168,3	1533	1725,7	1303		
TEE kcal	2474,7	1868,5	2556	1713,6	2360,5	2942,2	1864		

CD, Crohn`s disease; UC, ulcerative colitis; MFB, metabolic body fat; SLM, soft lean mass; LBM, lean body mass; BMR, basal metabolic rate; BMI, Body Mass Index TBF, total body water; TEE, total energy expenditure.

tus, body composition, muscle strength, and quality of life in patients with IBD in clinical remission showed that, despite most patients being well nourished (74%), both CD and UC patients have decreased body cell mass and handgrip strength (as a functional measure of nutritional status), when compared to controls. The study showed that the most prevalent form of malnutrition in CD patients is associated with excess body weight, coupled with inadequate dietary intake of micronutrients, secondary to dietary exclusion of certain foods. Moreover, in spite of appropriate intakes of energy and macronutrients, CD patients in remission have significantly lower plasma concentrations of several mentioned vitamins and minerals. A variety of nutritional and functional deficiencies have been observed in patients with active or inactive CD. The prevalence of malnutrition had decreased as awareness has increased. Recent studies showed that most patients in remission are in a good nutritional status and some are even overweight, but still have significant abnormalities in body composition (Sousa Guerreiro *et al.,* 2007). A significant component of the change in body weight with aging is attributable to an increase in body fat or a decrease in TBW secondary to a decrease in muscle or body cell mass. One limitation of this anthropometric approach is the reduced ability to differentiate levels of fatness and leanness among individuals. An alternative method for body-composition assessment is BIA. This method has practical features similar to anthropometry (e.g., safety, cost-effectiveness, convenience for the patient, and ease of use), and it has been used in large-scale studies of body composition and assessment of body fluid status. BIA measures of resistance and impedance are proportional to body water volume, if body electrolyte status is normal, and to the length of the conductor or stature (e.g., stature/resistance). This method uses regression analysis to derive prediction models to estimate FFM (Sun *et al.,* 2003). Our study demonstrated that patients with CD had nutrient deficiency observed as sarcopenia, reduced proteins and minerals. Conversely, in patients with metabolic syndrome, where, despite obesity, sarcopenia was present. (See Table 1)

Body composition reflects nutritional intakes, losses and needs over time. Undernutrition, i.e. fat-free mass (FFM) loss, is associated with decreased survival, worse clinical outcome and quality of life. In numerous clinical situations, such as obesity and chronic diseases, the measurement of body composition with available methods, such as dual-X ray absorptiometry, computerised tomography and BIA, can quantify the loss of FFM, whereas body weight loss and body mass index only inconstantly reflect FFM loss (Thibault, *et al*., 2012). Easy-to-use body composition methods such as BIA integrated to the routine of care allow sequential measurements for an initial nutritional assessment and objective patients follow-up.

Summarising the above discussion, we can conclude that body composition analysis for patients with inflammatory bowel disease (CD and UC), allows to perform more accurate control of the activity of the disease, efficacy of medical treatment and complication rate. Assessment of the nutritive status using BIA of patients with IBD showed that patients with CD had more expressed malnutrition, confirmed by decrease of total protein, TBW, SLM and LBM. Patients with metabolic syndrome had decrease of total protein, TBW, SLM and LBM, in spite of significant increase of the body mass index. Earlier and objective management of undernutrition, body composition assessment could contribute to reduce undernutrition-induced morbidity, worsening of quality of life, and health care costs by a timely nutrition intervention.

REFERENCES

Hartman, C, Eliakim, R, Shamir, R. (2009). Nutritional status and nutritional therapy in inflammatory bowel diseases. *World J. Gastroenterol*., **7**; **15**(21), 2570–2578.

Steen, B. (1997). Body water in the elderly: A review. *J. Nutr. Health Aging,* No. 1,142–5.

Chumlea, W.C., Guo, S.S., Zeller, C.M., Reo, N.V., Siervogel, R.M. (1999). Total body water data for white adults 18 to 64 years of age: The Fels Longitudinal Study. *Kidney Int.,* **56**, 244–252

Thibault, R., Genton, L., Pichard, C. (2012). Body composition: Why, when and for who? *Clinical Nutrition,* Aug. 31(4)*,* 435–447.

Sousa-Guerreiro, C., Cravo, M., Costa, A.R., Miranda, A., Tavares, L., Moura-Santos, P, MarquesVidal, P., Nobre Leitao, C. (2007). A comprehensive approach to evaluate nutritional status in Crohn's patients in the era of biologic therapy: A case control study. *Amer. J. Gastroenterol*., **102**, 2551–2556.

Valentini, L., Schaper, L., Buning, C., Hengstermann, S., Koernicke, T., Tillinger, W., Guglielmi, F.W., Norman, K., Buhner, S., Ockenga, J., Pirlich, M., Lochs, H. (2008). Malnutrition and impaired muscle strength in patients with Crohn's disease and ulcerative colitis in remission. *Nutrition*, **24**, 694–702.

Sun, S. S., Chumlea, W. C., Heymsfield, S. B., Lukaski, H. C., Schoeller, D., Friedl, K., Kuczmarski, R. J., Flegal, K. M., Johnson, C. L., van Hubbard. S. (2003). Development of bioelectrical impedance analysis prediction equations for body composition with the use of a multi component model for use in epidemiologic surveys. *Amer. J. Clin. Nutr.,* **77**, 331–340.

BIOELEKTRISKĀS IMPENDANCES ANALĪZES LOMA PACIENTU AR IEKAISĪGU ZARNU SLIMĪBU UN METABOLO SINDROMU ĶERMEŅA BAROJUMA STRUKTŪRAS IZVĒRTĒJUMĀ

Uzskata, ka cilvēka barojumam ir svarīga loma iekaisīgu zarnu slimību un metabolā sindroma attīstībā. Šī pētījuma mērķis bija izvērtēt ķermeņa barojuma struktūru divām atšķirīgām pacientu grupām Paula Stradiņa klīniskās universitātes slimnīcas, Gastroenteroloģijā centrā, kuriem diagnosticētas iekaisīgas zarnu slimības un metabolais sindroms, pielietojot ķermeņa bioelektriskās impedances analīzi. Ar Genius 220 Plus (*Jawon Medical*) aparatūru tika veikts ķermeņa masas indeksa (ĶMI), tauku daudzuma, atlieku masas, kopējā ķermeņa ūdens satura, ķermeņa barojuma struktūras, vielmaiņas tipa, bazālā metaboliskā līmeņa un kopējā enerģijas patēriņa novērtējums. Pēc iegūtajiem datiem redzams, ka ĶMI nekorelē ar metabolisko tauku daudzumu, kopējā ķermeņa ūdens satura un ķermeņa atlieku masas parametriem. Pacientiem ar Krona slimību vidējie ĶMI dati (vīr. 24,3 kg / m²); (siev. 20,2 kg / m²) bija neizmainīti, bet tika konstatētas būtiskas barojuma struktūras atšķirības, kas apstiprina standarta ĶMI aprēķinu nepilnības. Prospektīvā pētījumā pierādīts, ka precīzāka barojuma struktūras analīze ir klīniski lietderīga Krona slimnieku ārstēšanā, kur lielākajai daļai pacientu konstatē uzturvielu trūkumu, sarkopēniju, kas ir saistīta ar olbaltumvielu un minerālsāļu deficītu. Pacientiem ar metabolo sindromu tika konstatēta sarkopēnija, neskatoties uz aptaukošanos un palielinātu ĶMI.