

Assessment of changes in body composition measured with bioelectrical impedance in patients operated for pancreatic, gastric and colorectal cancer

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
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Article history: Received: 13.05.2019 Accepted: 05.02.2020 Published: 07.02.2020

ABSTRACT:

Introduction: A proper level of nutrition is significant in the period of convalescence in patients subject to major surgical procedures, particularly due to neoplastic disease. Bioelectrical Impedance Analysis, or BIA is a widely used method in assessing body mass composition. BIA measurement is easy, quick, cheap and repetitive.

Material and methods: We assessed the body composition of 56 patients (25 women and 31 men) hospitalized and operated at the Department of General and Oncological Surgery of the Wrocław Medical University in the years 2017–2018 using bioelectric impedance.

Results: The average body weight loss in the 4th postoperative day was 1.32% of body mass and on the day of release from hospital – 4.23% of body mass in relation to body mass upon admission. The percentage of body fat (FM – Fat Mass) in patients admitted to the department is above the normal range. The change in body composition in hospitalized patients mainly concerns the amount of adipose tissue and the amount of extracellular and intracellular water (ECW – Extracellular Water; ICW – Intracellular Water).

Conclusions: Bioelectrical impedance can be an easy and effective method of assessing body composition and its change in patients undergoing major surgery. Amongst the analyzed groups, patients operated for pancreatic cancer lose the largest percentage of body weight until discharge from the department. Loss of body mass mainly occurs as loss of fat mass (FM).

KEYWORDS:

body composition, bioelectrical impedance, colorectal cancer, pancreatic cancer, stomach cancer

ABBREVIATIONS

BCM – body cell mass
BIA – Bioelectrical Impedance Analysis
BMI – Body Mass Index
ECW – Extracellular Water
ERAS – Protocols for Enhanced Recovery After Surgery
FFM – free fat mass
FM – Fat Mass
ICW – intracellular water
MM – muscle mass
TBW – total body water
WHO – World Health Organization

INTRODUCTION

Bioelectrical Impedance Analysis, or BIA is a technique widely used to assess body composition. It is used, among others, to assess the hydration and nutrition of patients in various medical fields, including in nephrology and cardiology or sports medicine. Body composition parameters such as BMI (Body Mass Index), muscle mass (MM) or fat mass (FM) and phase angle may be risk factors for complications in patients undergoing surgery [1].

Beside the necessary equipment, knowledge of the patient's anthropometric data such as gender, age, height and weight are required to perform measurements. The enormous advantage of this test is

its non-invasiveness, low cost and ease of use as well as confirmed accuracy in estimating body composition in relation to reference values, which was also confirmed in patients with cancer [2–5].

An adequate level of nutrition affects the overall functioning of the body, the activity of the immune system and the ability to regenerate. It is particularly significant during the recovery period in patients undergoing surgery primarily due to cancer [6, 7]. According to Veltkamp et al., the loss of over 10% of body weight in the 3 months preceding surgery is one of the main risk factors for serious complications [8], while up to 20% of cancer patients die of cachexia [9]. For that reason, an adequate nutritional status of the patient becomes a major element in the treatment of patients operated for cancer. The present paper assessed body composition and its change in patients undergoing surgery due to gastric, pancreatic and colorectal cancers.

MATERIAL AND METHODS

We assessed 56 patients (25 women and 31 men) with an average age of 66.0 years (median 67.0 years) who were hospitalized and operated at the Department of General and Oncological Surgery of the Wrocław Medical University in 2017–2018. The patients were divided into 3 groups. The first group were patients operated for stomach cancer (n = 23), the second group was operated for pancreatic cancer (n = 21), and the third group was operated for colorectal cancer (n = 12). All patients had confirmed diagnosis

in histopathological examination. Body composition was assessed 3 times for each patient. Assessment was done upon admission to the department, on the 4th postoperative day and before the patient was discharged from the hospital.

Body composition was measured with a BIA-101 Akern single-frequency device (Italy), using a frequency of 50 kHz and with dedicated electrodes. The measurements were taken in supine position. The patient remained in this position for a minimum of 15 minutes prior to each measurement. The measurement of the patient's height and weight was performed using a free-standing scale and WE300P1 L Mensor bed scale (Poland). The collected data were analyzed using the Bodygram Version 1.31 software dedicated for BIA-101 device. The data was subjected to statistical analysis using Student's *t*-test.

RESULTS

The characteristics of the study group are provided in Tab. I. Tab. II. presents the values of patients' body weight changes on the 4th postoperative day and at discharge from the department in relation to the body weight on admission, depending on the study group. Tab. III. and IV. provide an assessment of the patients' body composition on admission to and upon discharge from the department.

DISCUSSION

The effect of electrical bioimpedance is based upon measuring the resistance and reactance of body tissues by applying a potential difference of a certain frequency and low intensity (below 1 mA) to electrodes located on the surface of the body. With this technique, it is possible to determine parameters such as total body water (TBW), intracellular body water (ICW), extracellular body water (ECW) contained in the body, and body cell mass (BCM), adipose tissue (FM) and muscle tissue (fat-free mass, or FFM) [5, 10]. Furthermore, the measurements allow to determine the phase angle which, according to currently prevailing hypotheses, can serve as a prognostic factor, among others to determine the risk of death or survival of patients in various clinical conditions [11, 12].

In this context, the repeatability and accuracy of results obtained using BIA should also be noted. In the published review regarding the comparison of body composition in surgical and oncological patients, the role of constant measurement conditions guaranteeing uniform results is emphasized [13]. In the presented case, to minimize the possible errors resulting from changes in the measurement method, all measurements were performed by one researcher.

There are many exponents and scales that determine the body's nutritional level. Some are based on the subjective assessment of the patient or the researcher, while others require specialized measurements. For example, serum albumin levels below 30 g/l correlate with an increased risk of complications after surgery [6, 14]. However, albumin levels are not routinely tested before each surgery. Assessing body composition using bioelectrical impedance can be an alternative to estimating nutritional status.

One of the basic parameters estimating the patient's nutrition is BMI. As demonstrated in Tab. I., the average BMI of operated pa-

tients fits in the overweight range (BMI > 25–30 kg/m²) according to WHO norms. Considering the age of patients (median 67.0 years), the range of BMI values can be recognized as comparable to the healthy population [15]. The highest BMI value is obtained for patients admitted for pancreatic cancer.

The average weight loss of the examined group is about 4.2% in relation to the initial body weight during the hospitalization period. The largest weight loss concerned patients operated for pancreatic cancer – close to 5% of body weight, while the smallest patients with colorectal cancer – about 3.2%. Aoyama reports that patients with stomach cancer lose an average of 3.4 kg body weight after a month which may constitute up to 5.9% [16]. Analyzing weight loss on day 4 of hospitalization, the smallest value was recorded in patients after surgery of pancreatic tumor. Despite the fact that no statistical significance was obtained, it may indicate that this group of patients loses weight in the later postoperative period. This could be associated with a longer recovery period as well as increased energy demand linked to regeneration after much more extensive surgery and the risk of complications. However, this remark requires further research and clarification. Observation of change in body composition indicates that patients after pancreatoduodenectomy lose about 1.2 kg, while after total gastrectomy even up to 7.2 kg within the first year after surgery. The loss mainly applies to fat mass (FM) [17]. In the group of patients with pancreatic cancer, nutrition should be carefully monitored even in the late postoperative period. As shown by data, this can permit effective maintenance of an adequate level of nutrition.

Analyzing the body composition of patients admitted to the department (Tab. III.) in the main ranges (FM, FFM, TBW), it can be concluded that it is approximately comparable for each group. The group of patients with stomach cancer is characterized by a much higher percentage of muscle mass and cell mass. In each group, the percentage of body fat (FM) is above the upper limit of normal compared to the healthy population [15, 18].

Tab. IV. presents the body composition of patients discharged from the department. An average decrease of 3 percentage points in body fat in each patient group was found. This confirms the previously obtained results, which indicate that in the annual observation after pancreatoduodenectomy and subtotal gastrectomy, weight loss is mainly associated with loss of fat mass (FM) [17]. Patients with pancreatic cancer have the lowest percentage of total water among all groups. In each group the total water level (TBW) at discharge is correspondingly higher than on admission. In the light of the data, this increase may be a naturally occurring process [19]. The perioperative strategy of hydrating has become a discussion point. The negative effects of dehydration and overhydration on postoperative results and complications are well known. Also proposed in recent years, the ERAS protocols (a set of protocols for Enhanced Recovery After Surgery) draw particular attention to the role of the correct level of hydration in patients in the perioperative period.

Disorders of ECW/ICW and ECW/TBW ratio may contribute to postoperative complications [7]. The change in these ratios is visible at the time of discharge from the department in all patient groups, especially in the group of patients with gastric cancer.

Further research is necessary to determine the level of hydration in patients operated for cancer during subsequent days after surgery.

Tab. I. General patient characteristics.

	GROUP 1 STOMACH CANCER	GROUP 2 PANCREATIC CANCER	GROUP 3 COLORECTAL CANCER	TOTAL
Number of patients	23	21	12	56
Women	11	11	3	25
Men	12	10	9	31
Age [years] (average)	62.8	64.5	70.6	66.0
Height [cm] (average)	169.1	168.4	171.5	169.7
Weight [kg] (average)	72.2	75	75.6	74.3
BMI [kg/m ²] (average)	25.18	26.4	25.8	25.8

Tab. III. Patient body composition depending on the group on admission to the department expressed as a percentage of the patient's total body weight.

	MEASUREMENT PERFORMED ON ADMISSION TO THE DEPARTMENT (AVERAGE VALUES)						
	FM%	FFM%	BCM%	MUSCLE%	TBW%	ECW%	ICW%
GROUP 1 Stomach cancer	30.43	69.76	51.42	54.47	52.14	53.86	53.86
GROUP 2 Pancreatic cancer	30.44	69.37	47.34	41.82	53.51	51.30	48.32
GROUP 3 Colorectal cancer	29.86	70.20	46.40	41.96	54.69	51.99	48.04

FM% – fat mass, FFM% – free fat mass, BCM% – body cell mass, Muscle% – muscle tissue, TBW% – Total body water, ECW% – Extracellular water, ICW% – Intracellular water

CONCLUSIONS

Bioelectrical impedance can be an easy and effective method for assessing body composition and its change in patients undergoing surgery.

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Tab. II. Change in weight on 4th postoperative day and upon discharge in relation to weight upon admission depending on the patient group.

	WEIGHT CHANGE ON DAY 4 [KG]	% WEIGHT CHANGE DAY 4 [%]	P	WEIGHT CHANGE DISCHARGE [KG]	% WEIGHT CHANGE DISCHARGE [%]	P
GROUP 1 Stomach cancer	-1.04	-1.43	0.030	-3.70	-4.52	0.010
GROUP 2 Pancreatic cancer	-0.80	-1.00	0.484	-3.58	-4.96	>0.001
GROUP 3 Colorectal cancer	-1.53	-1.54	0.082	-2.77	-3.20	0.004

Tab. IV. Patient body composition depending on the group on discharge from the department expressed as a percentage of the patient's total body weight.

	MEASUREMENT MADE AT DISCHARGE FROM THE DEPARTMENT (AVERAGE VALUES)						
	FM%	FFM%	BCM%	MUSCLE%	TBW%	ECW%	ICW%
GROUP 1 Stomach cancer	26.52	73.47	46.80	43.68	56.19	52.22	43.42
GROUP 2 Pancreatic cancer	26.99	73.14	45.18	42.14	54.67	53.78	49.73
GROUP 3 Colorectal cancer	27.28	72.72	47.04	42.75	56.73	52.42	47.65

FM% – fat mass, FFM% – free fat mass, BCM% – body cell mass, Muscle% – Muscle tissue, TBW% – Total body water, ECW% – Extracellular water, ICW% – Intracellular water

Patients operated for pancreatic cancer, despite having the highest average BMI on admission, lose the largest percentage of body weight until discharge from the department compared to the time of admission. Weight loss mainly occurs as loss of fat mass (FM).

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Liczba słów: 2300 Liczba stron: 4 Tabele: 4 Ryciny: – Piśmiennictwo: 19

DOI: 10.5604/01.3001.0013.7951 Table of content: <https://ppch.pl/issue/12756>

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Competing interests: The authors declare that they have no competing interests.



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Cite this article as: Dzierżek P, Kurnol K, Hap W., Frejlich E., Diakun A., Karwowski A., Kotulski K., Rudno-Rudzinska J., Kielan W.: Assessment of changes in body composition measured with bioelectrical impedance in patients operated for pancreatic, gastric and colorectal cancer; Pol Przegl Chir 2020; 92 (2): 8-11
