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Assessment of changes in the body composition in patients qualified for the operational treatment of the primary and metastatic liver tumors with the use of bioelectric impedance

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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ABSTRACT:

Introduction: Resection is an optimal way of treatment of hepatic tumors and metastasis from another organs. Operational injury may influence on patients body composition examined by bioelectrical impedance (BIA). Analysis of parameters may be helpful in identifying early changes indicating of deterioration in nutritional status.

Aim of the study: was to assess changes in body composition of patients before and after resection of liver tumors and potential radiofrequency ablation of lesions.

Material and methods: The study included a group of 50 patients of the Department of General, Gastroenterological and Oncological Surgery, Medical University of Warsaw, who were qualified for radical surgical treatment of tumors within the liver. Data on water content, fat, muscle and cell mass were analyzed.

Results: Comparing data obtained from patients before and after intervention in the liver, statistically significant ($p < 0.05$) loss of intracellular water, muscle mass, cell mass as well as adipose tissue was demonstrated. The phase angle value in these patients also significantly changed, decreasing by an average of 0.61°. On the other hand, the increase in content was noted in the case of extracellular water.

Conclusions: Surgical intervention within the liver causes noticeable, unfavorable changes in the body composition, as evidenced by the reduction in the value of muscle mass, as well as cellular mass, resulting in a decrease in the phase angle. Bioelectric impedance is a suitable method for assessing changes in body composition of patients undergoing liver resection and is useful in clinical practice. It is advisable to conduct further research in the group of patients undergoing invasive treatment of the liver due to: an increasing number of such operations and centers where this type of surgical intervention is performe.

KEYWORDS: liver tumors, bioelectrical impedance, phase angled

The paper presents results of bioelectrical impedance measurements carried out among patients before and after liver resection and radiofrequency ablation of lesions in liver.

In 2014 the incidence of malignant neoplasm of liver and intrahepatic bile ducts amounted to 1.1% in men (866 cases) and 0.7% in women (560 cases) in Poland [1]. Among hepatic tumors, metastases are diagnosed definitely much more often than primary tumors [2].

Radical resection of tumors is a well-established method of treatment, which is safe, burdened with a low complication rate and related with a decreasing rate of mortality [3, 4]. Liver is a crucial organ in a human organism due to its anatomical location and physiological functions. Maintaining a correct function of this organ is important for many metabolic processes, including those related to the state of nutrition, pharmacokinetics of drugs, retention of fluid in the body, as well as the possibility of using other potential methods of treatment of the underlying disease [5].

These indicators can be assessed through examinations, including a comprehensive assessment of water and fat content with bioelectrical impedance [6].

The aim of this study was to compare changes in body composition of patients before and after resection of liver tumors and radiofrequency ablation of lesions. Its implementation consisted in performing an impedance measurement before and after surgery. The metabolic estimation will enable the diagnosis of patients with a potentially unfavorable post-operative course after liver resection. The obtained analyzes are most likely to be used to create algorithms for patients in whom there are indications for nutritional intervention in order to minimize the consequences of surgical trauma.

MATERIALS AND METHODS

The study was conducted in the Department of General, Gastroenterological and Oncological Surgery, Medical University of Warsaw. The measurements were made in 65 patients in the period from March to December 2017, admitted to the clinic with a scheduled liver resection or thermoablation of focal lesions.

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Inclusion criteria were: the presence of resectable changes in the liver parenchyma and previously performed procedures such as: segmentectomy, hemihepatectomy, thermoablation of focal lesions, focal resection. However, the basis for exclusion from the study group was patient's death as a result of post-operative complications (2 cases) or disqualification due to the circumstances before and during the procedure (e.g.: hemodynamic instability, hormonal disturbance, neoplastic dissemination preventing effective surgery) as stated in 13 patients.

Of the 50 subjects, 46% were male and 54% were female. The average age was 60 years. The largest group of patients was between 60 and 70 years old – 36%.

The most common reason for surgery was metastatic changes (76%). Metastases from the large intestine (glandular type), accounted for 84% (31 cases). The primary location of the changes were also: stomach, kidney, breast, gallbladder, duodenum and eye melanoma (1 case each). Resection of primary tumors concerned 13 cases (24%) (hepatocellular carcinoma HCC, focal nodular hyperplasia FNH, hepatocellular adenoma, multilocular echinococcosis).

Among the operational procedures performed the largest group constituted segmentectomy (26 cases), followed by hemihepatectomy (14 cases), local resections of lesions (6 hospitalized patients), and radiofrequency ablation, as the smallest group of intervention, applied in 4 patients.

The study protocol included: measurement of height using the measuring rod produced by Spoland, measurement of weight by the weighing machine Tanita BF-662W, assessment of body composition by bioelectrical impedance method using the AKERN BIA 101 Anniversary analyzer. The collected parameters were as follows:

- total body water TBW;
- intracellular water ICW;
- extracellular water ECW;
- fat free mass FFM;
- muscle mass MM;
- fat mass FM;
- body cell mass BCM.

The patients undergoing surgery were subjected to a two-fold body composition analysis procedure. The first measurement was carried out 1 day before the scheduled operation, the second measurement was made between the 5th and 6th day after surgery, before the patient was discharged from hospital. The measurement was carried out at 25°C after at least 2.5 hours from the last meal.

The collected data was assessed using the Bodygram PRO 3.0 program. For statistical analysis, patients were divided into 4 groups:

- tumor neoplasia resections;
- segmentectomies;
- hemihepatectomies;
- focal radiofrequency ablations.

Statistical analysis was performed using the STATISTICA 13 PL program (StatSoft INC, USA) with the t-test. The obtained results did not have a normal distribution. The P value < 0.05 was considered statistically significant.

RESULTS

The indicators obtained from the BIA analyzer were subjected to statistical analysis. The largest statistically significant difference concerned the average extracellular water content, an increase of 1.58±2.38 lt (change from 19.57 to 21.14 for P < 0.001). A significant change was also observed in the fat mass, i.e. a decrease of 1.52±3.30 kg (change from 23.86 to 22.34 for P=0.002). The average fat percentage in men before surgery was 29±7.16%, and it decreased to 27.4±8.87%; in women before surgery it was 33.6±7.06%, and after surgery it decreased to 31.7±6.76%. Removal of tumors was also associated with a reduction in cell mass of 1.25±2.81 kg (change from 25.56 to 24.31 for P=0.003). Significantly, changes were also found for muscle mass of the subjects and intracellular water content. For muscles it was a decrease of 1.22±3.14 kg (from 31.98 to 30.78 for P=0.008), while for intracellular water it was a decrease of 0.9 lt ±2.00 lt (change from 20.00 to 19.10 for P=0.002). The amount of lean body mass and total water content did not differ significantly (P>0.05). The statistical analysis of changes before and after liver resection showed a significant decrease in phase angle values, on average by 0.61±0.77° (P<0.001).

The highest weight loss was observed in the group of patients who underwent segmentectomy (mean loss of 2.1±1.26 kg), the lowest decrease was noted in patients after hemihepectomy (mean loss of 0.3±1.54 kg). The highest values of the initial phase angle were found for patients after hemihepectomies (5.81±0.72°), while the lowest values were observed for patients after sole thermoablation of lesions (4.53±0.64°).

DISCUSSION

The analysis of the body's water spaces is only possible using the bioelectrical impedance method. This method is also a convenient, safe and reliable way to assess changes in body composition in both healthy people and those suffering from various chronic diseases, especially the ones that result from metabolic abnormalities. The assessment of the above changes may also be used in surgical departments to monitor the course of treatment [7, 8, 9, 10, 11].

Bearing in mind the published results from the studies carried out so far, we carried out similar measurements in groups of patients with cirrhosis [12, 13, 14, 15]. Changes in the composition of the body are also observed in groups of oncological patients [16, 17, 18, 19, 20, 21]. Based on the review of the literature, a decision was made to assess changes that occur after surgical intervention in oncological patients qualified for surgical treatment within the liver.

Intracellular water accounts for about 40% of total body weight, while extracellular water for around 20%. The ratio of these spaces varies throughout life, depending on age, gender and amount of adipose tissue. Extracellular water consists of interstitial fluid, intravascular fluid - plasma and transcellular water, which is the so-called „third space". This space constitutes 2.5% of body weight and it is the volume of water that is found in the digestive, urinary, sexual and respiratory systems, cerebrospinal fluid, synovial fluid in the joints, the eyeball fluid and serous space. The intracellular water is divided into extravascular water contained in the tissue cells and intravascular water contained in the morphing elements of the blood [22]. In the study group, it is possible to observe the

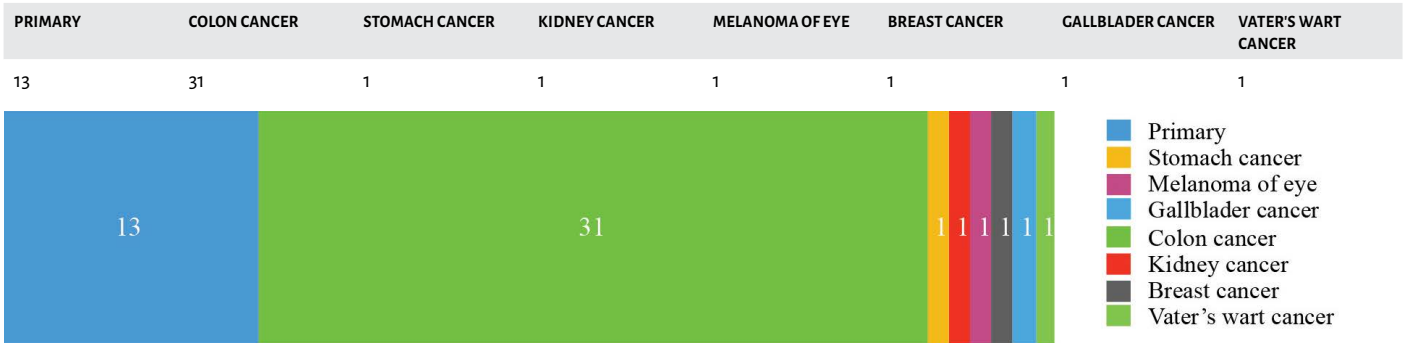

Fig. 1. Origin of tumors in research group (n = 50).

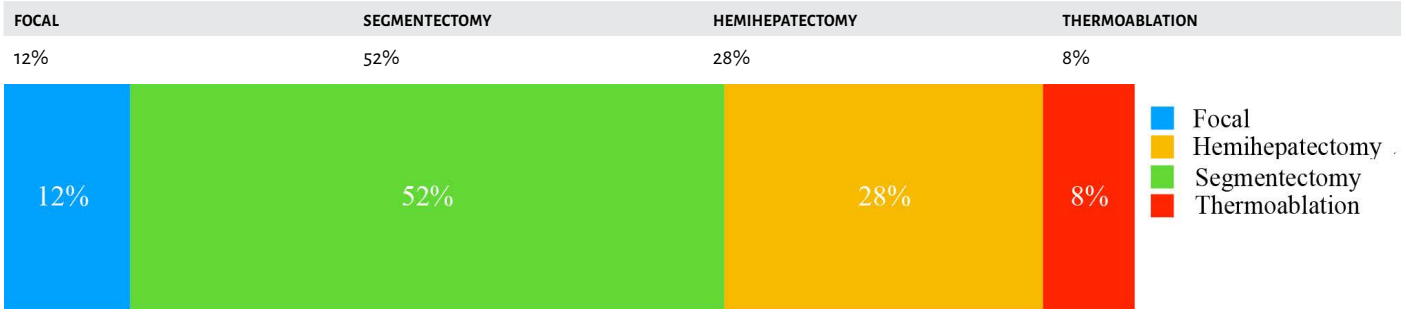

Fig. 2. Typy resekcji wątroby zastosowanych w grupie badanej w % (n = 50).

Tab. I. Statement of parameters obtained from BIA before and after liver resection.

RESULT OF CYTOLOGY ACCORDING TO WITH CLASSIFICATION BETHESDA	ECW [LT]	FM [KG]	BCM [KG]	MM [KG]	ICW [LT]	FFM [KG]	TBW [LT]	PA [°]
Before resection	19,57	23,86	25,56	31,98	20,00	51,28	39,58	5,33
After resection	21,14	22,34	24,31	30,76	19,10	52,15	40,25	4,72
Statistical analysis								
Difference	1,58	-1,52	-1,25	-1,22	-0,90	0,87	0,67	0,61
SD	2,38	3,30	2,81	3,14	2,00	3,74	2,85	0,77
Test t value	-4,69	3,26	3,15	2,74	3,19	-1,64	-1,67	5,67
p value	0,000	0,002	0,003	0,008	0,002	0,106	0,100	0,000

displacement of water from the intracellular space into the extracellular space with the simultaneous lack of significant differences in the total amount of water in the body. Such a tendency may indicate that this is a result of a surgical intervention, regardless of the amount of blood lost during the procedure. For the purpose of wider diagnostics of changes in the body's water spaces, the concentration of albumin, total protein as well as sodium and potassium ions should also be determined. This will allow a more accurate representation of changes in these spaces.

The assessment of fat content among the subjects showed its excess in the group of men, with the average content after surgery being 27.4% (standard 13.0–25.0% [23]). The percentage of adipose tissue in the examined women was within the range, with the average content after surgery being 31.7% (standard 23.0–36.0% [23]). In addition, surgery has been shown to reduce the content of this tissue.

The cell membrane forms a specific capacitor built from two layers. The conductive layer is contained in fragments of hydrophilic phospholipids directed to the outside and inside of the cell. On the other hand, the non-conductive layer, that is the dielectric layer, includes inwardly directed lipophilic fragments. Such a system forms capacitive resistance, i.e. reactance which mainly has impact on the value of the phase angle. Extracellular water and adipose tissue are components that do not show reactance, but they have active electrical resistance instead, i.e. resistivity. The phase angle is a value reflecting the overall health of the body as well as the nutritional status. It is used not only in clinical practice but also in dietetics and sports medicine. The reduction in cellular mass and muscle mass observed in patients correlates with a decreasing phase angle value and indicates deterioration of patient's health status. Such a tendency may be a bad prognostic factor. After surgery, there may be a breakdown of muscle proteins initiated by immunological mechanisms of inflammatory reactions in response to extensive abdominal trauma [10, 24].

The analysis of the described changes may contribute to further development of the currently used methods of surgical treatment, and at the same time improve the procedures of preoperative patient preparation and enable introduction of a postoperative course beneficial for the patient. It seems reasonable to demonstrate the role of clinical dietitians in this process who would be involved in

monitoring the nutritional status and preventing its deterioration and other complications. It is advisable to carry out further research on this matter in order to gain a vaster understanding of the accompanying changes after liver resection procedures and their clinical and metabolic consequences.

CONCLUSIONS

1. Surgical intervention within the liver causes noticeable, unfavorable changes in the body composition, as evidenced by the reduction in the value of muscle mass, as well as cellular mass, resulting in a decrease in the phase angle.

2. Bioelectric impedance is a suitable method for assessing changes in body composition of patients undergoing liver resection and is useful in clinical practice.

3. It is advisable to conduct further research in the group of patients undergoing invasive treatment of the liver due to: an increasing number of such operations and centers where this type of surgical intervention is performed.

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