ISSN: 3066-9820
Research Article
Journal of Clinical Surgery Care Research

Impact of Surgery on the Body Composition of Patients Undergoing Colon Cancer Surgery

Nieto Martos María del Rocío[1*], Juez Sáez, Luz Divina[1], Blazquez Sanchez, Javier[2], Pérez Izquierdo Cesar Barsen[1], Jiménez Lillo, Teresa[3], Andrade Yagual, Aldo Andrés[1], Die Trill, Javier[1], Fernandez Cebrian, Jose María[1], García Pérez, & Juan Carlos[1]

[1]Ramon y Cajal University Hospital. General Surgery Department. Madrid. Spain

[2]Ramon y Cajal University Hospital. Radiology Department. Madrid. Spain

[3]Alcalá de Henares University. Alcalá de Henares. Madrid

[*]Corresponding author: Nieto Martos María del Rocío, Ramon y Cajal University Hospital. General Surgery Department. Madrid. Spain.

Submitted: 22 January 2026 **Accepted:** 30 January 2026 **Published:** 05 February 2026

Citation: *Nieto Martos, M. del R., Juez Sáez, L. D., Blázquez Sánchez, J., Pérez Izquierdo, C. B., Jiménez Lillo, T., Andrade Yagual, A. A., Die Trill, J., Fernández Cebrián, J. M., & García Pérez, J. C. (2026). Impact of Surgery on the Body Composition of Patients Undergoing Colon Cancer Surgery. J of Clin surg Care Res, 5(1), 01-06.*

Abstract

Introduction: *Surgery is the main treatment for colon cancer (CC). There are few studies evaluating the impact of surgery on body composition. The main aim of this study was to analyze changes in body composition after colectomy for CC.*

Materials and Methods: *An observational and retrospective study of patients with CC was performed. Patients who underwent Enhanced recovery after surgery (ERAS) protocol were enrolled between December 2019 and June 2022. Pre- and postoperative measurements of each patient's musculoskeletal index (SMMI), psoas iliac index (PI), visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) were performed by computed tomography (CT). In addition, muscle attenuation measured in Hounsfield units (HU) was analyzed to assess the presence of myosteatosis.*

Results: *After surgery, patients' SMMI, PI, VAT and SAT decreased significantly in the patients ($p<0.001$). In addition, the number of patients with sarcopenia increased significantly (+11%). The number of patients with myosteatosis also increased significantly ($p<0.001$).*

Conclusions: *Surgical intervention has a negative impact on body composition in CC patients, with a significant decrease in muscle mass and visceral and subcutaneous fat. Further studies are needed to assess the impact of these changes on postoperative outcomes and long-term survival.*

Keywords: Sarcopenia, Colorectal Cancer, Low Musculoskeletal Mass, Body Composition, Myoesteatosis.

Introduction

Colorectal cancer (CC) is the third most diagnosed cancer worldwide and the second most common cancer in terms of mortality [1]. Although the treatment of colon cancer (CC) is currently based on a multimodality approach, oncological surgery remains the mainstay of treatment [2].

Compared to the general population, patients with colon cancer have a higher rate of malnutrition due to the combined effects of malignancy, host response to the tumour, chemotherapy treatment and the direct effects of bowel obstruction and malabsorption [3]. Some recent publications describe up to 35% incidence of malnutrition in patients with CC [4].

Body composition is an individual risk factor and there is increasing evidence that cancer patients undergo various changes that alter the proportions of muscle, fat, and bone [5]. In recent years there has been a growing interest in the assessment of body composition parameters with the aim of trying to anticipate and prevent postoperative complications.

Sarcopenia is a syndrome characterized by a gradual and widespread loss of skeletal muscle mass and strength [6]. Although not a new concept, there is growing interest in its prognostic implication for cancer patients. Several recent studies have shown that it can negatively influence overall survival, disease-free survival, recurrence-free survival and metastatic and non-metastatic cancer-specific survival [7,8,9].

On the other hand, more recent studies provide data not only on the quantity of muscle mass but also on the quality of this muscle. In recent years, the concept of myosteatosis, defined as fatty infiltration of muscle characterized by a decrease in lean mass and an increase in adipose tissue, leading to a reduction in its functional capacity, has gained importance [10]. As described by Martin L. et al [11] myosteatosis, defined as low muscle attenuation (measured in Hounsfield units) on CT scan, is associated with a worse oncological prognosis independent of body weight.

The new GLIM guidelines recommend the inclusion of a phenotypic criterion, such as low muscle mass, for the diagnosis of malnutrition. The guidelines suggest some forms of measurement such as the fat-free mass index (kg/m2) using dual-energy X-ray absorptiometry (DXA) or equivalent standards using other body composition methods such as bioelectrical impedance analysis (BIA), computed tomography (CT) or magnetic resonance imaging (MRI) [12]. In oncological patients CT is an excellent test for several reasons: it has high sensitivity and specificity for identifying muscle and fat, it is a rapid and easily reproducible test and, perhaps most importantly, it is part of the routine oncological work-up in patients with CC [13].

The aim of this study is to evaluate changes in body composition in terms of increased sarcopenia and myoesteatosis in patients undergoing colectomy for colon cancer.

Material And Methods

Design and Patient's Selection

A single-centre, observational, retrospective study was conducted to collect all patients who underwent colectomy for colon cancer with curative intent between December 2019 and June 2022. All patients were histologically diagnosed and staged by thoraco- abdomino-pelvic CT. Exclusion criteria were lack of digitized CT scan, distant metastasis at diagnosis, urgent surgery and lack of postoperative follow-up.

Data Availability

The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Body Composition Calculation

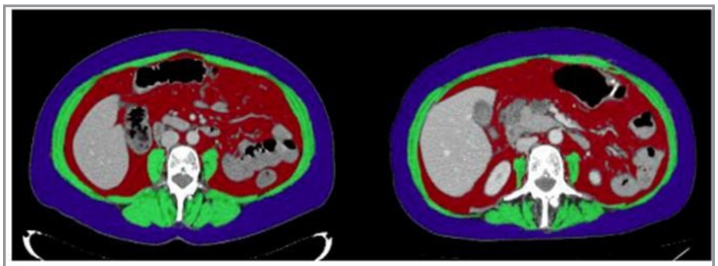
To calculate body composition, the preoperative CT images closest to the operation and the postoperative CT at one month after surgery were reviewed.

Images from each CT scan was extracted from the institutional PACS system and anonymously transferred to a Volume Analyzer SYNAPSE 3D image analysis tool from Fujifilm Imaging Technology. Three-mm slices were selected from an axial section of the abdomen at the mid-level of the L3 vertebra. Semi-automatic 2D segmentation was performed and all measurements were taken from this radiological section (Figure 1). Measurements were taken by an experienced radiologist or a trained observer. All measurements were performed twice. The interclass correlation coefficient between the two means was calculated and the mean of the two means was used for analysis.

The range of - 29 to + 150 in Hounsfield Units (HU) was used to identify muscle tissue. The radiological diagnosis of sarcopenia was established from the skeletal muscle mass index (SMMI), which was calculated as the sum of the cross-sectional areas at the L3 level of the abdominal wall muscles (psoas muscle, paraspinal, transverse abdominis, external and internal obliques and rectus abdominis muscles (cm2)) and normalized to the square of the patient's height (m2). In addition, the Psoas iliacus index (PI) (sum of the cross- sectional areas of both psoas (cm2)) was calculated. The range of - 150 to - 50 HU for visceral adipose tissue (VAT-cm2) and - 190 to - 30 HU for subcutaneous adipose tissue (SAT-cm)214 was used to measure adipose tissue.

For the definition of sarcopenia, we used the cut-off points published by Prado (SMMI ≤52.4 cm /m22 in men and ≤38.5 cm / m22 in women) [14]. Similarly, obesity was defined by VAT > 163.8 cm2 in men and > 80.1 cm2 in women. Muscle attenuation is defined by the mean of the Hounsfield units of the total abdominal musculature measured at the level of the third lumbar vertebra. Using the cut-off points for muscle attenuation associated with reduced survival described by Martin L., myosteatosis was less than 41 HU in normal weight patients and less than 33 HU in overweight or obese patients.

Postoperative adverse events were recorded according to the Clavien-Dindo classification [15].



Skeletal muscle mass is shown in green, visceral adipose tissue in red and subcutaneous adipose tissue in blue. On the left is the preoperative measurement of one of the patients in the sample. On the right is the measurement taken one month after surgery.

Figure 1: Axial section at L3 level

Statistical Analysis

Categorical variables were expressed as counts and percentages. Quantitative variables were expressed as mean with standard deviation or median with interquartile range according to their normality.

For the analysis of comparisons between groups, categorical variables were analyzed using the χ2 test or Fisher's exact test, as appropriate. For the analysis of continuous variables before and after surgery, paired tests were used (t-test for paired data or Wilcoxon test, after analysis of the normality of the variables using the Kolmogorov-Smirnov test).

Statistical analyses were performed using SPSS Statistics version 25. Differences were considered statistically significant when $p<0.05$ with a bilateral hypothesis.

Ethical Considerations

All procedures performed in studies involving human participants complied with the ethical standards of the institutional and/or national research committee. This study was approved by the Ethics Committee of the center. Due to the retrospective nature of the study, the Ethics Committee of the center waived the need of obtaining informed consent.

Results

Baseline Characteristics of the Sample

During the observation period, 104 patients who underwent colectomy for colon cancer were collected. Reasons for exclusion were lack of digitized preoperative CT images (n=3) and loss of follow-up (n=2). Finally, 99 patients were included.

The baseline characteristics of the sample are shown in table 1. Of the patients included in the study, 52% were men and 48% were women, with a median age of 68 years. Anesthetic risk according to ASA classification was 76% ASA II and 18% ASA III.

The most common comorbidity in the sample was AHT (47%), followed by DM (16%). A total of 48 right hemicolectomies, 12 left hemicolectomies, 38 sigmoidectomies and 1 total colectomy were performed. 25 patients in the sample had postoperative complications, of which 2% were to Clavien-Dindo grade III or higher.

Table 1: Baseline characteristics of the sample

VARIABLES	N=99
Age (years)	68,34 (61-77)
Gender •Male •Female	42 (42,4%) 57 (57,5%)
ASA risk1 •I •II •III	5 (5,1%) 76 (76,8%) 18 (18,2%)
Comorbidity •Hypertension (HT) •Diabetes Mellitus (DM) •Obstructive sleep apnea (OSA) •Ischemic cardiomyopathy (IC) •Chronic Pulmonary Obstructive Disease (COPD) •Atrial Fibrillation (AF) •Cronic Kidney Disease (CKD)	47 (47,5%) 16 (16,2%) 9 (9,1%) 4 (4%) 5 (5,1%) 4 (4%) 2 (2%)
Weight (kg)	75,65 (65-84)
Height (cm)	164,95 (158-171)
BMI (kg/m2)	27,69 (24-30)
Total proteins (mg/dL)	6,9 (6,6-7,2)
Preoperative nutritional assessment	68 (68,7%)
Hospital admission (days)	6 (5-7)
Minimally invasive approach	95 (96%)
Conversion to open surgey	5 (5%)
Surgical technique •Right hemicolectomy •Left hemicolectomy •Sigmoidectomy •Total colectomy	48 (48,5%) 12 (12,1%) 38 (38,4%) 1 (1%)
Postoperative complications	25 (25,3%)

Complications according Clavien-Dindo •I •II •IIIa •IIIb	13 (13,1%) 10 (10,1%) 1 (1%) 1 (1%)
SMMI (cm²/m²)	52,8 (46-60) *
VAT (cm²)	193,64 (103-285) **
SAT (cm²)	185,50 (113-231) ***
PI (cm²/m²)	6,72 (5-8) ****
Average muscle atenuation (UH)	26,33 (26,3-36,9) *****

ASA: American Society of Anesthesiologists1; HT: Hipertension; DM: Diabetes Mellitus; OSA: Obstructive sleep apnea; IC: Ischemic cardiopathy; COPD: Cronic obstructive pulmonary disease; CKD: chronic kidney diseas; AF: Atrial fibrillation; BMI: body mass index; SMMI: skeletal muscle mass index; VAT: visceral adipose tissue; SAT: subcutaneous adipose tissue; PI: Psoas iliacus index

To calculate the IMME, the sum of the cross-sectional areas of the psoas, paraspinal and abdominal wall muscles (cm2) was calculated and normalised to the square of the patient's height (m2).
Interclass correlation coefficient 0.995; ** Interclass correlation coefficient 0.996; *** Interclass correlation coefficient 0.996; **** Interclass correlation coefficient 0.999. ***** Interclass correlation coefficient 0.995

1 Doyle DJ, Hendrix JM, Garmon EH. American Society of Anesthesiologists Classification. [Updated 2023 Jun 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441940/

Impact of Surgery on Body Composition (Figure 2)
Pre-and post-operative radiological body composition values were measured. The median time between preoperative CT and postoperative CT was 41 (37-50) days. As a result of these calculations, all body composition parameters, both muscle mass (SMMI, PI) and body fat (VAT and SAT) showed a negative impact with surgery. Moreover, this decrease was statistically significant in all categories analyzed (p<0.001, p<0.001, p<0.001, p=0.02, respectively) (Figure 2). In addition, the diagnosis of sarcopenia increased from 35% (preoperatively) to 39% after surgery (p=0.003). As for myosteatosis, there was a statistically significant increase from 72.4% (pre-surgery) to 73.5% (post-surgery) (p=0.001). Regarding the definition of obesity, 3% fewer diagnosis of obesity were recorded after surgery (p<0.001). Figure 3, which shows the pre- and post-operative SMMI and VAT per patient, shows that 73% and 77% of patients, respectively, had a decrease in their radiological values after surgery.

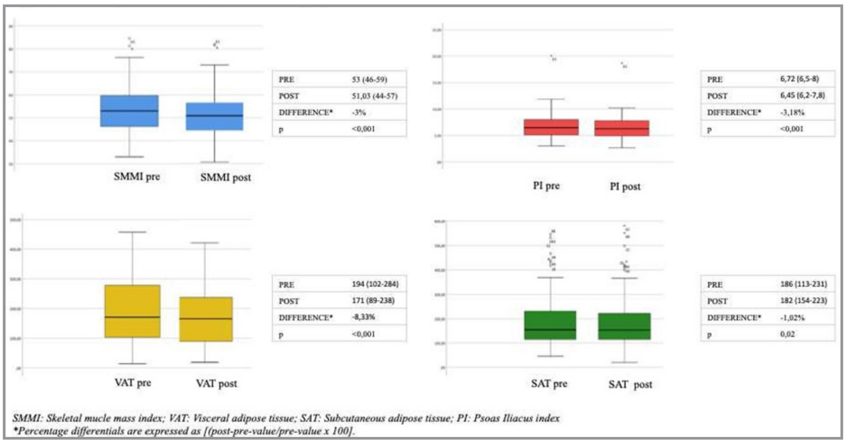
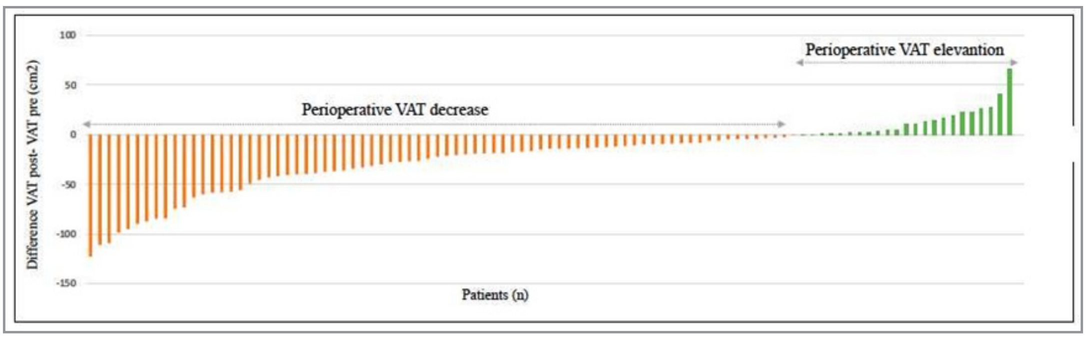
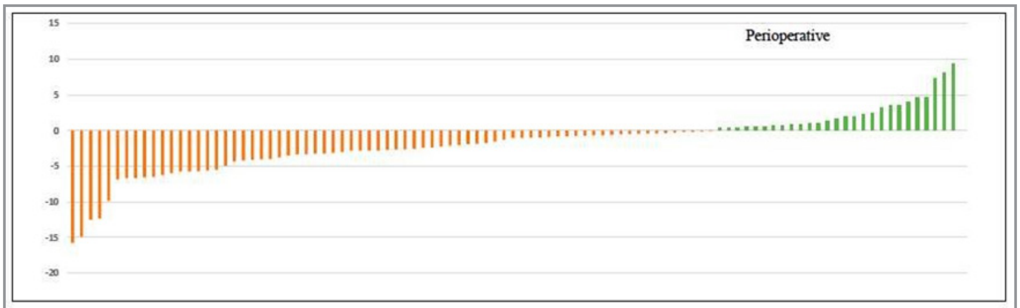


Figure 2: Anthopometric variation after surgery





Each vertical bar represents the variation in the analysed body composition parameter for each patient. SMMI: skeletal muscle mass index; VAT: visceral adipose tissue index. 73% and 77% of patients reduced their SMMI and VAT respectively after surgery.

Figure 3: waterfall plot of variation in perioperative IMME and TAV values

Discussion

The results of our work show that patients who undergo colectomy for CC have changes in body composition at the expense of a decrease in muscle mass and subcutaneous and visceral adipose tissue. Therefore, it appears that surgery has a negative impact on body composition parameters with a significant increase in the incidence of sarcopenia after surgery.

Recently, many publications have investigated the significance and impact of sarcopenia in cancer patients. In fact, the interest in this pathology is such that it is now recommended to include sarcopenia screening in the clinicopathological assessment of patients undergoing cancer treatment.

In the new GLIM guidelines for the diagnosis of malnutrition, there is consensus that muscle mass measurement should be routinely included in the screening of patients with suspected malnutrition [12]. However, there is no consensus on the best way to measure and define sarcopenia. In contrast to bioelectrical impedance or dual X-ray absorptiometry, CT can measure body composition at the organ level, in particular adipose tissue and total and regional skeletal muscle tissue and thus offers greater accuracy and specificity fin determining muscle mass and fat distribution (visceral, intermuscular and subcutaneous) [16]. In our series, CT has proven to be a useful test to quantify changes in body composition by identifying changes in muscle and fat tissue in the perioperative period.

Recent publications suggest that low muscle mass is associated with increased postoperative complications and a higher risk of morbidity and mortality. However, no studies have specifically measured the impact of surgical aggression on body composition in patients with CC and its impact on complications and long-term prognosis. In our work, patients have a negative impact on all body composition parameters. As shown by Trejo-Ávila et al in a recent meta-analysis, in patients with colorectal cancer, sarcopenia is an independent predictor of worse postoperative outcomes and longer hospital stay [17]. Another term related to sarcopenia is myosteatosis. Specifically, this term refers to muscle density. Although there are currently no officially established cut-off points for measurement, studies suggest that the presence of this condition would be associated with a worse oncological prognosis and a higher number of postoperative complications. Studies are needed to clarify this aspect and its relationship with the nutritional status of cancer patients.

This work has certain limitations, mainly due to the sample size and the retrospective nature of the study. Also, patient recruitment was carried out including the period of the COVID pandemic, which undoubtedly led to a decrease in the number of patients recruited compared to another cohort. On the other hand, many of the patients included in the study are elderly, which could lead to an increased prevalence of sarcopenia and myosteatosis in the sample. Older patients may have different outcomes to younger patients, and therefore the results can not necessarily be generalisable to the wider patient cohort.

In addition, it should be noted that the median time between pre- and post-operative CT scan is relatively short, so there will be necessary secondary follow up via later CT scans to determine if the impact of surgery on body composition was a short-term outcome, or one that lasted past the immediate post-operative period. Currently, very few publications have specifically addressed these issues. Although the current literature seems to suggest that patients who experience greater changes in body composition with surgery are associated with a higher number of postoperative complications, prospective studies with larger numbers of patients are needed to determine the true significance on postoperative morbidity, as well as the potential benefit of preoperative nutritional supplementation therapies. Identifying the role of these therapies on body composition may help to define strategies to mitigate muscle and fat loss in the perioperative period.

Conclusions

Surgical intervention has a negative impact on body composition in patients with CC, with a significant decrease in muscle mass and visceral and subcutaneous fat, as well as a significant increase in fat infiltration of muscle even in the early postoperative period. Although this loss seems to indicate an increased risk of postoperative complications, further studies are needed to assess the impact of nutritional supplementation.

References

1. Bray, F., Laversanne, M., Sung, H., Ferlay, J., Siegel, R. L., Soerjomataram, I., & Jemal, A. (2024). Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a cancer journal for clinicians, 74(3), 229-263.
2. Siegel, R. L., Wagle, N. S., Cercek, A., Smith, R. A., & Jemal, A. (2023). Colorectal cancer statistics, 2023. CA: A Cancer Journal for Clinicians, 73(3), 233–254. https://doi.org/10.3322/caac.21772
3. Umbelino, B., Silva, N., Brum, R., Dias, M., Barro-

so de Pinho, N., Gonzalez, M. C., & Avesani, C. M. (2018). Factors associated with sarcopenia in patients with colorectal cancer. Nutrition and Cancer. https://doi.org/10.1080/01635581.1412480

4. Gupta, A., Gupta, E., Hilsden, R., Hawel, J. D., Elnahas, A. I., Schlachta, C. M., & Alkhamesi, N. A. (2021). Preoperative malnutrition in patients with colorectal cancer. Canadian Journal of Surgery, 64(6), E621–E629. https://doi.org/10.1503/cjs.016820
5. Bianchini, F., Kaaks, R., & Vainio, H. (2002). Overweight, obesity, and cancer risk. The Lancet Oncology, 3(9), 565–574.
6. Goodpaster, B. H., Park, S. W., Harris, T. B., Kritchevsky, S. B., Nevitt, M., Schwartz, A. V., ... & Newman, A. B. (2006). The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61(10), 1059-1064.
7. Liu, P., Hao, Q., Hai, S., Wang, H., Cao, L., & Dong, B. (2017). Sarcopenia as a predictor of all-cause mortality among community-dwelling older people: A systematic review and meta-analysis. Maturitas, 103, 16–22.
8. Levolger, S., van Vugt, J. L. A., de Bruin, R. W. F., & IJzermans, J. N. M. (2015). Systematic review of sarcopenia in patients operated on for gastrointestinal and hepatopancreatobiliary malignancies. British Journal of Surgery, 102, 1448–1458.
9. Sun, G., Li, Y., Peng, Y., Lu, D., Zhang, F., Cui, X., Zhang, Q., & Li, Z. (2018). Can sarcopenia be a predictor of prognosis for patients with non-metastatic colorectal cancer? A systematic review and meta-analysis. International Journal of Colorectal Disease, 33, 1419–1427.
10. García-Díez, A. I., Porta-Vilaró, M., Isern-Kebschull, J., Naude, N., Guggenberger, R., Brugnara, L., Milinkovic, A., Bartolomé-Solanas, A., Soler-Perromat, J. C., Del Amo, M., Novials, A., & Tomás, X. (2024). Myosteatosis: Diagnostic significance and assessment by imaging approaches. Quantitative Imaging in Medicine and Surgery, 14(11), 7937–7957. https://doi.org/10.21037/qims-24-365
11. Martin, L., Birdsell, L., Macdonald, N., Reiman, T., Clandinin, M. T., McCargar, L. J., Murphy, R., Ghosh, S., Sawyer, M. B., & Baracos, V. E. (2013). Cancer cachexia in the age of obesity: Skeletal muscle depletion is a powerful prognostic factor, independent of body mass index. Journal of Clinical Oncology, 31(12), 1539–1547. https://doi.org/10.1200/JCO.2012.45.2722
12. Cederholm, T., & Jensen, G. L. (2019). GLIM criteria for the diagnosis of malnutrition: A consensus report from the global clinical nutrition community. Clinical Nutrition, 38(1), 1–9.
13. Giani, A., Famularo, S., Riva, L., Tamini, N., Ippolito, D., Nespoli, L., Conconi, P., Sironi, S., Braga, M., & Gianotti, L. (2020). Association between specific presurgical anthropometric indexes and morbidity in patients undergoing rectal cancer resection. Nutrition, 75–76.
14. Prado, C. M., Lieffers, J. R., McCargar, L. J., Reiman, T., Sawyer, M. B., Martin, L., & Baracos, V. E. (2008). Prevalence and clinical implications of sarcopenic obesity in patients with solid tumours of the respiratory and gastrointestinal tracts: a population-based study. The lancet oncology, 9(7), 629-635.
15. Dindo, D. (2009). The Clavien-Dindo classification of surgical complications. In M. Cuesta & H. Bonjer (Eds.), Treatment of postoperative complications after digestive surgery. Springer.
16. Shen, W., Punyanitya, M., Wang, Z., Gallagher, D., St.-Onge, M. P., Albu, J., ... & Heshka, S. (2004). Total body skeletal muscle and adipose tissue volumes: estimation from a single abdominal cross-sectional image. Journal of applied physiology, 97(6), 2333-2338.
17. Trejo-Ávila, M., Bozada-Gutiérrez, K., Valenzuela-Salazar, C., Herrera-Esquivel, J., & Moreno-Portillo, M. (2021). Sarcopenia predicts worse postoperative outcomes and decreased survival rates in patients with colorectal cancer: A systematic review and meta-analysis. International Journal of Colorectal Disease, 36, 1077–1096. https://doi.org/10.1007/s00384-021-03839-4