ORIGINAL ARTICLE

Prediction of short-term results after laparoscopic right hemicolectomy. Is sarcopenia superior to other methods?

Predicción de resultados a corto plazo tras hemicolectomía derecha laparoscópica. ¿Es la sarcopenia superior a otros métodos?

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Abstract

Objective: *We aimed to determine the factors that predict early mortality and morbidity in patients who underwent laparoscopic right hemicolectomy and their superiority over each other.* **Method:** *Demographic data, age-adjusted Charlson Comorbidity Index, American Society of Anesthesiologists Score, body mass index, modified-Glasgow Prognostic Score (mGPS), stage of disease, and sarcopenia were evaluated in patients who underwent right hemicolectomy between 2010-2022. Their superiority in predicting short-term outcomes was compared.* **Results:** *78 patients were included in the study. The complication rate was higher in sarcopenic patients (p = 0.002). A high mGPS score was associated with increased mortality risk (p = 0.012). Other methods were not found to be related to short-term results.* **Conclusions:** *Sarcopenia is useful for the prediction of complications, and the mortality rate can be estimated by the mGPS score. These are superior to the other short-term results prediction methods. However, randomized controlled studies are needed.*

Keywords: *Sarcopenia. Glasgow prognostic score. Short-term results.*

Resumen

Objetivo: *Determinar los factores que predicen la mortalidad y la morbilidad precoces en pacientes sometidos a hemicolectomía derecha laparoscópica y su superioridad entre ellos.* **Método:** *Se evaluaron datos demográficos, el índice de comorbilidad de Charlson ajustado por edad, el puntaje de la American Society of Anesthesiologists, el índice de masa corporal, el puntaje de pronóstico de Glasgow modificado (mGPS), el estadio de la enfermedad y la sarcopenia en pacientes que se sometieron a hemicolectomía derecha entre 2010 y 2022. Se comparó su superioridad en la predicción de resultados a corto plazo.* **Resultados:** *Se incluyeron en el estudio 78 pacientes. La tasa de complicaciones fue mayor en los pacientes sarcopénicos (p = 0.002). Una puntuación mGPS alta se asoció con un mayor riesgo de mortalidad (p = 0.012). No se encontró que otros métodos estuvieran relacionados con los resultados a corto plazo.* **Conclusiones:** *La sarcopenia es útil para la predicción de complicaciones y la tasa de mortalidad puede estimarse mediante la puntuación mGPS. Estos son superiores a los otros métodos de predicción de resultados a corto plazo. Sin embargo, se necesitan estudios controlados aleatorizados.*

Palabras clave: *Sarcopenia. Puntuación de pronóstico de Glasgow. Resultados a corto plazo.*

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Introduction

Even though the incidence of colorectal cancer has been increasing over the last few years, the mortality rates have been decreasing gradually[1]. Advances in diagnosis, treatment methods, and screening programs have affected survival outcomes positively[2]. One of the most important factors affecting survival is the early diagnosis and treatment of complications. Many methods have been identified in predicting mortality and complications of colorectal cancer patients in the post-operative period[3-11]. Biochemical parameters such as C-reactive protein (CRP), albumin levels, platelet count, neutrophil-lymphocyte ratios; pre-operative body mass index (BMI), stage of cancer, modified Glasgow Prognostic Score (mGPS); The American Society of Anesthesiologists (ASA) Score, and the age-adjusted Charlson comorbidity index (ACCI) which evaluate comorbidities, and sarcopenia scores, which assesses muscle quality, are the most used methods for the evaluation of mortality and morbidity. With the prediction and early diagnosis of complications, their treatment can be carried out in a shorter time. Thus, patients can be referred to adjuvant therapy right on time. And as a result, overall survival gets positively affected.

Sarcopenia is a syndrome that can lead to negative consequences such as physical disability, poor quality of life, and mortality due to the progressive loss of skeletal muscle mass and strength. It was first described by Rosenberg[12], and is usually prominent in the elderly and cancer patients. The easiest way to detect sarcopenia is through radiological methods. For this, the most frequently used muscle groups are the psoas muscle and abdominal wall muscles such as transversus abdominis, internal and external oblique muscles, and rectus abdominis. Skeletal muscle area in single-section images correlates well with total muscle volume, and an idea of the whole muscle mass can be obtained from these measurements[13]. In recent years, this method has been used more than others in evaluating morbidity, especially in cancer patients.

In our study, we aimed to determine the factors that predict early mortality and morbidity in patients who underwent laparoscopic right hemicolectomy and their superiority over each other. We aimed to evaluate stage of disease, obesity status, ASA score, ACCI, mGPS, and sarcopenia as predictive variables. Our primary outcome is to evaluate the relationship between our variables and complications and mortality. Our secondary outcome, on the other hand, is the analysis of our variables and other short-term results such as length of stay, operation time, and estimated blood loss.

Materials and methods

Our study was planned retrospectively in our institute's surgical oncology department. The data of the patients were searched using the electronic patient file system of the hospital. Approval was obtained from our university's ethics committee. Stages I, II, and III patients who underwent elective laparoscopic right hemicolectomy due to colon cancer between March 2010 and September 2022 were included in the study. Patients whose data could not be accessed and who underwent an additional surgical procedure and palliative surgery were excluded from the study. A total of 78 patients were included in the study after screening (Fig. 1).

Demographic data of the patients such as age, gender, height, and weight, operative information such as tumor localization, type of surgery, operation time, estimated blood loss, and pathological results such as tumor diameter, tumor type, tumor progressions, lymph node involvement were evaluated in the study. CRP and albumin levels from biochemical data, as well as the comorbidity status of the patients, were recorded to be analyzed in our study. During the follow-up period, length of stay, complications, and mortality were assessed. The formula of dividing the weight (kg) by the square of the height (m^2) was used when calculating the BMI of the patients. Obese patients were identified according to the obesity classification of the World Health Organization[14]. Stages were determined by the TNM staging specified in the eighth edition of the American Joint Committee on Cancer (AJCC)[15]. Stage I cancers were included in early-stage cancers, and Stages II and III cancers were included in advanced cancers. Comorbidities were scored according to ACCI[16]. The total score is the sum of the weighted scores for all variables. ACCI was assessed for all patients at baseline and patients were divided into three groups according to ACCI: 0-2, 3-4, and $\geq$ 5. One of the pre-operative indicators of systemic inflammation of the patients, mGPS, a measurement based on pre-operative serum albumin and CRP levels, was recorded. The calculation was made with the data in the last month before the operation. Patients with a CRP level of 10 mg/dl or less were determined as mGPS 0, those with a CRP level above 10 were determined as mGPS 1, and those with an albumin level above 35 g/L were determined as mGPS

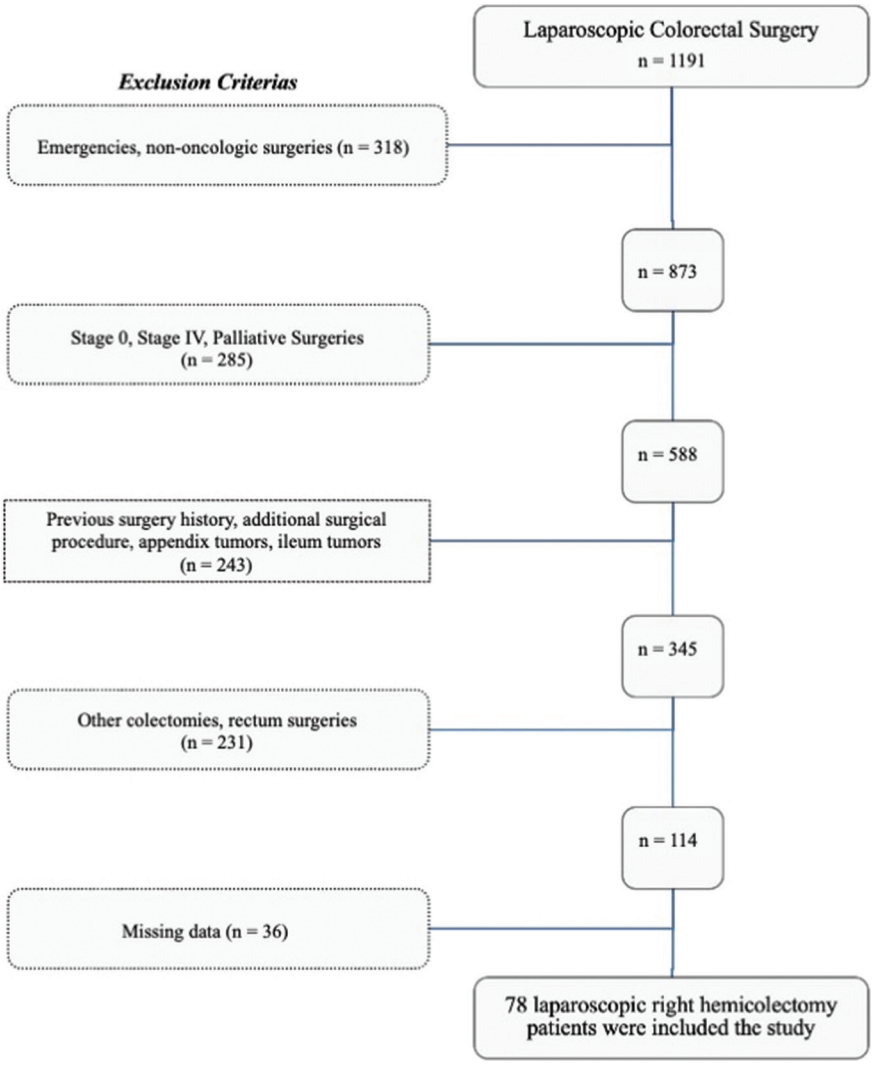

Figure 1. *Flow diagram of exclusion criteria.*

2. mGPS 0 is low score and shows good prognosis, mGPS 1 is moderate and shows moderate prognosis, and mGPS 2 shows poor prognosis[17]. Complications were classified according to the Clavien-Dindo Classification[18]. Clavien-Dindo ≥ 3 was considered a major complication. Others were included in the mild complication category.

For the assessment of sarcopenia, the previously described scoring over psoas muscle volume was calculated[19]. If the patient had a contrast-enhanced computed tomography (CT) taken within the last month, it was included in the study. Sarcopenia calculations were made by a specialist radiologist using the picture archiving and communication system. No information was given to the radiologist about the patients. L3 vertebrae were detected in the axial section, and the right and left psoas muscle areas were measured from the upper border of the vertebrae in square centimeters (cm^2) by freehand drawing method (Fig. 2). The first of these methods is the total psoas index (TPI). The total psoas area is used as a representation of total body muscle mass in the calculation[20]. The TPA values obtained by the sum of the right psoas area and the left psoas area were divided by the square meter (m^2) of the patient's height and normalized according to the patients, and TPI was obtained. Another method is the Hounsfield Unit average calculation (HUAC). This method also measures the Hounsfield Unit (HU) values of the areas and the muscle density and in a way gives an idea about the quality of the muscle. While this value is low in muscles with more adipose tissue, HU values are higher

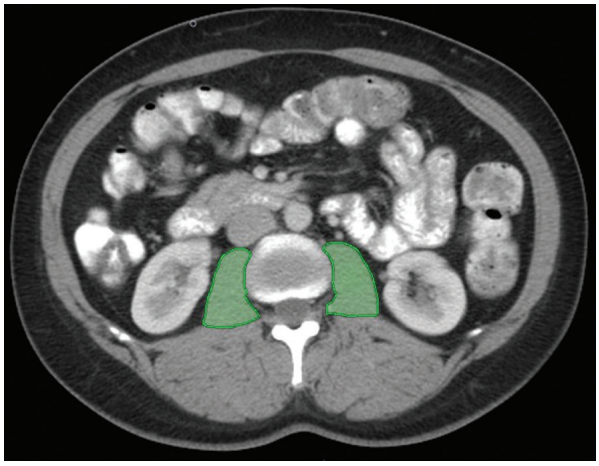

Figure 2. *Psoas area calculation by freehand drawing method.*

in psoas muscles that are richer than muscle[21]. {[(Right psoas mean HU * Right psoas area)/TPA] + [(Left psoas mean HU * Left psoas area)/TPA]}/2 formula is used in the calculation[22]. For both genders, patients in the last quartile of calculated TPI and HUAC values were considered sarcopenic. Patients who were considered sarcopenic at either TPI or HUAC were considered sarcopenic in total.

Perioperative care

In our institution, bowel preparation with two 135 mL rectal enemas and an oral laxative solution is performed one day before the operation as standard for all patients who are scheduled for colorectal surgery and who do not have an obstructive lesion. A nasogastric catheter and urinary catheter are inserted before the operation. Antibiotic prophylaxis is administered with 1 g ceftriaxone and 500 mg metronidazole before anesthesia induction. At least two general surgery specialists are involved in the operations.

All patients included in the study were operated with the laparoscopic method, while intra-abdominal pressure was maintained at an average of 12-15 mm/Hg. Anastomoses were performed side-by-side using a linear stapler with the extracorporeal method from the incision where the piece was removed. A suction drain was placed in the right paracolic area during the operations. All patients were admitted to the intensive care unit after the operation. Patients with good general conditions and stable hemodynamics were taken to their rooms. Urinary and nasogastric catheters were terminated on the first postoperative day as standard procedure. Routine mobilization and respiratory physiotherapy recommendations were made until discharge. The patients were followed up for at least 1 month after discharge.

Statistical analysis

The data were evaluated with the IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. package program. The conformity of the data to the normal distribution was evaluated with the Shapiro-Wilk test. Categorical variables were given as frequency (%) and continuous variables as median (interquartile range [IQR]). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Numerical variables were compared using either the Mann-Whitney U or Kruskal-Wallis test, as appropriate. Logistic regression analysis was used to determine the odds ratio for complication in sarcopenic patients. The logistic regression model was developed by adjusting for age, gender, ACCI, stage of disease, and mGPS.

Results

78 patients were included in the study. The median age was 63. 37 (47.4%) of the patients were female. The demographic features of the patients are summarized in table 1. The median TPI value was 4.37 (3.24-5.11) in women and 4.84 (3.75-5.50) in men. The median HUAC value was 23.45 (20.94-27.23) in women and 25.01 (22.22-27.71) in men. No significant difference was found between the two genders for both parameters (p = 0.123, p = 403, respectively). According to TPI or HUAC, 35 (44.9%) patients were defined as sarcopenic. The patient outcomes are listed in table 2 based on sarcopenia status.

Complication and mortality rates

A total of 13 (16.7%) complications were observed in patients: Grade 1 in two (2.6%) patients, Grade 2 in four (5.1%) patients, Grade 3a in two (2.6%) patients, Grade 4a in two (2.6%) patients, and Grade 5 in three (3.8%) patients. No statistically significant correlation was found between stage of disease, obesity status, ACCI, ASA score, and mGPS and complication rates (p = 0.605, 0.443, p = 0.267, p = 0.391, 0.797, respectively). The complication rate

Table 1. Baseline characteristics

Variable	Total (n = 78)	Non-sarcopenic (n = 43)	Sarcopenic (n = 35)	p-value
Age (years)*	63 (56-71)	63 (54-71)	63 (56-73)	0.381†
Sex				0.856‡
Female	37 (47.4%)	20 (46.5%)	17 (48.6%)	
Male	41 (52.6%)	23 (53.5%)	18 (51.4%)	
Localization				-
Caecum	44 (56.4%)	25 (58.1%)	19 (54.3%)	
Ascending colon	17 (21.8%)	10 (23.3%)	7 (20.0%)	
Hepatic flexure	15 (19.2%)	6 (14.0%)	9 (25.7%)	
Transverse colon	2 (2.6%)	2 (4.7%)	0 (0.0%)	
Operation				0.504§
Right Hemicolectomy	69 (88.5%)	37 (86.0%)	32 (91.4%)	
Extended Right Hemicolectomy	9 (11.5%)	6 (14.0%)	3 (8.6%)	
Tumor Size (cm)*	4.8 (3.0-6.0)	4.5 (3.4-6.0)	5.0 (3.0-6.5)	0.625†
Tumor Type				-
Adenocarcinoma	59 (75.6%)	33 (76.7%)	26 (74.3%)	
Medullary Carcinoma	2 (2.6%)	0 (0.0%)	2 (5.7%)	
Mucinous Adenocarcinoma	16 (20.5%)	10 (23.3%)	6 (17.1%)	
Neuroendocrine Carcinoma	1 (1.3%)	0 (0.0%)	1 (2.9%)	
T Stage				-
T1	12 (15.4%)	5 (11.6%)	7 (20.0%)	
T2	5 (6.4%)	5 (11.6%)	0 (0.0%)	
T3	43 (55.1%)	24 (55.8%)	19 (54.3%)	
T4a	14 (17.9%)	7 (16.3%)	7 (20.0%)	
T4b	4 (5.1%)	2 (4.7%)	2 (5.7%)	
Resected LN*	20 (15-26)	20 (14-25)	21 (16-27)	0.418†
Positive LN*	0 (0-2)	0 (0-2)	0 (0-2)	0.320†
N Stage				-
N0	47 (60.3%)	29 (67.4%)	18 (51.4%)	
N1a	7 (9.0%)	1 (2.3%)	6 (17.1%)	
N1b	11 (14.1%)	5 (11.6%)	6 (17.1%)	
N1c	3 (3.8%)	2 (4.7%)	1 (2.9%)	
N2a	5 (6.4%)	2 (4.7%)	3 (8.6%)	
N2b	5 (6.4%)	4 (9.3%)	1 (2.9%)	
Stage				0.151‡
Early	47 (69.3%)	29 (67.4%)	18 (51.4%)	
Advanced	31 (39.7%)	14 (32.6%)	17 (48.6%)	
BMI (kg/m^2)*	26.29 (23.34-28.93)	26.22 (23.74-29.11)	26.35 (22.97-28.81)	0.501†
BMI categorized				0.447‡
< 30	64 (82.1%)	34 (79.1%)	30 (85.7%)	
≥ 30	14 (17.9%)	9 (20.9%)	5 (14.3%)	
ACCI				-
0-2	9 (11.5%)	5 (11.6%)	4 (11.4%)	
3-4	31 (39.7%)	18 (41.9%)	13 (37.1%)	
≥ 5	38 (48.7%)	20 (46.5%)	18 (51.4%)	
ASA				-
ASA I	30 (38.5%)	19 (44.2%)	11 (31.4%)	
ASA II	40 (51.3%)	18 (41.9%)	22 (62.9%)	
ASA III	7 (9.0%)	5 (11.6%)	2 (5.7%)	
ASA IV	1 (1.3%)	1 (2.3%)	0 (0.0%)	
mGPS*	0.20 (0.10-0.44)	0.17 (0.09-0.34)	0.24 (0.12-0.59)	0.310†

*Reported as median (IQR).
†Mann-Whitney U test,
‡Chi-square test.
§Fisher's exact test.

Table 2. Outcomes of patients according to sarcopenia status

Variable	Total (n = 78)	Non-sarcopenic (n = 43)	Sarcopenic (n = 35)	p-value
Complication	13 (16.7%)	2 (4.7%)	11 (31.4%)	**0.002**‡
Major complication	7 (9.0%)	1 (2.3%)	6 (17.1%)	**0.041**§
Mortality	3 (3.8%)	0 (0.0%)	3 (8.6%)	0.086§
Length of stay (days)*	6 (6-7)	6 (6-7)	7 (6-9)	0.099†
Operation time (min.)*	158 (120-190)	155 (123-195)	160 (123-188)	0.948†
Estimated blood loss (mL)*	100 (60-140)	100 (50-150)	90 (60-120)	0.522†

*Reported as median (IQR).
†Mann-Whitney U test.
‡Chi-square test.
§Fisher's exact test.
In bold: values when a patient is sarcopenic, which increases the likelihood of experiencing all types of complications, including those classified as Clavien-Dindo grade I-II, not just major complications.

was higher in sarcopenic patients (31.4% vs. 4.7%, p = 0.002). In addition, the rate of major complications (≥ grade 3) was also found to be higher in sarcopenic patients (17.1% vs. 2.3%, p = 0.041). After adjusting for age, gender, ACCI, stage of disease and mGPS, sarcopenia was associated with an increased risk of complications (adjusted OR: 10.56, 95% CI: 1.91-58.34, p = 0.007). However, this increased risk was not statistically significant in the risk of major complications (adjusted OR: 7.22, 95% CI: 0.74-70.18, p = 0.088).

High mGPS was found to be associated with increased mortality risk. While no mortality was observed in 39 patients with low risk according to mGPS, mortality was observed in one (3.2%) of 31 patients with medium risk and two (25.0%) of 8 patients with high risk (p = 0.012). In addition, mortality was not observed in non-sarcopenic patients, whereas mortality was observed in three (8.6%) patients with sarcopenic, but the difference was not statistically significant (p = 0.086).

Length of stay

The median length of stay was 6 (6-7) days. No correlation was found between stage of disease, obesity status, ACCI and ASA scores, and length of stay (p = 0.867, p = 0.322, p = 0.549, p = 0.467, respectively). Patients with a low mGPS had a shorter hospital stay than those with a moderate or high score [6 (5-7) days vs. 7 (6-8) days, p = 0.011]. The hospital stay was longer in sarcopenic patients, but the difference was not statistically significant [7 (6-9) days vs. 6 (6-7) days, p = 0.099].

Operation time and estimated blood loss

The median operative time was 158 (120-190) min. No statistically significant correlation was found between the duration of the operation and the stage of disease, obesity status, ACCI, ASA score, mGPS, and sarcopenia (p > 0.05). The median estimated blood loss was 100 (60-140) mL. No statistically significant correlation was found between the estimated blood loss and disease stage, obesity status, ACCI, ASA, mGPS, and sarcopenia (p > 0.05).

Discussion

Colorectal cancer-related mortality rates are gradually decreasing in the United States and many western countries[23]. Early detection of the disease with screening programs, improved surgical techniques, and neoadjuvant and adjuvant treatments have significantly increased the survival time. However, mortality rates continue to increase, especially in Eastern Europe, and central and South American countries[24]. Surgical resection is the only known curative treatment for colorectal cancer, which is still a major problem all over the world. Surgical resection, on the other hand, is not innocent. Mortality and complications may develop after colorectal cancer surgery, as in any surgery. While morbidity rates can reach up to 35% in colorectal cancer surgery, mortality rates have been reported between 1% and 16.4%[25]. Predicting who may

develop complications and recognizing and treating them earlier may positively affect survival outcomes.

Sarcopenia differs from cachexia, which is characterized by decreased BMI and weight loss in cancer patients and indicates muscle mass loss[26]. It is an early diagnostic component and an indicator of nutritional status[27]. Sarcopenia can also be observed in obese patients, as it is an indicator of muscle mass loss, not weight loss. Sarcopenia is very common in gastrointestinal system malignancies, as in many cancer types[28]. The relationship between sarcopenia and oncological and clinical outcomes has been demonstrated in the previous studies[29-32]. As reported, sarcopenia is associated with a prolonged length of stay, increased mortality, and complication rates[33]. There are many studies that include negative medical results between colorectal cancers and sarcopenia[34-36].

Another parameter used prognostically like sarcopenia is mGPS. It was first used by Forrest et al. to predict the prognosis of inoperable lung cancer[37]. Although the ratio was used in the beginning, it was later modified and grouped[17]. Among the hemogram parameters, lymphocytes, monocytes, neutrophils, platelets, and red cell distribution width (RDW) and their ratios to each other are generally related to increased inflammatory processes. However, increased levels of CRP, which is itself an inflammatory marker, in the pre-operative period reflects an ongoing inflammatory reaction. It plays a role in the impairment of immune functions. Hypoalbuminemia is the indicator of impaired nutritional status and susceptibility to infection due to cancer. mGPS, calculated by the ratio of CRP and albumin level, is mostly preferred to predict long-term oncological outcomes and overall survival. However, in recent years, it has been reported that it may be associated with poor prognosis in the early post-operative period after colorectal cancer surgery[38].

In our analysis, we observed that sarcopenia, which we obtained from the measurements we made on the psoas muscle, was associated with complications. Early general complications are more common in sarcopenic patients. In addition, major complications were observed to be more frequent in sarcopenic patients. There was also an increased overall complication rate in sarcopenic patients in the multivariate analysis performed after adjusting for age, gender, ACCI, stage of disease, and mGPS. Therefore, care should be taken in terms of complications in laparoscopic right hemicolectomy operations to be performed in sarcopenic patients. However, sarcopenia has not been shown to influence predicting mortality. Instead of sarcopenia, mGPS should be used to evaluate mortality. mGPS is statistically significant in predicting mortality. There is an increased risk of mortality in patients with a high mGPS. While sarcopenia was superior in predicting complications, mGPS was found to be superior in predicting mortality.

No statistically significant relationship could be found between the stage of disease, obesity status, ACCI and ASA score, and complication and mortality, among the methods used in the literature for the evaluation of short and long-term outcomes. As is known, TNM staging is calculated by the extent of the tumor in the colon wall and lymph node, and the distant metastasis status. It is known that the long-term results of the disease are directly related to overall survival. We included Stages I, II, and III patients in our study. We found that staging was not associated with 30-day complications and mortality in our analysis. Another variable that we evaluated was obesity. In a study evaluating the relationship between long-term outcomes of colorectal cancer and BMI, no significant relationship was found between oncologic outcomes and BMI[3]. Since we know that cancer patients can be sarcopenic without being cachectic, we wanted to evaluate the obesity status in our study. However, we have seen that there is no relationship between short-term results and obesity status. Two of the calculations made with the comorbidities of the patients are the ASA score and ACCI. The ASA score is basically a scoring system used by anesthesiologists to determine surgical risk. ACCI, on the other hand, is a frequently used index in the literature to identify and classify comorbidities. Anemia, type 2 diabetes, hyperlipidemia, coronary artery disease, asthma, and chronic obstructive pulmonary diseases constituted most of the comorbidities in the patients included in the study. Wound healing could be impaired due to these diseases, and anastomotic leakage could increase. As a result, we would expect higher complication and mortality rates in those patients. However, we did not observe a relationship between ASA score and ACCI, which indicate comorbidity, and short-term results. We think that this is due to the fact that ASA score and ACCI are used for different purposes. Grouping and evaluating comorbidities as comorbidities that impair wound healing and those that do not impair wound healing, perhaps, would have enabled us to achieve more meaningful results. But this time, we would have evaluated the postoperative complications only on the basis of wound healing. Not evaluating cardiac, pulmonary, and all other complications would have been biased.

The secondary outcome of our study was to analyze our variables in terms of short-term outcomes other than complication and mortality. Cancer stage, obesity status, ASA score, and ACCI cannot be used predictively in the estimation of complications and mortality, as well as in the estimation of hospitalization time, operation time, and estimated blood loss. The relationship between sarcopenia, which is statistically significant in predicting complications, and mGPS, which we used to predict mortality, was first evaluated. Patients with a low mGPS and good prognosis have shorter hospital stays. In the study conducted by Xu et al., it was reported that mGPS could be used to predict long-term outcomes in colorectal cancers[39]. We aimed to evaluate short-term outcomes in colorectal malignancies. We have demonstrated that mGPS can be used to predict mortality and hospital stay. Again, in the literature, it has been shown that mGPS is associated with the length of stay of colorectal cancer patients[40]. When the relationship between sarcopenia and length of stay was evaluated, we observed that although it was not statistically significant, sarcopenic patients had a longer hospital stay.

As far as we know, it has not been evaluated before in the literature whether muscle loss, nutrition and inflammatory conditions of colorectal cancer patients will affect the operation time and intraoperative blood loss. Although van Wijk et al. previously reported that prolonged operation time is a risk factor for the development of sarcopenia[41], we aimed to evaluate the opposite of this situation in our study. However, we did not show both the sarcopenia status and the statistical relationship of mGPS with the operation time. Likewise, there was no correlation between estimated blood loss and mGPS and sarcopenia status.

There were some limitations of our study. Firstly, our study is a single-centered retrospective study. For better results, multicentric, randomized controlled trials could be preferred. In our study, only mGPS, which contains CRP, was evaluated among the inflammatory parameters. CRP alone and other parameters used in the hemogram were not included in our study. We aimed to evaluate different parameters since there were many studies of this kind in the literature before. Another shortcoming is that only laparoscopic right hemicolectomy patients were included in the study. Our study does not provide any information about other colon and rectal cancer patients. In determining our patient group in this way, we aimed to include patients who were treated more homogeneously and with standard treatment. However, this resulted in a low number of patients, and we may have caused selection bias. In addition, 36 patients who underwent laparoscopic right hemicolectomy and met other inclusion criteria, but whose data could not be reached, were excluded from the study. In this context, further studies with larger volumes will be needed. Finally, only short-term results were discussed in our study. Since the majority of our patients consist of surgeries we have performed in recent years, long-term results can be evaluated in the later stages as long-term follow-up is completed.

Our study is illuminating in terms of predicting short-term outcomes after laparoscopic surgery in right colon cancers. It is a study in which multiple different variables such as stage of disease, obesity status, sarcopenia status, mGPS, ASA score, and ACCI are evaluated together, and short-term results are investigated. In this respect, it appears in the literature as a pioneering study. Our study has shown that the mGPS and sarcopenia can be used to estimate complications and mortality. Again, to the best of our knowledge, this is a rare study that evaluates the estimation of operative time and estimated blood loss from short-term outcomes for colon cancers. We believe that it will contribute positively to the literature with these aspects. These are the positive aspects of our work.

Conclusion

Sarcopenia status and mGPS are superior to other methods in predicting early outcomes. Sarcopenia can be used in the development of complications, and the mGPS can be used to predict mortality. While increased complications are observed in sarcopenic patients, mortality is higher in patients with high mGPS. However, randomized controlled studies are needed to obtain more reliable results and to eliminate the question marks.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. Right to privacy and informed consent. The authors have obtained approval from the Ethics Committee for analysis and publication of routinely acquired clinical data and informed consent was not required for this retrospective observational study.

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