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Psoas Muscle Index – Could It Be an Indicator of Postoperative Complications in Colorectal Cancer? Case Presentation and Review of the Literature

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ABSTRACT

Introduction: Colorectal cancer is the third most commonly diagnosed cancer worldwide, and its incidence is rising in developing countries. Studies have shown an association between sarcopenia and various poor short-term outcomes in cancer patients who underwent surgery. In this case study, we sought to highlight the importance of a modern prognostic factor, the psoas muscle index (PMI), in colorectal cancer. **Case Presentation:** We present the case of a 59-year-old male patient with sigmoid cancer. We calculated the PMI as the sum of the areas of the left and right psoas muscle at the level of the L3 vertebra, divided by the square of the patient's height, using computed tomography measurements. We also measured the density of the proas muscles. Prior to surgery, the left psoas muscle had an area of 14.52 cm^2, and the right 14.54 cm^2, with a PMI of 9.4967 cm^2/m^2. The mean density of the psoas muscles was 43.60 UH. The surgery consisted in a rectosigmoid resection with termino-terminal colorectal anastomosis. The histopathological examination confirmed moderately differentiated adenocarcinoma, stage IIIB (pT3N1M0). The patient left the hospital eight days after surgery in good general condition. Long-term follow-up was performed by phone and CT scans at 1, 6, and 12 months. **Conclusions:** CT-measured PMI may be a potential prognostic imaging marker in patients with colorectal cancer that can be easily and routinely assessed preoperatively.

Keywords: psoas muscle index, colorectal cancer, modern prognostic factor

INTRODUCTION

In 1989, Irwin Rosenberg suggested the term 'sarcopenia' (from Greek 'sarx' or flesh and 'penia' or loss) to describe the age-related loss of muscle or lean mass. Sarcopenia is also a syndrome associated with reduction of strength and physical activity and a marker of frailty, and a key criterion to diagnose cancer cachexia, associated with increased postoperative morbidity and mortality.[1–3] According to GLOBOCAN 2020 data, colorectal cancer (CRC) is the third most deadly and fourth most common cancer worldwide, with an incidence that is rising in developing countries due to poor diet and sedentary lifestyle.[4] As reported by the American Society of Clinical Oncology, the overall 5-year survival rate for colon cancer is 64%. If the cancer is diagnosed in an early stage, the survival rate is 91%, but if it spreads to surrounding tissues, lymph nodes or other organs, the 5-year survival rate is 72%; in case of metastases, it decreases to only 14%.[5] According to different studies, sarcopenia has been shown to be a poor prognostic factor for patients with various types of cancers, such as pancreatic cancer or melanoma, and is associated with reduced overall survival in elderly patients with head and neck squamous cell carcinomas.[6–8] Abdominal computed tomography (CT) is routinely performed in colon cancer surgery, not only for staging but also to evaluate the patients' body composition. It represents one of the gold standard methods to assess skeletal muscle mass, being a reliable and reproducible tool to help confirm the diagnosis of sarcopenia. The CT scan has the advantage of performing a cross-sectional measurement of fat mass areas anywhere in the body and can also evaluate muscle quality.[9] Although not usually measured in clinical practice, the assessment of skeletal muscle mass using a cross-sectional CT is usually done at the lower edge of the L3 vertebra, and it strongly correlates with total body composition.[1] A preoperative radiological assessment of sarcopenia may identify colon cancer patients who are at risk of postoperative complications, such as anastomotic leakage, and can potentially suggest whether to perform a primary anastomosis or a stoma.[2,10]

In a study published in 2022, enrolling 197 male patients with rectal cancer, the psoas muscle index (PMI) was significantly higher in patients who had anastomotic leakage (AL) (median PMI: 856.6; p <0.0001), and the results of the study indicated that preoperative PMI measurement could predict the high-risk group for AL in case of male subjects with rectal cancer.[11]

Various studies have described a relationship between sarcopenia and various poor short-term outcomes in cancer patients who underwent surgery, including a higher perioperative mortality, prolonged hospitalization, physical impairment, and higher infection rates.[12,13] Sarcopenia also has a negative effect on the overall survival and disease-free survival of patients who undergo resection for locally advanced cancer of the rectum and obstructive colorectal cancer, and also on cancer-specific survival of patients with colorectal cancer.[14–16] The aim of this paper is to present our research method and the technique of calculating the psoas muscle index and psoas muscle density, based initially on a case presentation.

CASE PRESENTATION

We present the case of a 59-year-old male patient with a diagnosis of malignant left colon tumor, in whom we investigated whether CT-defined sarcopenia at the lower edge of the L3 vertebra could efficiently predict outcomes. Abdominal CT examinations were performed with iodine-based contrast agent injection. Axial sections were made at the lower edge of the L3 vertebral plate, using venous phases to better delimit the edges of the psoas muscles from the rest of the structures. The area of each psoas muscle, right and left, was measured transversely, at the lower edge of the L3 vertebral body, outlining the muscle edges. The result was recorded in cm^2. The measurements were performed with RadiANT Dicom Viewer version 2021.2 (64 bit), using the Closed Polygon tool to outline the muscle edges. The PMI, defined as the total area of the left and right psoas muscles (cm^2) at the level of the inferior edge of L3, divided by the square of the patient's height (m^2), was assessed with the use of CT. The unit of measurement was cm^2/m^2. The density of the psoas muscles was measured using the region of interest (ROI) positioned in the center of the muscle at the same level (lower vertebral edge of L3) on the axial section, by evaluating the average value of the measured Hounsfield units.

The preoperative CT examination (Figure 1) described a discrete soft-tissue mass that narrowed the sigmoid lumen over a distance of about 48 mm, with a thickness up to 10 mm and discrete infiltration of the pericolic fat. No dimensionally enlarged adjacent lymph nodes were described.

Prior to surgery, the surface areas of the left and right psoas muscles were 14.52 cm^2 and 14.54 cm^2, respectively (Figure 2), the total area being 29.06 cm^2. The square of the patient's height (1.75 m) was 3.06 m^2, yielding a PMI of 9.4967 cm^2/m^2.

The densities were 45.78 UH for the left and 41.42 UH for the right psoas muscle, resulting in a mean density of 43.60 UH before surgery.



FIGURE 1. Preoperative CT examination – a discrete soft-tissue mass that narrows the sigmoid lumen

During surgery, a narrowing sigmoid tumor was found, for which a rectosigmoid resection was performed with termino-terminal colorectal anastomosis using a circular stapling device. The histopathological examination confirmed moderately differentiated adenocarcinoma. The tumor invaded through the muscularis propria into the subserosa and had a high grade of tumor budding. One lymph node metastasis was detected among the 12 regional lymph nodes harvested; thus, the tumor was classified as stage IIIB (pT3N1M0).

The immunohistochemical examination showed that the tumor cells were positive for the MLH1 and MSH2 reaction, which indicated a stable microsatellite status and the likelihood of response to 5-fluorouracil therapy. The p53 reaction was positive over 50%. The immunohistochemistry profile indicated increased invasive capacity, but also a low risk of distant metastasis. The patient left the hospital eight days after surgery in good general condition, with no postoperative complications.

One month after the rectosigmoid resection, the areas of the left and right psoas muscles were 13.36 cm^2 and 14.17 cm^2, respectively (Figure 3), with a total area of 26.53 cm^2. The PMI was 8.669 cm^2/m^2. The densities were 48.43 UH for the left and 40.96 UH for the right psoas muscle, with a mean density of 44.69 UH.

At the 6-month follow-up, we measured the area of each psoas muscle again at the level of the L3 vertebral body. The results indicated decreased values, with an area of 12.98 cm^2 for the left and 12.49 cm^2 for the right psoas muscle (Figure 4), with a total area of 25.47 cm^2. The PMI was 8.3235 cm^2/m^2 at 6 months from the rectosigmoid resection with anastomosis. The newly measured densities were 50.51 UH for the left and 51.09 UH for the right psoas muscle, with an average of 50.08 UH.

At approximately one year after surgery, we reexamined the patient and performed a new contrast-enhanced CT examination, which illustrated the rectocolic anastomosis, without signs of tumor recurrence. No secondary liver metastasis or abdominopelvic lymph nodes of pathological importance were described.

The publication of this case report was approved by the Ethical Committee of the Mureș County Emergency Hospital, Târgu Mureș, Romania (no. 16240/04.07.2022) where the patient was admitted, and informed written consent was obtained from the patient.

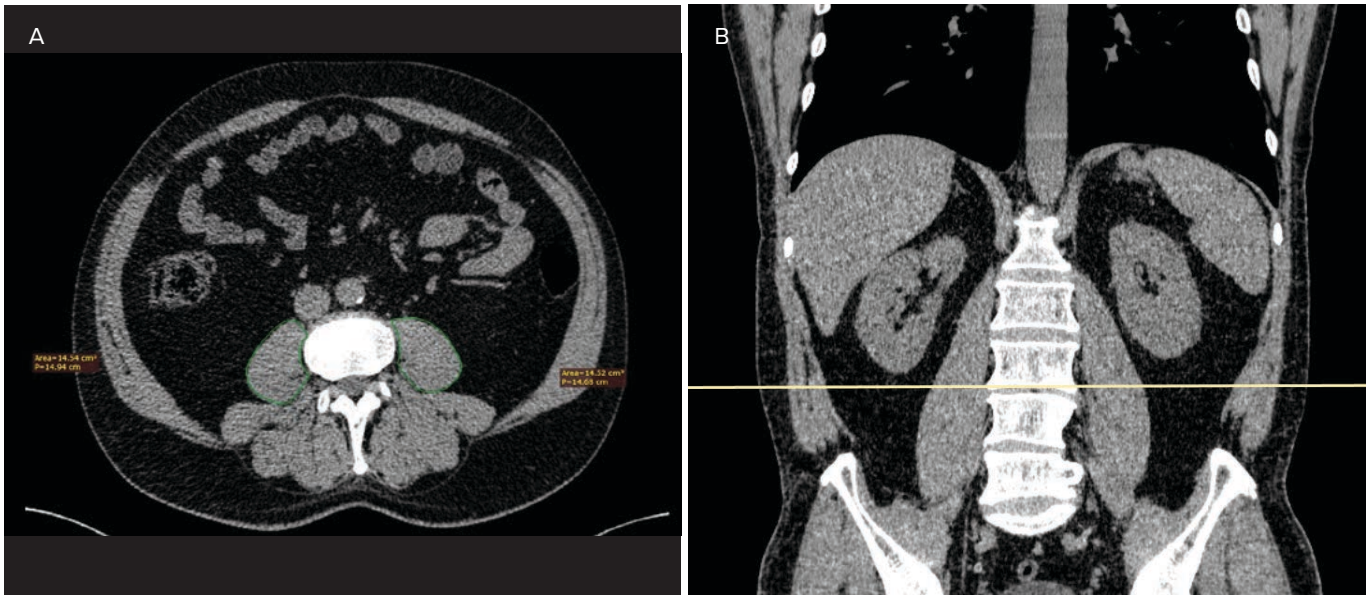


FIGURE 2. Before surgery. **A** – right psoas muscle: 14.54 cm^2; **B** – left psoas muscle: 14.52 cm^2, PMI: 9.4967 cm^2/m^2



FIGURE 3. One month after surgery. Right psoas muscle: 14.17 cm^2, left psoas muscle: 13.36 cm^2, PMI: 8.669 cm^2/m^2



FIGURE 4. Six months after surgery. Right psoas muscle: 12.49 cm^2, left psoas muscle: 12.98 cm^2, PMI: 8.3235 cm^2/m^2

DISCUSSION

The treatment of colon cancer is multidisciplinary, requiring the cooperation of a radiologist, surgeon, pathologist, and oncologist. New treatments for colorectal cancer have emerged, including laparoscopic/robotic surgery for primary disease, more aggressive metastasectomy, radiotherapy in case of rectal cancer, as well as neoadjuvant and palliative chemotherapies.

Skeletal muscle loss (sarcopenia) and frailty are important concepts in cancer surgery because of the association with adverse postoperative outcomes, and the radiological measurement of psoas muscle mass provides the possibility to quantify sarcopenia.[17]

For example, sarcopenia was an independent predictor of postoperative complications in esophageal cancer patients,[18] such as pulmonary complications or delayed gastric emptying, and infectious, gastrointestinal, and cardiopulmonary complications in patients following pancreatectomy for cancer.[19] A study that included 259 patients who underwent liver resection for colorectal liver metastasis showed that patients with sarcopenia had longer hospital stays and higher chances of an extended intensive care unit stay, and sarcopenia was associated with a higher risk of postoperative complications.[20]

The measurement of sarcopenia with the use of CT imaging as a measure of frailty is achieving increased recognition and has shown positive correlation with postoperative outcomes in several studies.[21]

The measurement of psoas density assesses not only the volume but also the quality of the muscle and seems to predict higher rates of poor outcomes compared to using psoas area only; hence, it can be considered a more precise tool for sarcopenia and frailty.[22] PMI and density values may indicate anastomosis insufficiency and morbidity in patients with colorectal malignancies. In a study published in 2019, in which out of 169 patients with colorectal resection for malignancy 140 had a primary anastomosis, it was shown that sarcopenia was linked to an increased risk of AL.[2]

In our case study, the patient had a preoperative PMI value of 9.4967 cm^2/m^2, which was higher than those reported in other studies.[11,23] In a study published in 2022 by Mizuuchi *et al.* in the Annals of Coloproctology, the established cut-off value for PMI was somewhat lower than our patient's values, but the difference was not significant. Large psoas muscle mass can be a predictive marker for AL in male patients with rectal cancer.[11] However, our patient had slightly higher PMI values and presented no complications due to his relatively young age and lack of other comorbidities.

Regarding colorectal cancer, several studies have proven a significant association between sarcopenia and a negative prognosis and mortality after curative surgery for colorectal cancer.[24,25] In the present case study, we investigated CT-defined sarcopenia at the level of the inferior endplate of the L3 vertebra. The psoas area is usually measured at a standard lumbar vertebral landmark (L3 or L4), but other landmarks, such as the umbilicus, have also been used.[26] In 2021, Yoshikawa *et al.* published a study where the PMI was measured at the L5 vertebra and was found to be an independent negative prognostic factor in patients from Japan who were treated for ovarian cancer.[27] Yoshikawa *et al.* also measured a median psoas muscle area of 12.7 cm^2 at the L5 vertebra, while Rutten *et al.* measured 13.3 cm^2 at the L3 vertebra.[28] Yoshikawa *et al.* hypothesized that their participants had a smaller muscle mass due to the fact that the L5 vertebra has a larger muscle area than the L3.[27]

The limitations of this paper are those of a single case report. By their nature, case reports are not chosen from representative population samples, thus they cannot provide facts about rates or ratios, incidences or prevalence, and the findings cannot be generalized. Our case study provided a useful examination of this relatively new preoperative predictive factor, the psoas muscle index and psoas muscle density, in which we described the measurement technique and its usefulness. The strength of this study lies in the presentation and detailed description of the radiological investigation method of sarcopenia, and the timely follow-up of the patient with repeated CT scans at 1, 6 and 12 months postoperatively.

CONCLUSIONS

Radiologically measured sarcopenia can be an important predictive risk factor for poor outcomes following surgery in cancer patients. The psoas muscle index may be a potential imaging biomarker for prognosis evaluation in colon cancer patients. The psoas muscle index can be easily assessed preoperatively using CT scans, which are routinely performed before surgery for staging, thus no additional costs are required.

CONFLICT OF INTEREST

The authors declare no competing interests.

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