CT assessment of sarcopenia in patients with pancreatic cancer and chronic pancreatitis

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Authors: E. Bulanova, V. K. Lyadov, E. A. Mershina, V. Sinitsyn; Moscow/ RU
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Purpose

Skeletal muscle loss, or sarcopenia, is associated with many clinical conditions, such as cancer, diabetes, acquired immune deficiency syndrome, burns, chronic obstructive pulmonary disease, chronic heart failure, chronic renal failure, rheumatoid arthritis and sepsis [1-4]. As metabolic disorders, such as cachexia and sarcopenia, are common conditions in patients with tumors and inflammatory diseases of the pancreas [5-6], we studied the role of CT in assessing sarcopenia in patients with pancreatic cancer and chronic pancreatitis.

Methods and Materials

We evaluated 49 CT-images of patients with stage II pancreatic cancer and chronic pancreatitis, which underwent operative treatment in 2009-2011. There were 20 patients (Group 1) with pancreatic cancer (9 men and 11 women, age range 47-82 years) and 29 patients (Group 2) with chronic pancreatitis (23 men and 6 women, age range 29-63 years). In all the patients CT was performed for diagnostic and staging purposes, no additional studies were made for body composition assessment.

Images were analyzed using commercially available software (Slice-O-Matic V4.3, Tomovision). A single axial CT-image at the level of the third lumbar vertebrae was assessed to measure cross-sectional areas (cm²) of skeletal muscle (m. psoas major, m. erector spinae, m. quadratus lumborum, m. obliquus externus abdominis, m. obliquus internus abdominis, m. transversus abdominis, m. rectus abdominis). Hounsfield units (HU) threshold for skeletal muscle was 150 to -29 HU (Fig. 1 on page 3). Also we measured the area of adipose tissue compartments (cm²). HU thresholds for adipose tissue compartments were: -150 to -50 for visceral adipose tissue (VAT), -190 to -30 for subcutaneous adipose tissue (SAT) and intramuscular adipose tissue (IAT) (Fig. 2 on page 3).

The values were normalized for the height of the patient to get the lumbar skeletal muscle index (L3 SMI) in cm²/m² [7-8]. The sex-specific sarcopenia cut-offs were 52.4 cm²/m² for men and 38.5 cm²/m² for women (Prado et al.) [7]. As it’s especially important to diagnose sarcopenia in overweighed patients, we compared our results with body-mass index (BMI) which was measured for each patient. The range normal of BMI was 18.6 to 24.9 kg/m².

We also evaluated the rate of complications and mortality in patients with and without sarcopenia.
Fig. 1: Structures that are segmented for body composition analysis and sarcopenia assessment. 1 - m. rectus abdominis, 2 - subcutaneous adipose tissue (SAT), 3 - m. obliquus externus abdominis, 4 - m. obliquus externus abdominis, 5 - m. obliquus internus abdominis, 6 - m. quadratus lumborum, 7 - m. psoas major, 8 - m. erector spinae, 9 - body of L3 vertebrae, 10 - intramuscular adipose tissue (IAT), 11 - visceral adipose tissue (VAT).
Fig. 2: Segmented CT-image of male patient with chronic pancreatitis. Segmented tissues are: red - skeletal muscles at the level of L3 vertebrae body, yellow - visceral adipose tissue (VAT), blue - subcutaneous adipose tissue (SAT), light grey - intramuscular adipose tissue (IAT).
Results

Group 1.

14 of 20 patients with pancreatic cancer were found sarcopenic (70% of group 1 patients, 8/9 men and 6/11 women). Mean value of lumbar skeletal muscle index in this group was 44.7±5.9 cm$^2$/m$^2$ for men and 35.7±3.8 cm$^2$/m$^2$ for women. Mean value of BMI was 25.4±2.5 kg/m$^2$. CT images of two patients with pancreatic cancer and different BMI values are shown in Fig. 3 on page 6 and Fig. 4 on page 6. First patient (1A-B) had normal BMI and L3 SMI values. In second patient BMI was increased but nevertheless this patient had sarcopenia (L3 SMI was decreased), BMI values were within normal range because of larger adipose tissue area.

Sarcopenia was diagnosed in 1/1 patient with decreased BMI (18.2 kg/m$^2$), in 7/10 patient with normal BMI (18.5-24.99 kg/m$^2$) and in 6/7 patients with increased BMI (25-29.99 kg/m$^2$). Two obese patients (BMI>30 kg/m$^2$) didn't have sarcopenia (Fig. 5 on page 6).

There was no significant difference in the rate of complications: 11/20 patients had complications in postoperative period (55%), among them 8 patients had sarcopenia (57%). Mortal cases (3 cases) were present only in the group of sarcopenic patients.

Group 2.

There were 18 sarcopenic of 29 patients with chronic pancreatitis (62%). Mean values of L3 SMI for men and for women were 47.0±6.6 cm$^2$/m$^2$ and 39.0±5.4 cm$^2$/m$^2$, respectively. Mean value of BMI in patients of group 2 was 22.16±2.3 kg/m$^2$. Different values of L3 SMI in two patients with same value of BMI are shown in Fig. 6 on page 7. It illustrates that the presence of sarcopenia didn't correlate with BMI values. Sarcopenia was diagnosed in 3/3 patient with decreased BMI (BMI<18.49 kg/m$^2$), in 13/18 patient with normal BMI (18.5-24.99 kg/m$^2$) and in 2/8 patients with increased BMI (25-29.99 kg/m$^2$) (Fig. 7 on page 8).

There were no perioperative complications and mortality in this group of patients.

There was no statistically significant difference between Group 1 and Group 2 (p>0.05) (Fig. 8 on page 9).

CT was also found as useful tool to evaluate the changes in body composition during the course of the disease. Fig. 9 on page 10 shows skeletal muscle loss and changes in body composition in male patient with chronic pancreatitis in 434 days period.
**Fig. 3:** Images of non-sarcopenic female patient with pancreatic cancer on the level of L3 vertebrae body. BMI - 23,3 kg/m², L3 SMI - 39,5 cm²/m². Skeletal muscle area - 110,5 cm², total adipose tissue area - 233,2 cm².

**Fig. 4:** Images of sarcopenic female patient with pancreatic cancer on the level of L3 vertebrae body. BMI - 27,7 kg/m², L3 SMI - 30,3 cm²/m². Skeletal muscle area - 87,5 cm², total adipose tissue area - 481,8 cm².
Fig. 5: Compartment of BMI and L3 SMI (presence of sarcopenia) in patients with pancreatic cancer (Group I).
**Fig. 6:** Different values of L3 SMI in two male patients with chronic pancreatitis and same value of BMI (22.1 kg/m²). Patient A (1A-B): L3 SMI - 53.5 cm²/m², skeletal muscle area - 179.2 cm², total adipose tissue area - 102.5 cm². Patient B (2A-B): L3 SMI - 36.2 cm²/m², skeletal muscle area - 122.1 cm², total adipose tissue area - 232.2 cm².
Fig. 7: Compartment of BMI and L3 SMI (presence of sarcopenia) in patients with chronic pancreatitis (Group II).
Fig. 8: The prevalence of sarcopenia in patients with pancreatic cancer and chronic pancreatitis.
Fig. 9: Skeletal muscle loss and the change in body composition in male patient with chronic pancreatitis. Follow-up study (2A-B) was made 434 days after the first one (1A-B). Skeletal muscle area decreased from 153,3 cm² to 120,2 cm², VAT area decreased from 181,8 cm² to 90 cm², SAT area decreased from 97,2 cm² to 44,7 cm², IAT increased from 8 cm² to 10,8 cm².
Conclusion

CT is a method of choice for diagnostics of pancreatic cancer and inflammatory diseases of the pancreas. It is also a useful tool to evaluate sarcopenia in these patients by using L3 skeletal muscle index, which can be measured using diagnostic CT-scans acquired during the routine care. Sarcopenia is highly prevalent in patients with pancreatic cancer and chronic pancreatitis (66% in our group of patients) and may be present in patients with any BMI values.

As metabolic disorders are important factor and are to be considered in surgical and combined treatment of pancreatic cancer, our results show that further research of sarcopenia in this group of patients is needed. The use of CT for body composition analysis opens up new possibilities in metabolic disorders research.

References

Personal Information