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The Influence of Preoperative Sarcopenia on Perioperative Nutritional Status Changes in Laparoscopic Liver Resection: A Single-Institution Retrospective Analysis

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Abstract

Background: The preoperative sarcopenia is reported to be strongly associated with postoperative worse outcomes, but few reports have addressed how the surgical stress impacts on the sarcopenic patients in the nutritional aspect. In this study, we aimed to clarify the nutritional status change after laparoscopic liver resection focusing on preoperative sarcopenia.

Methods: This study is a retrospective study of constitutive 42 patients who received laparoscopic liver resection between July 2018 and Dec 2019 in our single institute. The perioperative nutritional status change and body composition were assessed by blood test and Bioelectrical Impedance Analysis (BIA) with InBody 770.

Results: The patients were divided into sarcopenic patients (N=14) and non-sarcopenic patients (N=28). There was no significant difference in the patient background except for age. Although the blood tests showed similar preoperative nutritional results in two groups, BIA showed that sarcopenic patients had less BMI with undeveloped skeletal lean mass at every part than non-sarcopenic patients. According to the postoperative blood tests, it appeared laparoscopic liver resection did not negatively impact sarcopenic patients in contrast that non-sarcopenic patients showed postoperative nutritional deterioration. Of note, BIA found out that the only sarcopenic patients lost upper/lower body balance due to markedly reduced lower extremity lean mass.

Conclusion: This result suggested the importance of targeting lower extremity development for balanced body composition for the sarcopenic patients who receive laparoscopic liver resection before surgery.

Keywords: Laparoscopic liver resection; Sarcopenia; Nutrition

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Introduction

Sarcopenia is defined initially as a notable syndrome that is characterized by age-dependent loss of skeletal muscle mass following weakened strength and physical function with a negative impact on the disability, quality of life, and death [1]. Awareness toward sarcopenia is increasing in this super-aging society worldwide. The causes of sarcopenia are now broadly divided into two categories: Primary sarcopenia, which is merely age-dependent and secondary sarcopenia, which arises from the complicated factors other than aging, such as low physical activity, major organ failure, cancers, and malnutrition [2]. Among them, cancer in older people is a plausible condition promoting muscle atrophy due to cancer cachexia-induced hypercatabolic state and fluctuating diet intake in addition to aging [3]. Besides, we have increasing opportunities for performing laparoscopic liver resection for sarcopenic patients with liver cancers [4,5]. As both diseases of sarcopenia, cancer and chronic liver disease share similar mediators such as insulin resistance increased inflammation, and physical inactivity, they adversely affect each other [5]. The liver is a vital organ in our body in terms of maintenance of metabolic homeostasis, and liver resection accompanies by intraoperative liver ischemia and postoperative reduced remnant volume, possibly leading to impaired liver function. From these backgrounds, the sarcopenic patients who receive liver resection are supposed particularly vulnerable to surgical stress [6]. Previous reports also indicated that the presence of sarcopenia before surgery has an independent negative impact on the survival of the patients who receive liver resection [7,8]. In this current study, we aimed to assess how the presence of sarcopenia before surgery may affect perioperative nutritional status change in the patients who receive laparoscopic liver resection. To clarify this point, we did a retrospective medical chart review to examine the perioperative dynamic nutritional status changes utilizing blood test and bioelectrical impedance analysis with InBody 770.

Materials and Methods

From July 2018 to Dec 2019, a total of 42 patients received laparoscopic liver resection with full measurement of pre- and postoperative nutritional assessment. Medical records of the patients in this study were reviewed by the institutional review board and approved for the retrospective study protocol at Sakai City Medical Center. To analyze the clinical impact of laparoscopic liver resection on sarcopenic patients, we divided them into two groups: The sarcopenic group and the non-sarcopenic group based on the AWGS criteria [9]. Our study consisted of 14 patients in the sarcopenic group and 28 patients in the non-sarcopenic group. Table 1 gives a summary of the overall background of the patients in this study. The clinical and surgical characteristics of the patients were collected, including gender, age, background liver disease, preoperative liver function and liver condition, surgical procedure, operation time, intraoperative blood loss, surgical complication evaluated by Clavien-Dindo clarification, and the length of postoperative hospital stay. The two groups have a similar background with no statistical significance except for age. Sarcopenic patients were older than non-sarcopenic patients (77.1 ± 6.0 years old in sarcopenic patients *vs.* 70.0 ± 10.0 years old in non-sarcopenic patients, $p<0.05$). Most of the surgical procedure was non-anatomical liver resection in both groups. Furthermore, almost all of the patients in each group did not experience any severe surgical complications. The results of laboratory variables: Prothrombin Time (PT), albumin, prealbumin, transferrin, cholinesterase, BCAA (Branched Chain Amino Acids), BTR (BCAA/Tyrosine Ratio), TLC (Total Lymphocyte Count), and PNI (Prognostic Nutritional Index) [10] and BIA variables: Obesity index analysis, segmental lean analysis calculated in InBody 770. The percentage of the segmental lean analysis at every part was assessed by the standard lean mass calculated by the actual weight (InBody usa. com; https://inbodyusa.com/studies/). We employed the percentage rather than absolute muscle mass because the balance of percentage between upper and lower extremity is important in judging whether or not the patient has enough lean body mass to support their own body weight. These measurements were repeated before surgery and one month after surgery at outpatient.

Results

Table 2 shows the preoperative nutritional status in two groups. The blood tests, including PT, albumin, prealbumin, transferrin, cholinesterase, BCAA, BTR, TLC, and PNI, showed no statistically significant difference in the two groups. Obesity index analysis showed the sarcopenic patients had less BMI and a similar percentage of body fat to non-sarcopenic patients. The segmental lean analysis showed the sarcopenic patients had less developed lean mass at each body part than non-sarcopenic patients. Table 3 shows the perioperative nutritional status change in the two groups. Although sarcopenic patients showed reduced prealbumin and cholinesterase value, non-sarcopenic patients showed a marked decline in PT, albumin, prealbumin and cholinesterase value. In contrast, non-sarcopenic patients showed increased TLC value. BCAA, BTR, TLC, and PNI values were similar between pre- and post-operative period in two groups. Table 4 shows the BIA-based perioperative nutritional status changes in two groups. In two groups, postoperative SMI markedly declined with statistical significance. Obesity index analysis showed reduced BMI in non-sarcopenic patients, and unchanged percent body fat despite the presence/absence of sarcopenia. Notably, the segmental lean analysis showed that sarcopenic patients showed upper/lower body imbalance with markedly reduced lower extremity lean mass, whereas non-sarcopenic patients kept upper/lower body balance with a slight universal decline in every part.

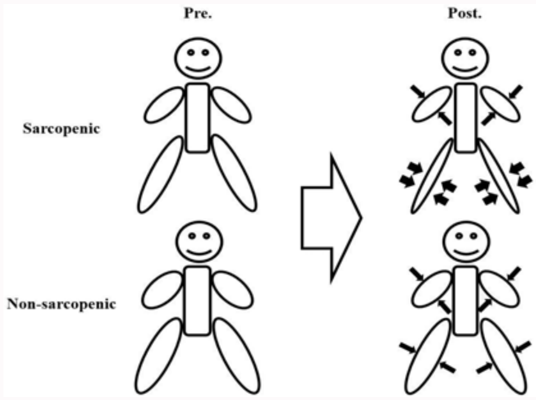

Figure 1: Illustration of perioperative body composition status change in two groups.

Table 1: Overall background of the patients in this study.

Variables	Sarcopenic (N=14)	Non-sarcopenic (N=28)	*p value*
SMI (kg/m^2), mean ± SD	M6.4 ± 0.3	M 7.4 ± 0.7	*<0.01[a]*
	F 4.9 ± 0.9	F 6.1 ± 0.6	*<0.05[a]*
Grip strength (kg), mean ± SD	M 25.9 ± 6.6	M 32.7 ± 5.2	*<0.05[a]*
	F 13.8 ± 4.5	F 20.2 ± 4.0	*<0.05[a]*
Gait speed (m/sec), mean ± SD	0.8 ± 0.3	1.0 ± 0.3	*<0.05[a]*
CLINICAL			
Gender Male:Female	9:05	18:10	*n.s.[c]*
Age (y), mean ± SD	77.1 ± 6.0	70.0 ± 10.0	*<0.05[a]*
HCC/others (meta plus others)	12:02	21:07	*n.s.[c]*
Cirrhosis: non-cirrhosis	4:10	4:24	*n.s.[c]*
Platelet ($/m^3$), mean ± SD	18.0 ± 7.8	20.0 ± 7.8	*n.s.[a]*
SURGICAL			
Op. time (min), mean ± SD	235 ± 100	244 ± 114	*n.s.[a]*
Blood loss (ml)	100 (0-1693)	155 (0-880)	*n.s.[b]*
Hr 0/1 + 2 + 3	13/1 + 0 + 0	24/4+ 0 + 0	*n.s.[c]*
Clavien-Dindo IIIa-V	1 (7.1%)	2 (7.1%)	*n.s.[c]*
Post. hospital stay (d), mean ± SD	8.4 ± 3.6[#]	7.6 ± 2.8	*n.s.[a]*

Data are expressed as mean ± standard deviation, median (minimum-maximum) or number (%)

[#]One patient transferred to a rehabilitation facility

Abbreviations: SMI: Skeletal Muscle Mass; M: Male; F: Female; HCC: Hepatocellular Carcinoma; meta: Metastatic liver cancer; Op. time: Operation Time; Hr: Hepatic resection; 0: Partial resection; 1: Segmentectomy; 2: Bisegmentectomy; 3: Trisegmentectomy

A: Student's t-test; b: Mann-Whitney U-test; c: Fisher's exact t test, significant p value is <0.05

Discussion

Regardless of the presence/absence of severe surgical

Table 2: Comparison of preoperative nutritional condition in two groups.

Variables	Sarcopenic (N=14)	Non-sarcopenic (N=28)	*p value*
Blood test-based			
PT (%) , mean ± SD	92.1 ± 6.8	91.8 ± 11.8	*n.s.*
Albumin (g/dL), mean ± SD	3.9 ± 0.3	4.1 ± 0.4	*n.s.*
Prealbumin (g/dL), mean ± SD	19.4 ± 6.1	19.7 ± 4.6	*n.s.*
Transferrin (mg/dL), mean ± SD	255.1 ± 47.6	293.6 ± 76.0	*n.s.*
Cholinesterase (U/L), mean ± SD	257.1 ± 80.2	250.7 ± 62.3	*n.s.*
BCAA (μU/mL), mean ± SD	461.8 ± 153.4	462.1 ± 104.4	*n.s.*
BTR, mean ± SD	5.9 ± 0.8	6.3 ± 1.9	*n.s.*
TLC (mm^3), mean ± SD	1833 ± 726	1656 ± 769	*n.s.*
PNI, mean ± SD	48.1 ± 4.6	49.6 ± 6.8	*n.s.*
BIA-based			
Obesity Index analysis			
BMI (kg/m^2), mean ± SD	21.6 ± 3.3	24.5 ± 4.4	*<0.05*
PBF (%), mean ± SD	29.3 ± 6.0	30.5 ± 9.3	*n.s.*
Segmental Lean analysis			
Right arm (%), mean ± SD	77.1 ± 9.1	91.1 ± 9.8	*<0.01*
Left arm (%), mean ± SD	75.8 ± 10.6	89.4 ± 9.0	*<0.01*
Trunk (%), mean ± SD	87.4 ± 5.7	94.5 ± 5.3	*<0.01*
Right leg (%), mean ± SD	84.8 ± 6.9	92.8 ± 8.1	*<0.01*
Left leg (%), mean ± SD	83.4 ± 7.8	93.2 ± 8.3	*<0.01*

Data are expressed as mean ± standard deviation

Abbreviations: PT: Prothrombin Time; BCAA: Branched Chain Amino Acids; BTR: BCAA/Tyrosine Ratio; TLC: Total Lymphocyte Count; PNI: Prognostic Nutritional Index; BMI: Body Mass Index; PBF Percent Body Fat

Analysis was performed by Student's t test, significant p value is <0.05

complications, the surgery itself may trigger the deterioration of the nutritional condition *via* some physiological and immunological mechanisms even if proper postoperative nutritional therapy was introduced [11-14]. Laparoscopic liver resection, especially non-anatomical, is considered a pretty less invasive operation with a short operation period, early start of diet intake, and short postoperative hospital stay [15,16]. Although laparoscopic liver resection is supposed feasible in the nutritional aspect, to date, there is few specific reports focusing on the perioperative dynamic change of nutritional status in sarcopenic patients who receive laparoscopic liver resection.

Nutritional assessment has been mainly based on the combination of physical examination (e.g., BMI), nutritional counseling, blood test-based parameters (e.g., albumin, prealbumin, transferrin, amino acid metabolism, serum cholinesterase, and total lymphocyte count) and nutritional index (e.g., PNI) as also used in this current study [17]. However, previous reports showed these conventional parameters are, although more accessible, not sufficient to screen and evaluate the nutritional status in the sarcopenic patients [18]. Blood test-based analysis could not adequately detect the nutritional change in sarcopenic patients. In this current study, we made use of InBody 770 as an accurate assessment tool to figure out how the sarcopenic patients may practically be impacted by laparoscopic liver resection. The results from the present study showed that even minimum invasive non-anatomical laparoscopic liver resection without severe surgical complications negatively affected the patients. Our main findings in this study were (1): As previously reported, blood test-based parameters cannot discriminate the sarcopenic from the non-sarcopenic patients (2): BIA-based analysis showed sarcopenic patients have insufficient skeletal muscle mass not only in whole-body but also at every body part in comparison with non-sarcopenic patients (3): Laparoscopic liver resection induced loss of skeletal muscle mass with deteriorated nutritional parameters in two groups (4): Segmental Lean analysis by InBody 770 clearly showed, although non-sarcopenic patients postoperatively had reduced but proportional upper/lower body balance, the sarcopenic patients had the upper/lower body imbalance with markedly reduced lower extremity lean mass (Figure 1). This central finding (Figure 1) may be clinically significant and challenging because upper/lower body imbalance with undeveloped lower extremity is strongly associated with the risk of falling, leading to worse quality of life due to disabilities or bedridden [19]. All patients never experienced falling during hospitalization, but this issue should matter in the long term after discharge. In general, lower extremity lean mass was supposed to decline quickly by aging and excessive rest [20,21]. Our results showing all patients in this study never experienced severe postoperative complications with early postoperative diet intake and ambulation probably suggested the vulnerability of the sarcopenic patients to surgery due to the decreased metabolic physiologic reserve as previously reported [22]. Although there was no significant perioperative decline of blood test-based parameters in sarcopenic patients, the postoperative values were less than those in non-sarcopenic patients (Table 3).

Table 3: The blood test-based perioperative nutritional change in two groups.

Variables	Sarcopenic (N=14)			Non-sarcopenic (N=28)		
	pre	post	*p value*	pre	post	*p value*
PT (%), mean ± SD	92.1 ± 6.8	86.6 ± 9.7	*n.s.*	91.8 ± 11.8	83.1 ± 11.9	*<0.01*
Albumin (g/dL), mean ± SD	3.9 ± 0.3	3.7 ± 0.4	*n.s.*	4.1 ± 0.4	3.9 ± 0.4	*<0.01*
Prealbumin (g/dL), mean ± SD	19.4 ± 6.1	16.1 ± 5.9	*<0.05*	19.7 ± 4.6	16.7 ± 5.5	*<0.01*
Transferrin (mg/dL), mean ± SD	255.1 ± 47.6	240.8 ± 43.1	*n.s.*	293.6 ± 76.0	277.7 ± 64.3	*n.s.*
Cholinesterase (U/L), mean ± SD	257.1 ± 80.2	215.5 ± 78.2	*<0.01*	250.7 ± 62.3	212.4 ± 72.2	*<0.01*
BCAA (μU/ml), mean ± SD	461.8 ± 153.4	396.1 ± 60.8	*n.s.*	462.1 ± 104.4	438.6 ± 100.3	*n.s.*
BTR, mean ± SD	5.9 ± 0.8	5.5 ± 0.8	*n.s.*	6.3 ± 1.9	5.8 ± 1.8	*n.s.*
TLC (mm^3), mean ± SD	1833 ± 726	1898 ± 771	*n.s.*	1656 ± 769	1872 ± 945	*<0.01*
PNI, mean ± SD	48.1 ± 4.6	45.5 ± 7.4	*n.s.*	49.6 ± 6.8	48.1 ± 7.5	*n.s.*

Data are expressed as mean ± standard deviation

Abbreviations: PT: Prothrombin Time; BCAA: Branched Chain Amino Acids; BTR: BCAA/Tyrosine Ratio; TLC: Total Lymphocyte Count; PNI: Prognostic Nutritional Index

Analysis was performed by paired t-test between pre and post in each group. Significant p value is <0.05

Table 4: The BIA-based perioperative nutritional change in two groups.

Variables	Sarcopenic (N=14)			Non-sarcopenic (N=28)		
	pre	post	*p value*	pre	post	*p value*
SMI (kg/m^2), mean ± SD	5.8 ± 0.9	5.5 ± 0.9	*<0.01*	6.8 ± 1.0	6.6 ± 1.0	*<0.01*
Obesity Index analysis						
BMI (kg/m^2), mean ± SD	21.7 ± 3.4	21.4 ± 3.5	*n.s.*	24.7 ± 4.5	24.0 ± 4.3	*<0.01*
PBF (%), mean ± SD	29.8 ± 5.9	29.9 ± 6.5	*n.s.*	30.8 ± 9.9	30.2 ± 10.4	*n.s.*
Segmental Lean analysis						
Right arm (%), mean ± SD	77.1 ± 9.1	76.1 ± 7.7	*n.s.*	91.1 ± 9.8	89.9 ± 10.4	*n.s.*
Left arm (%), mean ± SD	75.8 ± 10.6	74.9 ± 7.9	*n.s.*	89.4 ± 9.0	88.3 ± 9.8	*n.s.*
Trunk (%), mean ± SD	87.4 ± 5.7	87.1 ± 5.2	*n.s.*	94.5 ± 5.3	94.2 ± 5.8	*n.s.*
Right leg (%), mean ± SD	84.8 ± 6.9	80.4 ± 6.2	*<0.01*	92.8 ± 8.1	92.1 ± 10.3	*n.s.*
Left leg (%), mean ± SD	83.4 ± 7.8	79.0 ± 7.0	*<0.01*	93.2 ± 8.3	92.0 ± 10.1	*n.s.*

Data are given as mean ± standard deviation.
Abbreviations: BMI: Body Mass Index; PBF: Percent Body Fat
Analysis was performed by paired t-test between pre and post in each group. Significant p value is <0.05

Furthermore, sarcopenic obese accounted for the majority (64%, 9/14) in the sarcopenic patients, consistent with previous reports showing that sarcopenic obese is strongly associated with physical difficulties based on some physiological mechanisms [23-25]. These complicated factors mentioned above may contribute to this dynamic change found only in sarcopenic patients. Although we could not collect any more detailed data about self-reported postoperative physical activity, diet intake, and physical ability after discharge, these sarcopenic patients may be sedentary as not to have any walking habit or exercise [26]. To our knowledge, this study was the first to describe the surgical stress-induced upper/lower body imbalance in sarcopenic patients. Despite our essential findings, this study has a few limitations. First, this was a retrospective, single-center study with a small number of patients. Second, due to the retrospective design of the study, we were unable to assess timely practical muscle function, such as muscle strength and balance ability. Nevertheless, our findings are significant to suggest evidence to support the significance of prehabilitational intervention in sarcopenic patients. From collecting evidence that the negative impact of preoperative sarcopenia [8,27], the necessity of preoperative intervention is increasing. Notably, the nutritional prehabilitation is reported effective in terms of improving functional ability and nutritional condition before surgical stress and subsequent quick recovery due to sufficient metabolic reserve in a clinical setting [28,29]. According to the impressive reports, our department launched our nutritional prehabilitation project for the sarcopenia patients who will receive curative surgery for abdominal cancer, including liver cancer, from Jan 2019 after approval of the institutional review board at Sakai City Medical Center (Ref N0.102). The nutritional prehabilitation protocol mainly consists of walking exercise and resistance training focusing on developing the lower extremity in concert with proper nutritional counseling and supplementation.

Conclusion

This study demonstrated that laparoscopic liver resection negatively impacted on the patients in the nutritional aspect. Notably, the sarcopenic patients showed upper/lower body imbalance with marked reduction of lower extremity lean mass in comparison that non-sarcopenic patients keep body balance, suggesting the importance of nutritional prehabilitation for sarcopenic patients who receive laparoscopic liver resection.

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