Association between Visceral Fat and Body Mass Index in Patients with Cirrhosis

Kenichiro Yasutake[1,2], Motoyuki Kohjima[3], Yusuke Murata[4], Manabu Nakashima[4], Makoto Nakamuta[2,3] and Munechika Enjoji[2,4*]

[1]*Department of Health and Nutrition Sciences, Faculty of Health and Social Welfare Sciences, Nishikyushu University, Kanzaki, Japan*

[2]*Clinical Research Center, Kyushu Medical Center, National Hospital Organization, Fukuoka, Japan*

[3]*Department of Gastroenterology, Kyushu Medical Center, National Hospital Organization, Fukuoka, Japan*

[4]*Health Care Center, Fukuoka University, Fukuoka, Japan*

Abstract: Obesity has recently become a critical problem in patients with cirrhosis in Japan; however, its true prevalence and prognosis remain poorly understood. In this study, we investigated abdominal fat areas, including subcutaneous and visceral fat areas (VFA), in 49 cirrhotic patients and analyzed the association between VFA and body mass index (BMI). Fat areas were examined by computed tomography. Patients were classified as somatometric obesity and visceral obesity based on their BMI (cut-off value: 25 kg/m^2) and VFA (cut-off value: 100 cm^2), respectively. The mean BMI was 23.5±3.3 kg/m^2 (<25 kg/m^2, 35 cases; ≥25 kg/m^2, 14 cases) and mean VFA was 108.5±118.8 cm^2 (<100 cm^2, 25 cases; ≥100 cm^2, 24 cases). Thirteen out of 14 patients with BMI ≥25 kg/m^2 had a VFA ≥100 cm^2, and 11 of 35 patients with BMI <25 kg/m^2 had a VFA ≥100 cm^2. Thus, almost half of the cirrhotic patients in this study had visceral obesity, including a high proportion of patients with BMI <25 kg/m^2. These results suggest that visceral obesity, as well as BMI, should be considered in patients with cirrhosis, and individual nutritive management regimes should be designed according to the results.

Keywords: Liver cirrhosis, abdominal fat, visceral obesity, chronic hepatitis, malnutrition, overnourishment.

1. INTRODUCTION

Overeating and lack of exercise are increasing problems in advanced countries, resulting in a higher proportion of obese individuals, especially among the middle-aged and elderly. Generally, lower socioeconomic status associated with obesity in highly developed countries are most common with education and occupation [1]. Obesity is also a growing problem in patients with cirrhosis, in contrast to protein energy malnutrition (PEM), which has previously been an important problem [2]. According to an assessment in Japanese patients with liver cirrhosis (LC), the incidence of patients with PEM (body mass index (BMI) <18.5kg/m^2) decreased from 9.2% in 2002 to 5.1% in 2007–2011, while the incidence of somatometric obesity (BMI ≥25 kg/m^2) increased from 20% in 1995 to 30.6% in 2007–2011 [3-5]. A major reason of this transition is the increasing popularity of overnourishment among patients with LC (of both viral and non-viral etiologies) [6, 7]. Obesity is a significant risk factor for hepatocellular carcinoma, which has a poorer prognosis in obese than in non-obese LC patients [2, 3]. Hepatic carcinogenesis in obese patients may be accelerated by fatty change of the liver which accompanies obesity/overnourishment. Reduction of obesity/overweight is therefore major clinical importance for cirrhotic patients. Moreover, control of visceral fat is relevant to the prevention of insulin resistance and diabetes, of which visceral fat is a major cause, and which frequently accompany LC. However, to the best of our knowledge, few studies have investigated visceral fat in cirrhotic patients. In this study, we examined visceral fat and BMI in cirrhotic patients, and analyzed the association between them.

2. PATIENTS AND METHODS

Forty-nine cirrhotic patients who underwent computed tomography (CT) at the National Hospital Organization Kyushu Medical Center from January to July 2010, were enrolled in this study. Patients with ascites, encephalopathy, jaundice (total bilirubin >3.0 mg/dL), or Child-Pugh class C were excluded. Total abdominal fat areas (TFA), visceral fat areas (VFA), and subcutaneous fat areas (SFA) were evaluated using Fat Scan Ver.3.0 (N2 System, Hitachi, Japan) on CT imaging at the navel level [8]. Height, weight, and waist circumference (WC) were measured before breakfast on the day of CT. WC was measured by placing a measuring tape horizontally at the navel level. BMI was calculated by somatometry. In this study, somatometric obesity was defined as BMI ≥25 kg/m^2, and visceral obesity was defined as VFA ≥100cm^2 [9].

*Address correspondence to this author at the Health Care Center, Fukuoka University, 8-19-1 Nanakuma, Jonan-ku, Fukuoka 814-0180, Japan; Tel: +81 92-871-6631; Fax: +81 92-863-0389; E-mail: enjoji@adm.fukuoka-u.ac.jp

ISSN: 2223-3806 / E-ISSN: 1927-5951/14

Data are expressed as means ± SD. Statistical analysis was performed using JMP software (SAS Institute Inc., Cary, NC, USA). Differences between categorical variables were analyzed using Fisher's exact tests or χ^2 tests. Mann-Whitney *U* tests were used for continuous variables. Correlations were evaluated by Pearson product-moment correlation coefficients. A *p* value <0.05 was considered statistically significant. The study protocol was approved by the Ethics Committee of Kyushu Medical Center and written informed consent was obtained from all patients.

3. RESULTS

The study population included 49 patients with LC (male/female ratio 34/15; age 67.9±8.4 years). The mean values of BMI, WC, TFA, VFA, and SFA were 23.5±3.3 kg/m^2, 89.7±10.2 cm, 267.1±118.8 cm^2, 108.5±59.7 cm^2, and 156.6±72.0 cm^2, respectively (Table **1**). VFA was positively correlated with other variables (BMI, WC, TFA, and SFA) in these cirrhotic patients (Figure **1**).

When somatometric obesity was evaluated by BMI, 35 patients were classified as non-obese (BMI <25 kg/m^2) and 14 as obese (BMI ≥25 kg/m^2). Body weight, WC, TFA, VFA, and SFA levels were significantly higher in the BMI ≥25 kg/m^2 group compared with the BMI <25 kg/m^2 group, but there was no significant difference between the groups in terms of other clinical parameters (Table **1**). Based on visceral obesity evaluated by VFA, 25 patients were classified as non-obese (VFA <100 cm^2) and 24 as obese (VFA ≥100 cm^2). As for the classification based on BMI, body weight, BMI, WC, TFA, and SFA levels were all significantly higher in the VFA ≥100 cm^2 group compared with the VFA <100 cm^2 group (Table **2**).

Next, we further categorized patients into four groups according to their combined BMI (<25 or ≥25 kg/m^2) and VFA (<100 or ≥100 cm^2) values (Figure **2**). Fourteen out of 49 (28.6%) patients had somatometric obesity (BMI ≥25 kg/m^2) and 24 out of 49 (49%) had visceral obesity (VFA ≥100 cm^2). Within the 14 patients with BMI ≥25 kg/m^2, 13 patients showed VFA ≥100cm^2, compared with only 11 of the 35 patients with BMI <25 kg/m^2.

4. DISCUSSION

Recent trends in nutritive management of cirrhotic patients have considered the clinical importance of controlling somatometric obesity defined by BMI, as well as improving PEM, because of the risk of

Table 1: Patient BMI Profiles

	Total	BMI < 25	BMI ≥ 25	*p*
Gender (M/F)	34/15	23/12	11/3	NS
Age (years)	67.9±8.4	68.4±9.1	66.7±6.5	NS
Child-Pugh A/B	27/22	19/16	8/6	NS
viral/non-viral	46/3	33/2	13/1	NS
DM (+/–)	13/36	9/26	4/10	NS
Hypertension (+/–)	12/37	9/26	7/7	NS
Dyslipidemia (+/–)	12/37	2/33	2/12	NS
Height (cm)	160.1±9.3	158.8±9.1	163.3±9.5	NS
Weight (kg)	60.6±12.0	55.5±8.0	73.1±11.4	< 0.01
BMI (kg/m^2)	23.5±3.3	22.0±2.1	27.3±2.5	< 0.01
WC (cm)	89.7±10.2	85.7±7.6	99.8±8.9	< 0.01
TFA (cm^2)	267.1±118.8	219.6±76.0	385.8±125.6	< 0.01
VFA (cm^2)	108.5±59.7	89.2±34.8	156.8±80.5	< 0.01
SFA (cm^2)	156.6±72.0	130.5±52.0	221.9±75.0	< 0.01
Albumin (g/dL)	4.0±0.5	4.0±0.5	4.0±0.6	NS
ALT (IU/L)	54.5±41.3	59.6±47.3	42.1±15.8	NS
T Bil (mg/dL)	1.0±0.7	0.9±0.4	1.1±1.1	NS
FSG (mg/dL)	123.5±44.1	119.4±45.9	135.4±37.8	NS

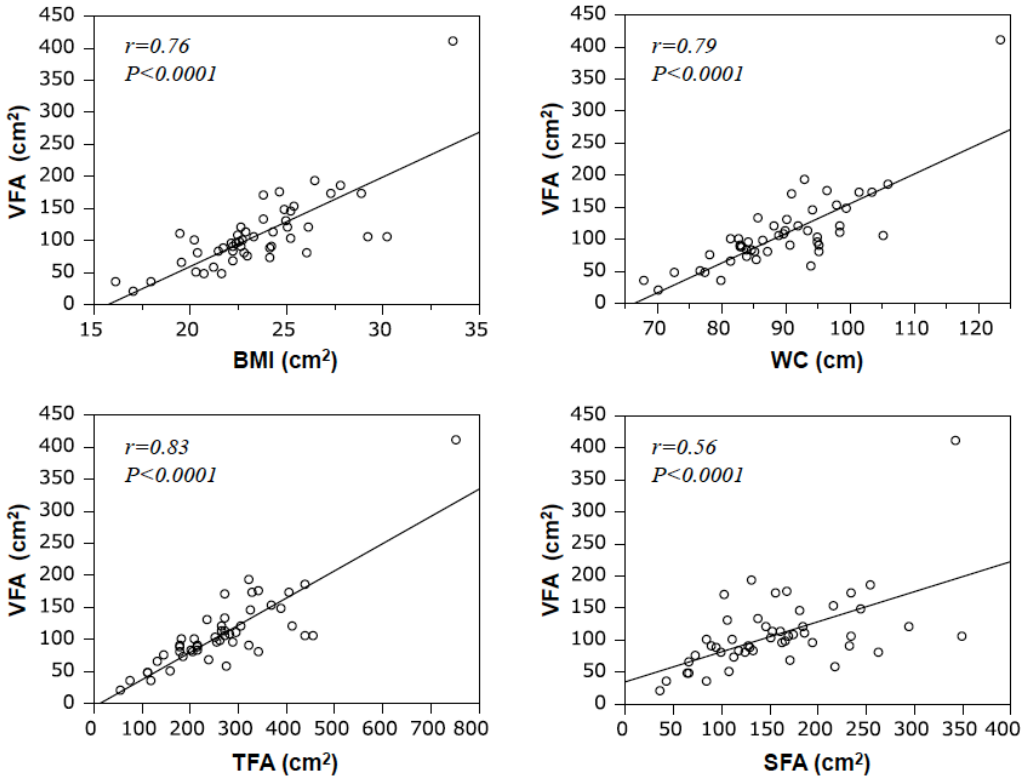

Figure 1: Correlations between visceral fat areas (VFA) and other variables: body mass index (BMI), waist circumference (WC), total abdominal fat areas (TFA), and subcutaneous fat areas (SFA).

Table 2: Patient VFA Profiles

	VFA <100	VFA ≥100	*p*
Gender (M/F)	15/10	19/5	NS
Age (years)	68.2±8.1	67.7±8.9	NS
Child-Pugh A/B	11/14	16/8	NS
viral/non-viral	24/1	22/2	NS
DM (+/–)	8/17	5/19	NS
Hypertension (+/–)	8/17	8/16	NS
Dyslipidemia (+/–)	2/23	2/22	NS
Height (cm)	158.3±7.8	162.0±8.0	NS
Weight (kg)	54.2±8.1	67.2±12.0	< 0.01
BMI (kg/m^2)	21.6±2.2	25.5±3.0	< 0.01
WC (cm)	83.5±7.3	96.2±8.7	< 0.01
TFA (cm^2)	196.2±72.5	340.9±113.2	< 0.01
VFA (cm^2)	72.3±22.0	146.1±63.5	< 0.01
SFA (cm^2)	123.9±58.7	190.6±70.0	< 0.01
Albumin (g/dL)	3.8±0.5	4.1±0.5	NS
ALT (IU/L)	67.3±52.7	41.7±19.0	NS
T Bil (mg/dL)	1.0±0.5	0.9±0.8	NS
FSG (mg/dL)	124.1±52.5	122.8±34.5	NS

DM, diabetes mellitus BMI, body mass index; WC, waist circumference; TFA, total abdominal fat areas; VFA, visceral fat areas; SFA, subcutaneous fat areas; ALT, alanine aminotransferase; T Bil, total bilirubin; FSG, fasting serum glucose.

	VFA ≥ 100 (cm^2)	VFA < 100 (cm^2)	
BMI ≥ 25 (kg/m^2)	13 (26.6%)	1 (2.0%)	14 (28.6%)
BMI < 25 (kg/m^2)	11 (22.4%)	24 (49.0%)	35 (71.4%)
	24 (49.0%)	25 (51.0%)	

Figure 2: Categorization of obese and non-obese patients. Cirrhotic patients were classified by body mass index (BMI) and visceral fat areas (VFA).

carcinogenesis and deteriorating prognosis. However, few studies have investigated visceral obesity in cirrhotic patients. In this study, we examined the association between somatometric obesity (BMI ≥25 kg/m^2) and visceral obesity (VFA ≥100 cm^2) in Japanese patients with LC.

In this study population, VFA showed significant positive correlations with BMI, WC, TFA, and SFA, in accordance with previous results in healthy Japanese [10], and in patients enrolled in the Dallas Heart Study [11] and Framingham Heart Study [12]. It may be inevitable that WC, BMI, TFA, VFA and SFA are significantly higher in obese compared with non-obese patients, regardless of the use of BMI or VFA to define obesity. Although insulin resistance was not evaluated in this study, there were no significant differences between the groups in terms of other blood biochemistry variables. We suggest the association between abdominal fat and metabolic syndrome-related examinations should be evaluated in cirrhotic patients.

In the current study, the incidence of obesity defined by BMI ≥25 kg/m^2 was only 28.6%, while that defined by VFA ≥100 cm^2 was higher (49.0%). A previous study detected visceral obesity (VFA ≥100 cm^2) in 48% of 586 Japanese individuals who entered hospital for a thorough medical examination. In addition, almost half of these subjects with visceral obesity (26% of total examinees) was somatometrically non-obese (BMI <25 kg/m^2) [13]. These incidences are similar to those in patients with LC in the present study. Importantly, these results suggest that nearly half of those undergoing thorough medical examination, and half of all cirrhotic patients have visceral obesity, and that visceral obesity is not always consistent with somatometric obesity by BMI. Thus, cirrhotic patients may demonstrate a higher rate of visceral obesity, which cannot be detected by measurements of BMI. Glucose intolerance in cirrhotic patients is generally considered to be associated with peripheral insulin resistance and impaired glucose uptake in peripheral tissues [14]. However, the existence of increased visceral fat may also be a major contributory factor to insulin resistance and glucose intolerance. Future, large-scale cohort studies are needed to obtain clinical evidence for this hypothesis.

In this study, almost half of cirrhotic patients had visceral obesity, including a considerable proportion of somatometrically non-obese patients (BMI <25 kg/m^2). Given that simple portable devices for measuring visceral fat are currently available [15, 16], we suggest that visceral fat, as well as BMI, should be measured in cirrhotic patients to allow better individualized nutritive management.

ACKNOWLEDGEMENT

This research was supported in part by the Research Program of Intractable Disease provided by the Ministry of Health, Labor, and Welfare of Japan and a Grant-in-Aid for Clinical Research from the National Hospital Organization of Japan. All authors declare that they have nothing to disclose regarding funding or conflict of interest with respect to this manuscript.

REFERENCES

[1] McLaren L. Socioeconomic status and obesity. Epidemiol Rev 2007; 29: 29-48. http://dx.doi.org/10.1093/epirev/mxm001

[2] Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 2003; 348: 1625-38. http://dx.doi.org/10.1056/NEJMoa021423

[3] Muto Y, Sato S, Watanabe A, Moriwaki H, Suzuki K, Kato A, *et al.* Effects of oral branched-chain amino acid granules on

event-free survival in patients with liver cirrhosis. Clin Gastroenterol Hepatol 2005; 3: 705-13. http://dx.doi.org/10.1016/S1542-3565(05)00017-0

[4] Tajika M, Kato M, Mohri H, Miwa Y, Kato T, Ohnishi H, Moriwaki H. Prognostic value of energy metabolism in patients with viral liver cirrhosis. Nutrition 2002; 18: 229-34. http://dx.doi.org/10.1016/S0899-9007(01)00754-7

[5] Shiraki M, Nishiguchi S, Saito M, Fukuzawa Y, Mizuta T, Kaibori M, *et al.* Nutritional status and quality of life in current patients with liver cirrhosis as assessed in 2007-2011. Hepatol Res 2013; 43: 106-12. http://dx.doi.org/10.1111/hepr.12004

[6] Campillo B, Bories PN, Leluan M, Pornin B, Devanlay M, Fouet P. Short-term changes in energy metabolism after 1 month of a regular oral diet in severely malnourished cirrhotic patients. Metabolism 1995; 44: 765-70. http://dx.doi.org/10.1016/0026-0495(95)90190-6

[7] Yasutake K, Bekki M, Ichinose M, Ikemoto M, Fujino T, Ryu T, *et al.* Assessing current nutritional status of patients with HCV-related liver cirrhosis in the compensated stage. Asia Pac J Clin Nutr 2012; 21: 400-5.

[8] Yoshizumi T, Nakamura T, Yamane M, Islam AH, Menju M, Yamasaki K, *et al.* Abdominal fat: standardized technique for measurement at CT. Radiology 1999; 211: 283-6. http://dx.doi.org/10.1148/radiology.211.1.r99ap15283

[9] Hiuge-Shimizu A, Kishida K, Funahashi T, Ishizaka Y, Oka R, Okada M, *et al.* Absolute value of visceral fat area measured on computed tomography scans and obesity-related cardiovascular risk factors in large-scale Japanese general population (the VACATION-J study). Ann Med 2012; 44: 82-92. http://dx.doi.org/10.3109/07853890.2010.526138

[10] Oka R, Miura K, Sakurai M, Nakamura K, Yagi K, Miyamoto S, *et al.* Comparison of waist circumference with body mass index for predicting abdominal adipose tissue. Diabetes Res Clin Pract 2009; 83: 100-5. http://dx.doi.org/10.1016/j.diabres.2008.10.001

[11] Vega GL, Adams-Huet B, Peshock R, Willett D, Shah B, Grundy SM. Influence of body fat content and distribution on variation in metabolic risk. J Clin Endocrinol Metab 2006; 91: 4459-66. http://dx.doi.org/10.1210/jc.2006-0814

[12] Fox CS, Massaro JM, Hoffmann U, Pou KM, Maurovich-Horvat P, Liu CY, *et al.* Abdominal visceral and subcutaneous adipose tissue compartments: association with metabolic risk factors in the Framingham Heart Study. Circulation 2007; 116: 39-48. http://dx.doi.org/10.1161/CIRCULATIONAHA.106.675355

[13] Nakamura T, Matsuzawa Y. Life style-related diseases and fat cells. Nihon Naika Gakkai Zasshi 2001; 90: 1753-8. http://dx.doi.org/10.2169/naika.90.1753

[14] Imano E, Kanda T, Nakatani Y, Motomura M, Arai K, Matsuhisa M, *et al.* Impaired splanchnic and peripheral glucose uptake in liver cirrhosis. J Hepatol 1999; 31: 469-73. http://dx.doi.org/10.1016/S0168-8278(99)80039-7

[15] Ida M, Hirata M, Odori S, Mori E, Kondo E, Fujikura J, *et al.* Early changes of abdominal adiposity detected with weekly dual bioelectrical impedance analysis during calorie restriction. Obesity 2013; 21: E350-3.

[16] Ida M, Hirata M, Hosoda K, Nakao K. Abdomen specific bioelectrical impedance analysis (BIA) methods for evaluation of abdominal fat distribution. Nihon Rinsho 2013; 71: 262-5.

Received on 16-12-2013 Accepted on 07-01-2014 Published on 31-01-2014

DOI: http://dx.doi.org/10.6000/1927-5951.2014.04.01.1