in vivo *35*: 363-371 (2021)
doi:10.21873/invivo.12267

Predictors for Grip Strength Loss in Patients With Chronic Liver Diseases

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Abstract. *Background/Aim: To elucidate factors associated with secular changes of grip strength (GS) in patients with chronic liver diseases (CLDs) (n=241, 102 males, median age=63 years, 87 liver cirrhosis cases). Materials and Methods: ΔGS (kg/year) was defined as [GS value (second time) – GS value (first time)]/[time interval between the first and second time]. GS loss (GSL) was defined as ΔGS <0 kg/year. Results: The median ΔGS in patients with non-LC, Child-Pugh A (n=70) and Child-Pugh B (n=17) were 0.3, –0.2 and –1.6 kg/year (overall p<0.0001). In the multivariate analysis of factors linked to the GSL for all cases, extracellular water (ECW) to total body water (TBW) ratio was significant (p=0.0007). In the multivariate analysis in male, no significant factor was found, while in female, ECW to TBW ratio was significant (p=0.0024). Conclusion: Liver functional parameters can be closely linked to the GSL especially in female CLD patients.*

The liver is the pivotal organ for the metabolism of the human body (1, 2). Advanced chronic liver diseases (CLDs) are frequently associated with disease-related sarcopenia (*i.e.*, secondary sarcopenia) (1-6). Therefore, it is meaningful to consider skeletal muscle as one organ and discuss sarcopenia in relation to organs in the medical treatment and research of liver diseases. CLD patients with sarcopenia can involve both impaired protein synthesis and accelerated muscle proteolysis in skeletal muscles (1, 2). A previous meta-analysis reported the close association between sarcopenia and mortality in CLD patients (4). Many high-quality studies of sarcopenia led to recognition as a disease entity with the awards of an ICD 10 code in 2016 (7). In addition, the recent revisions of diagnostic criteria for sarcopenia in European or Asian guidelines have made sarcopenia research more exciting (8, 9).

Grip strength (GS) does not require difficult movements and can be measured easily and safely in a short time, and thus it is suitable for measuring muscle strength in daily medical care. GS, which is mainly the muscle strength of the upper body, has significant correlations with the muscle strength in the lower limbs and many other parts, and it is used as an index to assess the degree of muscle strength of the whole body (10-13). GS seems to be the main determinant of physical activity (8). Recent numerous studies have also shown that decreased GS is linked to an elevated risk of disease development, disease progression and mortality. However, the impact of skeletal muscle mass rather than GS had mainly been focused in sarcopenia researches for the past several decades (14-30). In our recent study, we emphasized the significance of GS on composite hepatic events in CLD patients (15). Hanai *et al*. reported that reduced GS rather than skeletal muscle mass and fat mass was significantly linked to an increased risk of mortality in cirrhotic patients (16). However, to our knowledge, data for factors related to the secular changes of GS in CLDs are scarce (31). The aim of this study was to elucidate factors associated with secular changes of GS in patients with CLDs.

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Key Words: Chronic liver disease, grip strength loss, secular change, liver function.

Patients and Methods

Patients. Using a retrospective computerized database, a total of 241 CLD individuals who visited our Hospital between January 2013 and April 2020 were analyzed. Diagnosis for liver cirrhosis (LC) was determined according to the current guidelines (32). All analyzed patients received GS measurement twice with an interval of at least 3 months. The most suitable intervention for each underlying liver disease was performed (32-35). The study protocol rigorously conformed to the 1975 Helsinki Declaration, and approval of ethics was obtained from the institutional review board in our hospital. An opt out method was employed.

GS, SMI and ΔGS. A low-GS was defined as <26 kg in males and <18 kg in females based on the Japanese Society of Hepatology (JSH) guidelines (36). Likewise, a low-skeletal muscle index (SMI, SMI indicates appendicular muscle mass divided by height squared [kg/m^2]) was defined as <7.0 kg/m^2 in males and <5.7 kg/m^2 in females using bioelectrical impedance analysis (36). Sarcopenia was defined as both low-GS and low-SMI (36). ΔGS (kg/year) was defined as [GS value (second time) – GS value (first time)] ÷ [time interval between the first time and the second time (year)]. GS loss (GSL) was defined as ΔGS <0 kg/year. We investigated factors associated with the GSL.

Statistical analyses. As for the continuous parameters, Mann-Whitney *U*-test, Student's t-test, analysis of variance or Kruskal-Wallis test was employed to adequately assess differences between groups. As for the categorical parameters, Fisher's exact test or Pearson χ^2 test was employed to assess differences between groups. Baseline significant parameters in the univariate analysis were subjected to the multivariate logistic regression analysis to choose candidate parameters. In the multivariate analyses of items associated with the GSL, the median value for each significant item in the univariate analysis was selected to classify the study cohort into the two categorical groups. In the analysis of correlation between parameters, Pearson's correlation coefficient (r) was employed. A $p<0.05$ denotes statistical significance by the statistical analysis software (JMP 14 (SAS Institute Inc., Cary, NC)).

Results

Baseline characteristics. The baseline characteristics of the analyzed subjects (n=241, 102 males, median age=63 years) are presented in Table I. There were 178 patients (73.9%) with albumin-bilirubin (ALBI) grade 1, 60 (24.9%) with ALBI grade 2 and 3 (1.2%) with ALBI grade 3. LC was seen in 87 patients (36.1%: Child-Pugh A/B/C in 70/17/0 patients, respectively). Eight male patients (7.8%) had a GS decrease, while 28 female patients (20.1%) had a GS decrease (36). Twenty-seven male patients (26.5%) had an SMI decrease, while 47 female patients (33.8%) had an SMI decrease (36). Collectively, sarcopenia was found in 17 patients (7.1%) [4 male patients (3.9%) and 13 female patients (9.4%)]. The median time interval between the first time GS measurement and the second time GS measurement was 1.41 years. The median [interquartile range (IQR)] ΔGS (kg/year) for all cases was 0 (–1.0, 0.9) kg/year (Figure 1A).

Table I. *Baseline characteristics (n=241).*

Variables	All cases (n=241)
Age (years)	63 (52, 70)
Gender, male/female	102/139
Liver disease etiology HCV/HBV/others	154/21/66
Presence of sarcopenia, yes/no	17/224
Presence of LC, yes/no	87/154
Body mass index (kg/m^2)	22.8 (20.5, 25.7)
SMI (kg/m^2), male	7.635 (6.9375, 8.1225)
SMI (kg/m^2), female	5.965 (5.52, 6.49)
Grip strength (kg), male	34.375 (29.675, 40.3375)
Grip strength (kg), female	20.95 (18.75, 23.35)
ECW to TBW ratio	0.388 (0.384, 0.390)
Total bilirubin (mg/dl)	0.8 (0.6, 1.0)
Serum albumin (g/dl)	4.2 (3.9, 4.4)
ALBI score	–2.82 (–3.035, -2.565)
ALBI grade, 1/2/3	178/60/3
Prothrombin time (INR)	1.06 (1.01, 1.12)
Platelet count (×10^4/mm^3)	17.3 (11.9, 22.55)
AST (IU/l)	27 (21, 37)
ALT (IU/l)	23 (15, 40)
eGFR (ml/min/1.73m^2)	82 (71, 96.5)

Data are expressed as number or median value (interquartile range). HCV: Hepatitis C virus; HBV: hepatitis B virus; LC: liver cirrhosis; SMI: skeletal muscle index; ECW: extracellular water; TBW: total body water; ALBI: albumin-bilirubin; INR: international normalized ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate.

ΔGS (kg/year) according to gender, age, sarcopenia, body mass index (BMI), ALBI grade, Child-Pugh classification and liver disease etiology. The median (IQR) ΔGS (kg/year) in males (n=102) and females (n=139) were 0.3 (–1.05, 1.1) kg/year and –0.2 (–1.0, 0.7) kg/year, respectively, (p=0.5429) (Figure 1B, C and 2A). The median (IQR) ΔGS (kg/year) in patients aged 65 years or more (n=109) and less than 65 years (n=132) were –0.2 (–1.4, 0.65) kg/year and 0.3 (–0.6, 1.175) kg/year, respectively, (p=0.0672) (Figure 2B). The median (IQR) ΔGS (kg/year) in patients with sarcopenia (n=17) and without sarcopenia (n=224) were 0.1 (–0.35, 1.1) kg/year and 0 (–1.0, 0.9) kg/year, respectively, (p=0.5950) (Figure 2C). The median (IQR) ΔGS (kg/year) in patients with BMI ≥25 kg/m^2 (n=72) and <25 kg/m^2 (n=169) were –0.1 (–1.3, 0.7) kg/year and 0.1 (–0.7, 0.975) kg/year, respectively, (p=0.4789) (Figure 2D). The median (IQR) ΔGS (kg/year) in patients with ALBI grade 1 (n=178) and ALBI grade 2 or 3 (n=63) were 0.2 (–0.6, 1.0) kg/year and –0.5 (–1.9, 0.5) kg/year, respectively, (p=0.0064) (Figure 2E). The median (IQR) ΔGS (kg/year) in patients with non-LC (n=154) , Child-Pugh A (n=70) and Child-Pugh B (n=17) were 0.3 (–0.6, 1.2) kg/year, –0.2 (–1.425, 0.325) kg/year and -1.6 (–4.5, –0.1) kg/year, respectively [p=0.0002 (non-LC *vs*. Child-Pugh A), p=0.0255 (Child-Pugh A *vs*. B), p<0.0001 (non-LC *vs*. Child-

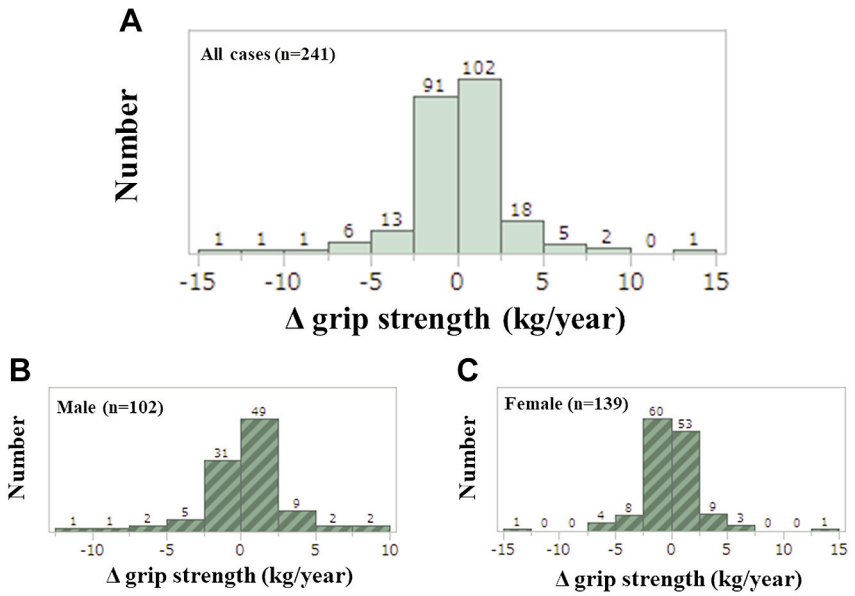

Figure 1. *The distribution of ΔGS (kg/year) [GS value (second time) – GS value (first time)] ÷ [time interval between the first time and the second time (year)] for all cases (n=241) (A), male cases (n=102)) (B) and female cases (n=139) (C).*

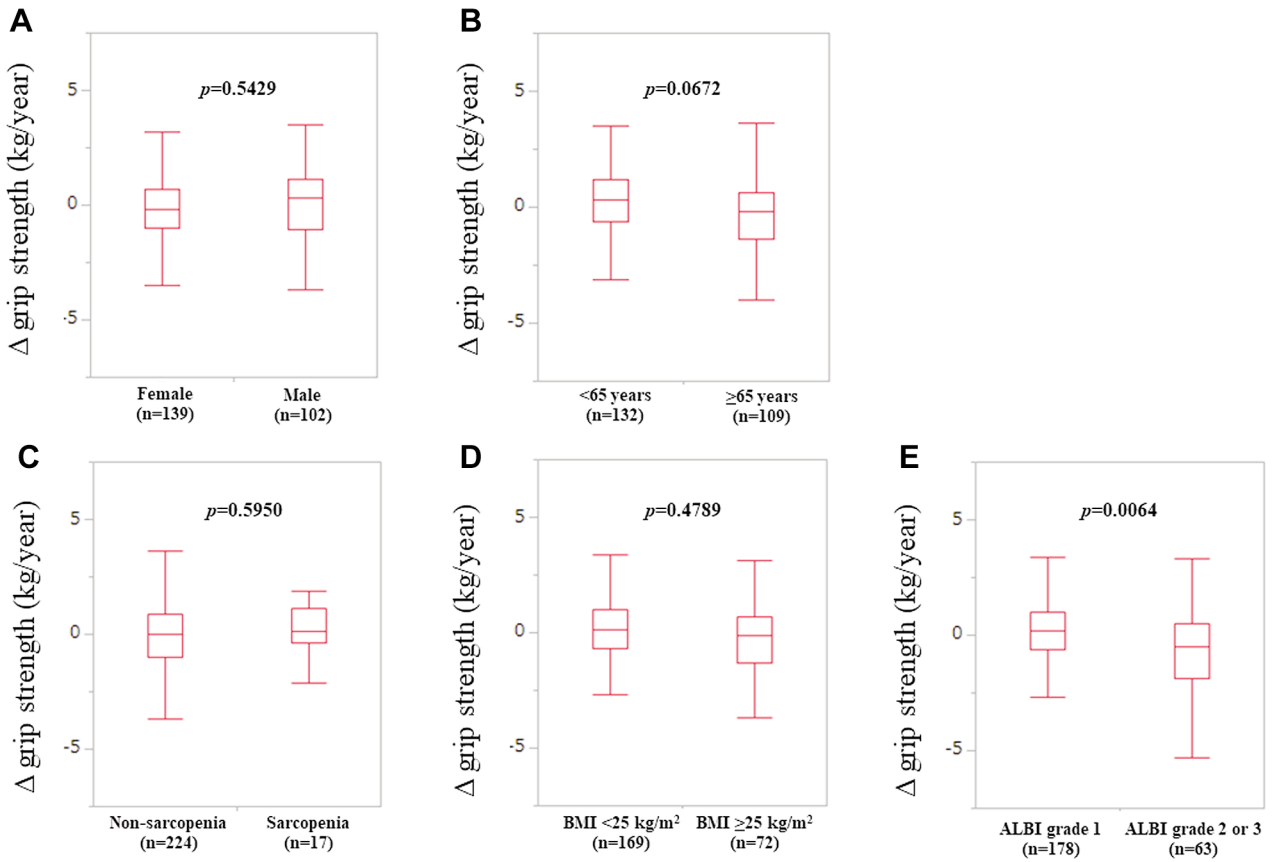

Figure 2. *ΔGS (kg/year) according to gender (A), age (B), sarcopenia (C), body mass index (Figure 2D), albumin-bilirubin grade (E).*

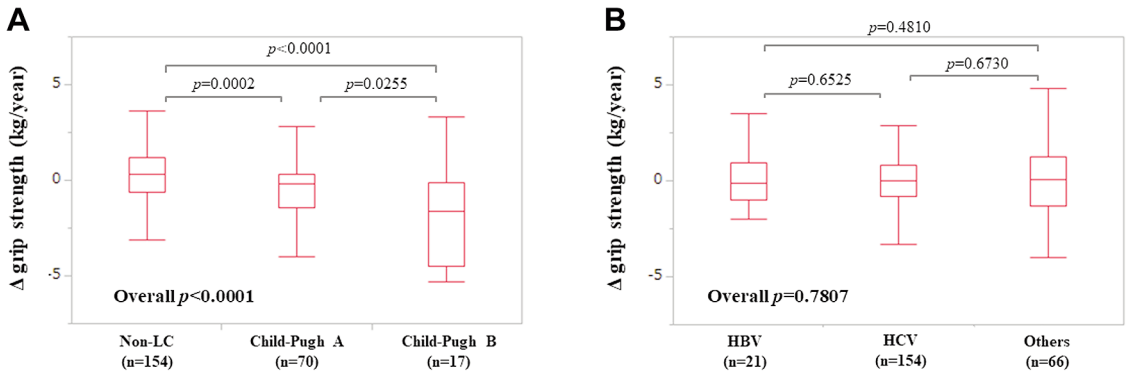

Figure 3. *ΔGS (kg/year) according to Child-Pugh classification (A) and liver disease etiology (B).*

Pugh B) and overall $p<0.0001$] (Figure 3A). The median (IQR) ΔGS (kg/year) in patients with hepatitis B virus (HBV, n=21), hepatitis C virus (HCV, n=154) and others (n=66) were –0.1 (–1.0, 0.95) kg/year, 0 (–0.775, 0.8) kg/year and 0.05 (–1.325, 1.225) kg/year, respectively [$p=0.6525$ (HBV *vs.* HCV), $p=0.6730$ (HCV *vs.* others), $p=0.4810$ (HBV *vs.* others) and overall $p=0.7807$] (Figure 3B).

Correlation between ΔGS and baseline continuous parameters according to gender. Regarding correlations between ΔGS and baseline continuous parameters, significant associations were found in age (r=–0.24 and $p=0.0171$) as for male gender, and total bilirubin (r=–0.26 and $p=0.0023$), serum albumin (r=0.21 and $p=0.0148$), ALBI score (r=–0.25 and $p=0.0027$), prothrombin time-INR (PT-INR) (r=0.30 and $p=0.0003$), platelet count (r=0.31 and $p=0.0002$) and extracellular water (ECW) to total body water (TBW) ratio (r=–0.42 and $p<0.0001$) as for female (Table II).

Table II. *Correlation between ΔGS (kg/year) and baseline continuous parameters according to gender.*

	Male		Female	
	r	*p*-Value	r	*p*-Value
Age	–0.24	0.0171	–0.09	0.2810
BMI	–0.04	0.7115	–0.02	0.8590
Baseline GS	–0.02	0.8756	0.07	0.3913
Baseline SMI	–0.02	0.8755	0.03	0.7660
Total bilirubin	–0.006	0.9538	–0.26	0.0023
Serum albumin	0.17	0.0850	0.21	0.0148
ALBI score	–0.15	0.1238	–0.25	0.0027
Prothrombin time (INR)	0.12	0.2197	0.30	0.0003
Platelet count	–0.11	0.2787	0.31	0.0002
AST	0.09	0.3859	–0.09	0.2874
ALT	0.18	0.0724	0.02	0.7740
eGFR	0.09	0.3841	–0.08	0.3312
ECW to TBW ratio	–0.14	0.1552	–0.42	<0.0001

BMI: Body mass index; GS: grip strength; SMI: skeletal muscle index; ALBI: albumin-bilirubin; INR: international normalized ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate; ECW: extracellular water; TBW: total body water.

Uni- and multivariate analyses of factors linked to the GSL for all cases. For all cases, GSL was found in 113 patients (46.9%). The univariate analysis of factors associated with the GSL identified that 6 had values of $p<0.05$: age ($p=0.0006$), presence of LC ($p<0.0001$), serum albumin ($p=0.0015$), ALBI score ($p=0.0009$), PT-INR ($p=0.0040$) and ECW to TBW ratio ($p<0.0001$) (Table III). Serum albumin was excluded from the multivariate analysis as ALBI includes serum albumin. In the multivariate analysis of the remaining 5 factors, ECW to TBW ratio was found to be significant ($p=0.0007$), while presence of LC tended to be significant ($p=0.0706$). Corresponding odds ratio (OR) and 95% confidence interval (CI) for each variable were demonstrated in Table IV.

Uni- and multivariate analyses of factors linked to the GSL for male cases. For male cases, GSL was found in 40 patients (39.2%). The univariate analysis of factors associated with the GSL identified that 4 had values of $p<0.05$: age ($p=0.0044$), presence of LC ($p=0.0380$), estimated glomerular filtration rate (eGFR) ($p=0.0273$) and ECW to TBW ratio ($p=0.0217$) (Table V). In the multivariate analysis of the 4 factors, no significant factor was found, while eGFR tended to be significant ($p=0.0826$). Corresponding OR and 95% CI for each variable were demonstrated in Table VI.

Uni- and multivariate analyses of factors linked to the GSL for female cases. For female cases, GSL was found in 73

Table III. *Univariate analysis of factors linked to GSL for all cases (n=241).*

	GSL, yes (n=113)	GSL, no (n=128)	*p*-Value
Age (years)	66 (57, 71.5)	60 (47, 67)	0.0006
Etiology, HCV/HBV/others	70/11/32	84/10/34	0.7989
Gender (male/female)	40/73	62/66	0.0500
Presence of LC, yes/no	56/57	31/97	<0.0001
Presence of sarcopenia, yes/no	6/107	11/117	0.4507
BMI (kg/m^2)	23.1 (20.3, 26.1)	22.65 (20.525, 25)	0.7322
Total bilirubin (mg/dl)	0.8 (0.7, 1.15)	0.8 (0.6, 1.0)	0.1903
Serum albumin (g/dl)	4.1 (3.8, 4.3)	4.25 (4.0, 4.5)	0.0015
ALBI score	–2.74 (–2.935, –2.375)	–2.885 (–3.11, –2.6525)	0.0009
Prothrombin time (INR)	1.08 (1.03, 1.14)	1.045 (1.0, 1.1)	0.0040
Platelet count (×10^4/mm^3)	16 (11.1, 20.65)	18 (12.825, 23.1)	0.0501
AST (IU/l)	28 (22, 39)	25.5 (19, 35)	0.9843
ALT (IU/l)	21 (14.5, 35)	24 (16, 42)	0.2369
eGFR (ml/min/1.73m^2)	79 (67, 91.5)	84.5 (73.25, 99)	0.0770
ECW to TBW ratio	0.392 (0.396, 0.397)	0.386 (0.382, 0.390)	<0.0001

Data are shown as median (interquartile range). GSL: Grip strength loss; HCV: hepatitis C virus; HBV: hepatitis B virus; LC: liver cirrhosis; BMI: body mass index; ALBI: albumin-bilirubin; INR: international normalized ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate; ECW: extracellular water; TBW: total body water.

patients (53.3%). The univariate analysis of factors associated with the GSL identified that 6 had values of $p<0.05$: presence of LC ($p=0.0003$), serum albumin ($p=0.0239$), ALBI score ($p=0.0111$), PT-INR ($p=0.0034$), platelet count ($p=0.0008$) and ECW to TBW ratio ($p<0.0001$) (Table VII). Serum albumin was excluded for the multivariate analysis as ALBI includes serum albumin. In the multivariate analysis of the remaining 5 factors, ECW to TBW ratio was found to be significant ($p=0.0024$), while ALBI score tended to be significant ($p=0.0895$). Corresponding OR and 95% CI for each variable were demonstrated in Table VIII.

Table IV. *Multivariate analysis of factors linked to GSL for all cases.*

	Odds ratio	95% confidence interval	*p*-Value
Age ≥63 years	1.101	0.589-2.059	0.7624
Presence of LC	1.877	0.949-3.714	0.0706
ALBI score ≥-2.82	1.526	0.854-2.725	0.1546
Prothrombin time (INR) ≥1.06	1.113	0.580-2.101	0.7416
ECW to TBW ratio ≥0.388	3.069	1.590-5.921	0.0007

LC: Liver cirrhosis; ALBI: albumin-bilirubin; INR: international normalized ratio; ECW: extracellular water; TBW: total body water.

Discussion

GS is the main determinant of physical activity (8). GS well reflects the degree of muscle strength of the whole body (10-13). GS can be a marker of nutritional status because muscle function responds early to nutritional deficiencies (10). GS measurement is a key part of the JSH assessment criteria for sarcopenia in liver disease (36). However, in the current European guidelines, Asian guidelines or JSH guidelines, description of secular changes in GS is not found anywhere (8, 9, 36). Few data with regard to GSL in CLD patients are currently available (31). Thus, elucidating risk factors for the GSL in patients with CLDs seems to be clinically meaningful.

In our multivariate analysis for all cases, ECW to TBW ratio was found to be an independent factor and presence of LC tended to be a significant factor linked to the GSL. ECW to TBW ratio in CLDs represents edematous status and liver function (37). Management of edematous status in CLDs should be pivotal for avoiding GSL. In our previous investigation, we reported the significant negative correlation between ECW to TBW ratio and walking speed in patients with CLDs, which are similar to the current data (38). As shown in Figure 3, the stepwise decrease of ΔGS was found according to the liver disease severity. While Hiraoka *et al*. reported the significant correlation between serum albumin level and the GSL, which are in line with our data (31).

In the correlation between ΔGS and baseline continuous parameters according to gender, and in the multivariate analyses of factors linked to the GSL according to gender, large differences between male and female were found. Age significantly correlated with ΔGS in male, while not in female. Total bilirubin, serum albumin, ALBI score, PT-INR, platelet count and ECW to TBW ratio significantly correlated with ΔGS in females, while not in males. ECW to TBW ratio was an independent predictor linked to the GSL in females, while not in males. Hanai *et al*. reported that GS was

Table V. *Univariate analysis of factors linked to GSL for male cases (n=102).*

	GSL, yes (n=40)	GSL, no (n=62)	*p*-Value
Age (years)	65.5 (54.25, 71.75)	55.5 (45.75, 65)	0.0044
Etiology, HCV/HBV/others	22/6/12	40/7/15	0.6267
Presence of LC, yes/no	20/20	18/44	0.0380
Presence of sarcopenia, yes/no	1/39	3/59	0.9999
BMI (kg/m^2)	23.5 (21.8, 25.8)	23.05 (21.4, 25.55)	0.9119
Total bilirubin (mg/dl)	0.9 (0.7, 1.2)	0.8 (0.6, 1.1)	0.3041
Serum albumin (g/dl)	4.1 (3.7, 4.4)	4.25 (4.0, 4.5)	0.0896
ALBI score	–2.755 (–2.9375, –2.2475)	–2.87 (–3.13, –2.65)	0.0697
Prothrombin time (INR)	1.08 (1.03, 1.155)	1.05 (1.0, 1.13)	0.2339
Platelet count (×10^4/mm^3)	17.4 (11.8, 22.5)	16.45 (11.7, 22.15)	0.6005
AST (IU/l)	26 (23.25, 38.75)	27.5 (20.5, 38.25)	0.5790
ALT (IU/l)	24.5 (18.25, 43)	30 (16.75, 48.5)	0.1954
eGFR (ml/min/1.73m^2)	78.5 (67, 97.75)	87 (78.75, 107.25)	0.0273
ECW to TBW ratio	0.3875 (0.381, 0.394)	0.384 (0.380, 0.388)	0.0217

Data are shown as median (interquartile range). GSL: Grip strength loss; HCV: hepatitis C virus; HBV: hepatitis B virus; LC: liver cirrhosis; BMI: body mass index; ALBI: albumin-bilirubin; INR: international normalized ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate; ECW: extracellular water; TBW: total body water.

independently associated with mortality regardless of gender in LC patients, however, as for secular changes in GS in patients with CLDs, clinicians should be fully aware of gender differences (16). On the other hand, in the multivariate analysis for the GSL in male, eGFR tended to be significant. A previous study reported that in community-dwelling older males (n=789), mild-to-moderate renal impairment at baseline was associated with GS decline, which is in agreement of our results (39).

Sung *et al*. reported that encephalopathy, higher level of Wisteria floribunda agglutinin-positive Mac-2 binding protein (liver fibrosis marker), advanced age, and sarcopenia were independent adverse predictors for skeletal muscle mass loss in 166 LC patients (40). While contrary to our expectations, sarcopenia and advanced age were not independent factors linked to the GSL in our results. In this study, sarcopenia was found in only 17 patients (7.1%) (4 male patients and 13 female patients), and the small number of sarcopenic patients may be one of possible causes of our results. In addition, the severity of underlying liver disease rather than advanced age may be associated with the GSL.

According to the report of Japan sports agency (JSA), the median values of GS in patients aged 60-64 years were 42.85 kg in male and 26.3 kg in female, while in our data (median age=63 years), the median values of GS were 34.375 kg in males and 20.95 kg in females, which were lower than the JSA data. These may be attributed to the disease-related muscle functional decline. JSA also reported that GS peaks at 35 to 39 years for male and 40 to 44 years for female, and then decreases with aging. In our data, there were 128 patients (53.1%) without GSL. In the analyzed subjects, the most suitable intervention for each underlying liver disease was performed during the follow-up period. These interventions may lead to the maintenance of GS value. However, further examinations are required to confirm whether medical interventions ameliorate GS value in CLD patients.

Table VI. *Multivariate analysis of factors linked to GSL for male cases.*

	Odds ratio	95% confidence interval	*p*-Value
Age ≥63 years	1.438	0.512-4.039	0.4923
Presence of LC	1.799	0.693-4.671	0.2290
eGFR <82 ml/min/1.73m^2	2.144	0.901-5.901	0.0826
ECW to TBW ratio ≥0.388	1.555	0.526-4.602	0.4271

LC: Liver cirrhosis; eGFR: estimated glomerular filtration rate; ECW: extracellular water; TBW: total body water.

Several limitations to our study must be acknowledged. First, this single-center study had a retrospective nature. Second, our cohort was heterogeneous including various etiologies for underlying liver diseases and various degrees of liver functional reserve. Third, various interventions for each subject have been done during the follow-up period, making bias for the interpretation of changes of GS values. Fourth, our results were derived from data of only Japanese CLD patients and our study cohort did not include Child-Pugh C patients. Finally, GS value can vary depending on patient conditions. Caution must be, therefore, taken in interpreting the results. Despite the limitations, our study results denote that baseline liver functional parameters are closely linked to the GSL especially in female CLD patients. In conclusion, we would like to emphasize the importance

Table VII. *Univariate analysis of factors linked to GSL for female cases (n=139).*

	GSL, yes (n=73)	GSL, no (n=66)	*p*-Value
Age (years)	66 (58, 71.5)	63.5 (53, 69.25)	0.1296
Etiology, HCV/HBV/others	48/5/20	44/3/19	0.8403
Presence of LC, yes/no	36/37	13/52	0.0003
Presence of sarcopenia, yes/no	5/68	8/58	0.3844
BMI (kg/m^2)	22.4 (19.575, 26.475)	22.1 (20.075, 24.25)	0.5306
Total bilirubin (mg/dl)	0.8 (0.7, 1.05)	0.7 (0.575, 0.9)	0.3002
Serum albumin (g/dl)	4.1 (3.9, 4.3)	4.25 (4.0, 4.5)	0.0239
ALBI score	–2.74 (–2.935, –2.51)	–2.935 (–3.08, –2.67)	0.0111
Prothrombin time (INR)	1.08 (1.025, 1.135)	1.035 (0.99, 1.0925)	0.0034
Platelet count (×10^4/mm^3)	15.3 (10.65, 20.5)	19.15 (13.7, 24.675)	0.0008
AST (IU/l)	28 (22, 39)	24 (18.75, 33)	0.4537
ALT (IU/l)	19 (13, 31.5)	20.5 (13, 32.75)	0.8467
eGFR (ml/min/1.73m^2)	80 (70, 90.5)	82 (65.75, 91)	0.9114
ECW to TBW ratio	0.393 (0.390, 0.399)	0.387 (0.385, 0.39425)	0.0011

Data are shown as median (interquartile range). GSL: Grip strength loss; HCV: hepatitis C virus; HBV: hepatitis B virus; LC: liver cirrhosis; BMI: body mass index; ALBI: albumin-bilirubin; INR: international normalized ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate; ECW: extracellular water; TBW: total body water.

of baseline liver function as a useful predictor for the GSL in patients with CLDs.

Conflicts of Interest

The Authors declare no conflicts of interest.

Authors' Contributions

Data curation, Hiroki Nishikawa, Kazunori Yoh, Hirayuki Enomoto, Naoto Ikeda, Tomoyuki Takashima, Nobuhiro Aizawa and Takashi Nishimura; Formal analysis, Hiroki Nishikawa; Supervision, Shuhei Nishiguchi and Hiroko Iijima; Writing – original draft, Hiroki Nishikawa and Kazunori Yoh; Writing – review & editing, Hirayuki Enomoto.

Table VIII. *Multivariate analysis of factors linked to GSL for female cases.*

	Odds ratio	95% confidence interval	*p*-Value
Presence of LC	1.541	0.559-4.250	0.4045
ALBI score ≥-2.82	1.943	0.903-4.181	0.0895
Prothrombin time (INR) ≥1.06	1.088	0.468-2.530	0.8439
Platelet count <17.3×104/mm^3	1.813	0.769-4.272	0.1752
ECW to TBW ratio ≥0.388	3.569	1.544-8.246	0.0024

LC: Liver cirrhosis; ALBI: albumin-bilirubin; INR: international normalized ratio; ECW: extracellular water; TBW: total body water.

Acknowledgements

The Authors would like to thank Yasuko Higuchi in our hospital for the anthropometry measurement. This work was partly supported by Hyogo Innovative Challenge, Hyogo College of Medicine, Japan.

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Received September 23, 2020
Revised October 4, 2020
Accepted October 12, 2020