Handgrip Strength as an Important Bed Side Tool to Assess Malnutrition in Patient with Liver Disease

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Background: Malnutrition is frequently present in patients with cirrhosis. Anthropometric measures such as body mass index (BMI), mid arm muscle circumference (MAMC), triceps skin fold thickness (TST) and subjective global assessment (SGA) have some limitations in assessment of malnutrition. This study aims to determine the prevalence of malnutrition in non-hospitalized cirrhotic and chronic hepatitis patients and to assess handgrip (HG) strength as a tool for identifying malnutrition. **Methods:** Consecutive patients of cirrhosis ($n = 352$), chronic hepatitis ($n = 189$) and healthy controls ($n = 159$) were enrolled. All patients underwent MAMC, TST, HG and SGA assessment. Malnutrition was diagnosed on basis of SGA score. Values of MAMC, TST and HG below the 5th percentile or less than 60% of healthy controls were considered as abnormal. **Results:** According to SGA (taken as standard) 24% patients with chronic hepatitis and 56% of patients with cirrhosis had malnutrition ($P = 0.001$). In patients with chronic hepatitis prevalence of malnutrition according to MAMC (12%), TST (31%) and HG (18%). In patients with cirrhosis prevalence of malnutrition according to MAMC (27%), TST (60%) and HG (42%). HG exercise strength had the highest area under curve 0.82 (95% confidence interval (CI) 0.78–0.86, $P = 0.001$) compared to MAMC 0.60 (95% CI 0.55–0.64, $P = 0.001$) and TST 0.65 (95% CI 0.61–0.69, $P = 0.001$) for assessing malnutrition. On comparison of HG, TST and MAMC, the sensitivity was 67%, 60% and 31%, respectively, Specificity was 95%, 71% and 89%, respectively, and diagnostic accuracy was 87%, 67% and 71%, respectively. **Conclusion:** HG strength is an excellent tool to assess at bed side the nutrition status in patients with cirrhosis and has the highest diagnostic accuracy compared to other anthropometric tests such as MAMC and TST. (J CLIN EXP HEPATOL 2017;7:16–22)

Malnutrition is commonly present in patients with liver disease and its prevalence varies from 20% in compensated liver disease to more than 80% in those patients with decompensated liver disease.^{1–4} Many factors contribute to malnutrition in these patients which include anorexia, early satiety, ascites, frequent hospitalization, pancreatic insufficiency, bacterial overgrowth and misconception about the dietary intake. Nutritional status is considered to be a predictor of morbidity and mortality in patients with advanced liver disease.^{5,6} Malnutrition is a negative prognostic factor associated with life-threatening complications such as refractory ascites, spontaneous bacterial peritonitis, hepatorenal syndrome and variceal hemorrhage.⁷ Malnutrition also has important implications in liver transplantation and it has been demonstrated that patients with a worse nutritional status

before the transplant have increased postoperative complications and higher mortality rates.⁸

Assessing patient nutritional status by traditional anthropometric methods is difficult in patient with cirrhosis due to presence of ascites and pedal edema.^{9,10} In practice, nutritional status in these patients has been assessed by combining anthropometry with history and physical examination, with a focus on nutritional aspects which we believe are clearly insufficient.

Subjective global assessment (SGA) is a proven nutritional assessment tool highly predictive of nutrition-associated complications.¹¹ Nutrition screening with SGA and anthropometric measurements are an important first step in the early identification of malnutrition and its management.^{12,13} SGA is a bedside assessment tool used to collect information on dietary intake, weight change, and gastrointestinal symptoms. It includes examination for subcutaneous fat loss, muscle wasting, edema, and ascites. The SGA is commonly used to assess patients with liver disease because it is simple and cost-effective. We believe there is no clearly established standard to measure malnutrition in cirrhotic patients, but also believe the SGA is a better clinical assessment tool than using visceral proteins or anthropometry. In this study, the gold standard adopted was the SGA because there is evidence that clinical evaluation is better than anthropometric or biochemical assessment. SGA has been used as gold standard for assessment

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Abbreviations: BMI: body mass index; CTP: Child-Turcotte-Pugh; HG: handgrip; MAC: mid arm circumference; MAMC: mid arm muscle circumference; SGA: subjective global assessment; TST: triceps skin fold thickness

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of nutrition in various other studies in patients with cirrhosis.^{14,15}

Number of tools are available as an aid for the nutritional assessment of the cirrhotic patient however, none are without limitations. Sarcopenia or loss of skeletal muscle mass is the major component of malnutrition and is a frequent complication in cirrhosis that adversely affects clinical outcomes. These include survival, quality of life, development of other complications and post liver transplantation survival. Radiological image analysis is currently utilized to diagnose sarcopenia in cirrhosis. Evaluation of muscle activity is considered a good nutritional index, and measuring non-dominant handgrip (HG) strength is a functional method to assess nutritional status.¹⁶ Study by Alvares-da-Silva and Reverbel da Silveira¹⁷ had shown that there was a high prevalence of malnutrition in cirrhotic outpatients, especially when assessed by HG, which was superior to SGA and prognostic nutritional index in this study. HG was the only technique that predicted a significant incidence of major complications (uncontrolled ascites, hepatic encephalopathy, spontaneous bacterial peritonitis, and hepatorenal syndrome) developed in 1 year in undernourished cirrhotic patients. There is paucity of data from Indian subcontinent on the assessment of nutritional status in cirrhosis. We assessed the nutritional status of patients with cirrhosis using anthropometric measurement such as body mass index (BMI), mid arm muscle circumference (MAMC), triceps skin fold thickness (TST), HG strength and SGA score in all patients.

MATERIALS AND METHODS

This was a prospective study of 700 adults who were assigned to one of three groups: group 1 consisted of healthy subjects ($n = 159$), group 2 consisted of patients who had chronic hepatitis and no cirrhosis ($n = 189$) and group 3 consisted of patients who had cirrhosis ($n = 352$). All patients were recruited from the Gastroenterology Outpatient Clinic. Cirrhosis was diagnosed on the basis of clinical, biochemical, radiological or liver biopsy findings suggestive of cirrhosis. Chronic hepatitis was diagnosed based on liver biopsy and fibroscan value which is more than 7 kPa and less than 11 kPa.¹⁸ Patients were excluded if they had any associated co morbid illness like uncontrolled diabetes mellitus, acquired immunodeficiency syndrome, tuberculosis, chronic renal failure, muscle disease, and/or rheumatologic disease, hepatocellular carcinoma or any malignancy, hepatic encephalopathy at time of assessment of nutrition status and active drug abuse. Patients with joint disease and neuropathy were also excluded. Healthy subjects were taken from hospital staff and healthy volunteers of patients. All healthy subjects had normal ultra sound of abdomen, negative hepatitis B and C serology and normal liver and kidney

functions tests. None of these subjects had history of significant alcohol intake and their fibroscan value was less than 5 kPa.

Nutritional assessment was done using anthropometrical and clinical methods, as well as biochemical and hematological laboratory examinations, which are available and can be routinely used for clinical practice in general hospitals in developing countries. BMI was defined as the body mass divided by the square of the body height, and was expressed in units of kg/m^2 . In our study patient weight included ascites and/or pedal edema if he had any at the time of enrollment. SGA was done according to the proposition of Detsky et al.¹⁹ A detailed history was recorded with appetite, caloric intake, change in body weight. Based on this evaluation, patients were classified into three groups: well, moderately malnourished and severely malnourished. The anthropometric evaluation was performed with the patient in the supine position according to the usual parameters: height, weight, TST, mid arm circumference (MAC) and MAMC measured on the right arm, using established methods. The triceps skin fold was calculated as the mean of three measurements using the Lange skin fold caliper midway between the acromion and tip of the olecranon. Arm circumference was evaluated at the right arm, at a midpoint equidistant from the acromion and olecranon, with the patient in the upright position and the arm flexed at 90° . The MAMC was calculated by the formula $\text{MAMC (cm)} = \text{MAC} - [3.14 \times \text{TST (cm)}]$.¹⁵ The diagnosis of malnutrition was based on SGA score. Values of MAMC, TST and HG below the 5th percentile or less than 60% of healthy controls were considered as abnormal and patients were diagnosed to have malnutrition.²⁰

HG was measured in the morning by dynamometry by the same examiner who performs the other anthropometry measurements. Subjects sat in front of the dynamometer, were instructed on its use, and became familiar with the apparatus by using the dominant hand. Then, with the non-dominant hand, subjects used the two shafts located in the lower part of the dynamometer. Three measurements were taken and the highest was considered.¹⁷ The study was approved by the hospital ethics committee and informed consent was obtained from all subjects.

STATISTICAL METHODS

Values were presented as mean $\pm$ standard deviation, number of patients, or a percentage. The exact Fisher test or the chi-square test was used to compare the prevalence and the severity of malnutrition according to the severity and the etiology of the hepatic disease. Correlation between the variables was assessed using Spearman's rank correlation coefficient. The diagnostic performance of various anthropometric measurements was assessed by receiving operator characteristic curves taking SGA as the gold

Table 1 Baseline Characteristics of Patients.

Parameters	Healthy controls (n = 159)	Chronic hepatitis (n = 189)	Cirrhosis (n = 352)	P
Age (years)	42.1 ± 14	42.2 ± 14	42.7 ± 12.3	0.26
M:F	126:33	138:51	283:69	0.23
Body mass index	25.5 ± 3.4	26 ± 4.3	24 ± 4.2	0.001
Hb (g/dl)	13 ± 2	12.2 ± 2	10.5 ± 2.5	0.001
TLC (10 ³ /ml)	6.7 ± 1.6	6.9 ± 2.4	5.5 ± 2.7	0.03
Platelet count 10 ⁶ /ml	207 ± 98	188 ± 87	137.3 ± 77	0.001
Total bilirubin (mg/dl)	1 ± 0.3	1.4 ± 1.5	2.9 ± 2.3	0.001
Albumin (g/dl)	4.1 ± 0.5	3.7 ± 0.7	2.8 ± 0.7	0.001
AST IU/l	31.3 ± 14.2	52 ± 39	91 ± 69	0.001
ALT IU/l	32.3 ± 18	51 ± 39	55 ± 45	0.001
Total cholesterol (mg/dl)	224 ± 45	173 ± 33	117.9 ± 31.5	0.001
Triglycerides (mg/dl)	131 ± 15	134 ± 13	59 ± 15	0.001
CTP score	–	–	8.1 ± 1.9	–
Etiology ALD:HBV:HCV:crypto:others	–	36:80:22:9:42	115:56:38:115:37	–

CTP score, Child–Turcotte–Pugh score; ALD, alcohol related liver disease; HBV, hepatitis B; HCV, hepatitis C; Crypto, cryptogenic.

standard. *P* value <0.05 was considered statistically significant. Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) software for Windows, version 20.0.

RESULTS

Consecutive patients of cirrhosis (*n* = 352), chronic hepatitis (*n* = 189) and healthy controls (*n* = 159) were enrolled over a period of 1 year (March 2012 to April 2013). Base line characteristics of subjects enrolled are shown in Table 1.

Prevalence of Malnutrition in Patients in Patients with Liver Disease

In healthy adults the mean MAC was 29.9.6 ± 3.3 cm and MAMC was 24.2 ± 3.7 cm, HG measure was 17.6 ± 3.1 kg and TST was 18.2 ± 4.6 mm. There was significant difference in these anthropometric parameters when patients

with chronic hepatitis and cirrhosis were compared to healthy controls (Table 2). We also find significant difference in MAC, MAMC, TST and HG in patients with chronic hepatitis and cirrhosis (Table 2).

The prevalence of malnutrition in healthy subjects as per SGA is zero but other parameters showed prevalence of malnutrition as 0.6%. According to SGA 24% patients with chronic hepatitis and 56% of patients with cirrhosis had malnutrition (*P* = 0.001). Prevalence of malnutrition according to MAMC was 12% and according to TST was 31% in chronic hepatitis patients. Similarly prevalence varies from 27% (MAMC) to 60% (TST) in patients with cirrhosis (Table 3).

Correlation of HG Strength, MAMC, TST, SGA and Child–Turcotte–Pugh (CTP) Score

There was significant correlation of HG strength (*r* = −0.289, *P* = 0.001), MAMC (*r* = −0.379, *P* = 0.001),

Table 2 Anthropometric Measurement in Different Groups.

	Healthy controls (Gp-1) (N = 159)	Chronic hepatitis (Gp-2) (N = 189)	Cirrhosis (Gp-3) (N = 352)	P (Gp-1 vs Gp-2)	P (Gp-1 vs Gp-3)	P (Gp-2 vs Gp-3)
BMI (N = 159)	25.5 ± 3.4	26.2 ± 4.3	23.9 ± 4.2	0.09	0.001	0.001
MAC (cm)	29.9 ± 3.3	24.8 ± 4.6	22.3 ± 5.3	0.001	0.001	0.001
MAMC (cm)	24.2 ± 3.7	20.2 ± 5.0	19.1 ± 5.5	0.001	0.001	0.001
TST (mm)	18.2 ± 4.6	14.5 ± 7.2	10.2 ± 5.1	0.001	0.001	0.001
HG (kg)	17.6 ± 3.1	16.9 ± 5.2	11.6 ± 4.8	0.12	0.001	0.001
SGA (A:B:C)	159:0:0	163:15:11	154:84:114	0.001	0.001	0.001
Fibroscan	4.1 ± 0.6	7.2 ± 2.2	43.3 ± 21.0	0.001	0.001	0.001

BMI, body mass index; MAC, mid arm circumference; TST, triceps skin fold; HG, handgrip; SGA, subjective global assessment.

Table 3 Prevalence of Malnutrition in Cirrhosis, Chronic Hepatitis and Healthy Controls.

	Healthy controls (Gp-1) (n = 159)	Chronic hepatitis (Gp-2) (n = 189)	Cirrhosis (Gp-3) (n = 352)	P (Gp-2 vs Gp-3)
Handgrip (n) (%)	1 (0.6)	34 (18)	147 (42)	0.001
MAMC (n) (%)	1 (0.6)	23 (12)	96 (27)	0.001
TST (n) (%)	1 (0.6)	59 (31)	209 (60)	0.001
SGA (n) (%) (mod:severe)	0	15 (8):11 (6)	84 (24):114 (32)	0.001

Table 4 Prevalence of Malnutrition According to Child's Score.

Parameter	HG strength N (%)	MAMC N (%)	TST N (%)	SGA (mild to moderate:severe) N (%)
Child's A (n = 82)	25 (30)	6 (7)	32 (39)	18:18 (22:22)
Child's B (n = 177)	67 (38)	50 (28)	97 (56)	39:56 (22:32)
Child's C (n = 93)	55 (59)	40 (43)	80 (86)	27:40 (29:43)

MAC, mid arm circumference; TST, triceps skin fold; HG, handgrip; SGA, subjective global assessment.

Table 5 Sensitivity, Specificity and Diagnostic Accuracy of Different Parameters in Assessment of Malnutrition.

Parameter	Sensitivity (%)	Specificity (%)	Diagnostic accuracy (%)
HG	67	95	87
MAMC	31	89	71
TST	60	71	67

MAC, mid arm circumference; TST, triceps skin fold; HG, handgrip.

TST ($r = -0.302$, $P = 0.001$) and SGA ($r = 0.236$, $P = 0.001$) with CTP score in patients with cirrhosis.

Of 352 patients with cirrhosis 82 (23%) were Child A, 177 (50%) were Child B and 93 (27%) were Child C. Prevalence of malnutrition according to CTP score is shown in Table 4. There was significant correlation of malnutrition with worsening of CTP score.

There was a significant increase in malnutrition as the Child's status increases from Child A to Child C when others parameters like HG strength, MAMC and TST were used ($P = 0.001$) (Table 4).

Prevalence According to Etiology (Alcohol vs Non-alcohol)

When we subcategorize patients according to etiology of cirrhosis and chronic hepatitis as alcoholic ($n = 151$) and non-alcoholic ($n = 390$) we found that there was no significant difference of malnutrition between the groups when we compared HG strength (31% vs 34%, $P = \text{NS}$ (non significant)), MAMC (24% vs 21%, $P = \text{NS}$), TST (55% vs 48%, $P = \text{NS}$) and SGA score of mild to moderate plus severe (41% vs 42%, $P = \text{NS}$). Hence, etiology of chronic hepatitis and cirrhosis did not matter in our patients.

Sensitivity and Specificity of Different Anthropometric Parameters for Evaluation of Malnutrition

Taking a cut off (below the 5th percentile or less than 60%) for HG exercise (<10.5 kg), MAMC (<14.5 cm) and TST (<10.9 mm), HG exercise strength had the highest area under curve 0.82 (95% confidence interval (CI) 0.78–0.86, $P = 0.001$) compared to MAMC 0.60 (95% CI 0.55–0.64, $P = 0.001$) and TST 0.65 (95% CI 0.61–0.69, $P = 0.001$). Hence HG is the single most important parameter at bedside to evaluate the nutritional status of cirrhosis compared to SGA as gold standard (Table 5). HG strength showed highest sensitivity, specificity and diagnostic accuracy for the diagnosis of malnutrition in patients with chronic liver disease (Figure 1).

DISCUSSION

Malnutrition is a commonly seen in patients with liver disease and multiple factors are contributory for malnutrition in patients with cirrhosis.²¹ In this large study of 700 patients of which 189 patients had chronic hepatitis and 352 patients had cirrhosis the prevalence of malnutrition based on SGA score was 14% in chronic hepatitis and 56% in patients with cirrhosis. We used different anthropometric measurement such as MAMC, TST and HG measurement and found that HG measurement had highest sensitivity (67%), specificity (95%) and diagnostic accuracy (87%) compared to MAMC and TST for the diagnosis of malnutrition in these patients and it can be easily used at bedside for nutritional assessment in patients with cirrhosis.

Figure 1 Figure showing handgrip strength as highest sensitivity and specificity in diagnosing malnutrition compared to MAMC and TST.

Malnutrition is considered a negative prognostic factor associated with life-threatening complications such as refractory ascites, spontaneous bacterial peritonitis, hepatorenal syndrome and variceal hemorrhage.^{7,17} Many studies have shown that malnutrition is prevalent in all forms of liver disease: from 20% in compensated liver disease to more than 80% in those patients with decompensated liver disease.⁴⁻⁶ In a study by Teiusanu et al.²² malnutrition was correlated with clinical severity of liver disease. The mild-moderate malnourished patients are 88% Child B, and over 58% had viral etiology of cirrhosis. Our study showed prevalence of malnutrition in patients with cirrhosis increased as the severity of cirrhosis increased (Child A 44%, Child B 54% and Child C 72%). TST (mm) and MAC (cm) decrease significantly according to the Child score, a positive correlation was found between these two parameters and the severity of cirrhosis. Similar were the results of Houissa et al.²⁰ who found malnutrition was found in 35 patients (79.5%). TST and MAMC less than 60% were found in respectively 72% and 25% of patients. TST and MAMC decreased significantly according to the Child score ($P = 0.014$ and 0.032 , respectively) a positive correlation was found between these two parameters and the severity of cirrhosis.

The identification of an optimal method of nutritional assessment in patients with cirrhosis is difficult because many of the traditionally measured parameters, such as weight, BMI and biochemical values, vary with the severity of liver disease independently of nutritional status. BMI is probably the most widely utilized nutritional assessment tool in the general population and thus is familiar to most

clinicians; however, its utility is limited in the setting of cirrhosis because standard BMI cut-offs are inaccurate in patients who have significant volume overload, especially ascites; this inaccuracy could cause clinicians to overestimate the nutritional status of patients with liver disease.¹³⁻¹⁵

SGA uses clinical criteria to determine nutritional status and it is more useful than objective measures alone for identifying individuals at nutritional risk because of the ability to encompass the multitude of factors influencing the nutritional status. In this study, the gold standard adopted was the SGA because there is evidence that clinical evaluation is better than anthropometric or biochemical assessment. In our study SGA had shown that malnutrition was present in 14% in patients with chronic hepatitis and 56% in patients with cirrhosis and it showed significant correlation with CTP score (0.236 , $P = 0.001$). According to SGA mild to moderate and severe malnutrition was present in 44% in Child A, 54% in Child B and 72% in Child C. Similar were the results with HG strength, MAMC and TST which showed higher incidence of malnutrition in Child C compared to Child B and Child A. This study also confirms the important relationship between malnutrition and liver function already observed by others.¹⁷⁻²⁰ However assessing SGA score at bedside is cumbersome and not routinely done by many physicians.

Evaluation of muscle activity is considered a good nutritional index, and measuring non-dominant HG strength is a functional method to assess nutritional status. Prevalence of malnutrition according to HG strength was 18% in chronic hepatitis group and 42% in patients

with cirrhosis. Similarly the prevalence of malnutrition increased as assessed by HG strength as Child's status increased from Child's A to Child's C ($P = 0.001$). We did not find any difference in malnutrition according to etiology of cirrhosis (alcohol vs non-alcohol) and this correlated with previous published studies that showed that it was not etiology but stage of liver disease which had positive correlation with malnutrition.^{23,24} HG strength would be different in men and women and different cut-offs should be taken to diagnose malnutrition in females and males patients with cirrhosis. However in our study we had 20% female patients in cirrhosis group and 25% in chronic hepatitis group and we analyzed them jointly for easy understanding of our study data in patients with cirrhosis. When compared with other methods of evaluation of malnutrition in patients with chronic hepatitis and cirrhosis we found HG had highest diagnostic accuracy (87%) of detecting the malnutrition compared to MAMC (71%) and TST (60%). We did not follow these patients for the development of cirrhosis related complications but study by Alvares-da-Silva and Reverbel da Silveira¹⁷ had shown that HG, but not SGA or prognostic nutritional index, predicted a poorer clinical outcome at 1 year follow-up in patients with cirrhosis. We also presume that as HG strength is highly correlated with SGA, HG alone can be safely used in clinical practise to assess nutritional status in patients with cirrhosis and predictions of future cirrhosis related complications.

The strength of this study was that we had enrolled large number of patients of chronic hepatitis and cirrhosis. We used commonly used anthropometric measurement (HG, TST and MAMC) for the evaluation of nutrition in patients with chronic liver disease and also assessed simultaneously SGA which is considered as gold standard. We did not follow these patients for the development of cirrhosis related complications which could have given us the answer which parameter is directly linked with complications of cirrhosis and malnutrition.

In conclusion, the prevalence of malnutrition is high in patients with cirrhosis and varies with the method used for its assessment. SGA is commonly used for the assessment of malnutrition and showed higher prevalence in cirrhosis compared to chronic hepatitis. Malnutrition is directly correlated with Child's status and etiology of cirrhosis has no effect on malnutrition in this study. HG strength is a useful tool to assess at bed side the nutrition status in patients with cirrhosis and has the highest diagnostic accuracy compared to other anthropometric tests such as MAMC and TST.

AUTHOR'S CONTRIBUTIONS

Study concept, data analysis, data collection, interpretation and critical revision: Praveen Sharma. Data collection and editing of manuscript: Abdul Rouf, Abdul Matin,

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CONFLICTS OF INTEREST

The authors have none to declare.

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