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Original Article

Handgrip Strength as a Useful Marker of Nutritional Status Assessment in Cirrhotic Patients

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Abstract:

Background: *Protein energy malnutrition is a recognized feature of cirrhosis of liver. Anthropometric measures such as body mass index (BMI), mid arm circumference (MAC), triceps skin fold thickness (TSFT) and subjective global assessment (SGA) have some limitations in assessment of malnutrition. The objective of this study was to assess the efficacy of hand grip strength in nutritional assessment of cirrhotic patient and its sensitivity and specificity in detecting malnutrition.*

Materials and methods: *This was a cross sectional observational study conducted in the Department of Gastroenterology, BSMMU, Shahbag, Dhaka, during the period September 2018 to August 2019. In total of one hundred and thirty (130) eligible patients more than 18-year-old, diagnosed as cirrhosis of liver were enrolled.*

Results: *Out of one hundred and thirty (130) cirrhotic patients, there were 62.3% (81) malnourish according to SGA rating, where 37.7% were moderately malnourish and 24.6% patients were severely malnourished. HGS had the highest area under curve 0.84 (95% confidence interval (CI) 0.77–0.91, P=0.001) compared to MAC 0.80 (95%CI 0.72–0.87, P=0.001) and TSFT 0.75 (95% CI 0.66–0.83, P=0.001) for assessing malnutrition. In comparison of HGS, TSFT and MAC, the sensitivity was 75.5%, 53% and 71%, respectively. The Specificity was 88.9%, 87% and 75% respectively and diagnostic accuracy was 89%, 87% and 82% respectively in assessing malnutrition.*

Conclusion: *HGS is a simple, bed side tool that can be used to assess the muscle status and can be used in a complementary manner with other methods for proper assessment of the patients.*

Keywords: Cirrhosis of liver, Nutritional status assessment marker, Handgrip strength.

Introduction:

Cirrhosis is a widespread disruption of normal liver structure by fibrosis and the formation of regenerative nodules that are caused by any of various chronic progressive conditions affecting the liver. It may be compensated or decompensated when complicated by one or more of the following features; jaundice, ascites, hepatic encephalopathy, and raised prothrombin time. Cirrhosis is virtually irreversible, unless the underlying

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cause of cirrhosis is removed and may eventually lead to liver failure, ammonia toxicity, gastrointestinal hemorrhage, kidney failure, hepatic coma and death. Major complications of cirrhosis include portal hypertension, oesophageal varices, hypersplenism, ascites, SBP, hepatorenal syndrome type I and II, hepatic encephalopathy, malnutrition, impairment of lipid synthesis, metabolism, coagulopathy, fibrinolysis factor deficiency, HCC etc.[1]

Patients with cirrhosis frequently suffer from malnutrition and micro/macronutrient deficiencies. Malnutrition rate is reported to be 60% in decompensated cirrhosis and 20% in compensated cirrhosis.[2] The aetiology of malnutrition in cirrhosis is multifactorial including reduced oral intake due to loss of appetite, malabsorption and various metabolic abnormalities. Often, cirrhotic patients have metabolic disturbances (e.g., low zinc or magnesium level) that can promote taste alteration.[3] Once hepatic encephalopathy occurs, a low-protein diet is still recommended by some physicians, sometimes with severe protein restriction. All of the above leads to loss of fat mass but most importantly sarcopenia.[4] Ascites, leg oedema from hypoalbuminemia in cirrhotic patients also leads to malnutrition.[5]

Index of disease severity for patients with end-stage liver disease has been classified by Child-Turcotte-Pugh (CTP) scoring system. The identification of a novel method for nutritional assessment in patients with cirrhosis is demanding. Conventionally measured parameters of nutritional status such as body mass index, anthropometry and biochemical parameters vary with the severity of liver disease and they rarely estimate exact nutritional status.[6] Subjective Global Assessment (SGA) uses clinical criteria to determine nutritional status and lack of any objective measurements makes it highly variable in estimating malnutrition.[7]

Over the past few years, a number of investigators have reported that sarcopenia occurs in 30–70% of cirrhotic patients.[8] The clinical significance of sarcopenia in liver disease, primarily in cirrhosis is due to the high prevalence and adverse impact on clinical outcome measures including survival, quality of life, development of other complications of cirrhosis, and post-liver transplant outcomes.[9] Etiology and severity of the underlying liver disease, duration of illness, age and co-morbidities contribute to the severity of sarcopenia.[10] Despite being widely recognized as a major complication of cirrhosis, most therapies to date are based on the principle of ‘‘deficiency replacement” rather than targeted treatments, and have generally been ineffective.[11]

Muscle wasting in the cirrhotic patient is an evidence of malnutrition. This muscle wasting correlating with the functional loss can be measured with the handgrip strength (HGS). Association of HGS and health decline has been previously described in the aged population with functional disability[12]. Recently HGS is being regarded as a predictor of postoperative complications, mortality and functional decline making handgrip dynamometry (HGD) a broader application tool for screening procedure.[13] There was a high prevalence of malnutrition in cirrhotic outpatients, especially when assessed by HG, which was superior to subjective global assessment (SGA) and Prognostic Nutritional Index in the study in 2005 by Silveira[14], HGS is the technique that predicted a significant incidence of major complications in 1 year in undernourished cirrhotic patients. HGS has its wide implication these days; it is a useful tool for continuous and systematic assessment of muscle mass related to nutritional status in patients on dialysis.[15]

In a study in 2010 by *Bin et al.*, the prevalence of malnutrition was significant in patients with Crohn’s Disease (CD), even in clinical remission. They had compared the different nutritional assessment methods, 26.7% of the patients were malnourished according to the MAC (Mid arm circumference), 29.3% according to the MAMC (Mid arm muscle circumference), 18.7% according to the SGA, 6.7% according to the BMI, 37.3% according to the TSF (Triceps skin fold) and 73.3% according to the HGS. No statistically significant associations were found for disease location, its behavior, drugs utilized, ESR, CRP, age of patients and disease time with the nutritional state verified by HGS, TSF, MAMC and SGA. They found that BMI should not be used as reference in this population. The HGS detected a high prevalence of nutritional risk in patients with CD in remission.[16]

Shaimaa *et al*. in 2016, had found that 74 out of 78 patients of decompensated cirrhosis had impaired HGS with highly significant correlation to the degree of PEM

(P<0.001).[17] By performing regression analysis for HGS it confirmed the presence of causal effect with PEM with P-value of 0.03 and β coefficient of -0.27 with 95% confidence interval. Also showed a border line significant correlation with MAC (p-value of 0.052) which seems to be logic as MAC also showed significant correlation to PEM. But for TSF it didn't show significant correlation to PEM. The sensitivity and specificity of HGS regarding prediction of moderate to severe malnutrition were 100% and 40% respectively along with PPV and NPV of 86.9% and 100% respectively, as well as accuracy of 88%.

In a prospective study of 80 alcoholic liver disease patients, 69 patients survived and 11 patients died within the 3 month study duration. Mean HGS was significantly higher in the survivors (24.23±5.86) compared to nonsurvivors (18.04±4.82) (P=0.0011). There was a strong negative correlation between the HGS and Child-Pugh score (P=<0.0012). The sensitivity of HGS was 88.41% in predicting short term mortality.[18]

Conventionally measured parameters of nutritional status, such as body mass index, anthropometry, and biochemical parameters vary with the severity of liver disease and they rarely estimate exact nutritional status.There is no gold standard method for assessment of the nutritional status of cirrhotic patient; identification of novel methods for nutritional assessment in patient with cirrhosis is demanding. HGS has its wide implication in patient of compensated and decompensated cirrhosis with impaired HGS has significant correlation to the degree of PEM. So we want to assess the nutritional status of cirrhotic patients of different classes with Handgrip strength by using Handgrip dynamometer.

Previously nutritional status assessment in cirrhotic patient or assessment of malnutrition by Hand grip strength was not done in Bangladesh. So we want to assess the nutritional status of cirrhotic patients of different classes with Handgrip strength by using Handgrip dynamometer. Subjective Global Assessment (SGA) was considered as gold standard method for assessing malnutrition in cirrhotic patient.[7]

Materials and Methods:

This observational cross sectional analytical study was carried out during the period of September 2018 to August 2019 in the department of Gastroenterology, BSMMU, Dhaka.

Patients admitted and attending outpatient of Gastroenterology Department diagnosed cirrhosis of liver were taken for the study. Total of 130 cirrhotic patients were enrolled in the study. Their clinical history, examination & initial investigation report was noted in the standard data sheet. Severity of liver disease was assessed by Child-Turcotte-Pugh score. Nutritional status was assessed with Subjective Global Assessment, Anthropometric measurement and Hand Grip Strength recorded of patient of In-patient Department as well as outpatient department of Gastroenterology, BSMMU. Subjective Global Assessment (SGA) was considered gold standard for assessment and comparison of malnutrition.

Handgrip strength (HGS), a measure of maximum voluntary force of the hand, has been described as the simplest method in assessing muscle function. This technique has been demonstrated to be a reliable screening tool in the assessment of nutritional risk in hospital admission as well as a useful indicator of nutritional status in the non-hospitalized population, particularly in identifying individuals with chronic malnutrition. Grip strength was measured in the dominant and non-dominant hands with a strain gauge dynamometer in three positions: lying at 30 degree in bed with elbows supported, seated in an armchair with elbows supported and in a chair with elbows unsupported. The average of three readings made in each position, each 1 min apart, was recorded.

Patients are presented and described in detail is a clinical technique called subjective global assessment (SGA), which assessed nutritional status based on features of the history and physical examination. Patients are graded on SGA as A: well nourished- (SGA- A), B: mild or moderately malnourished (SGA- B) and C: severely-malnourished (SGA-C).

After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows based computer software devised with Statistical Packages for Social Sciences version 22. After compilation, data were presented in the form of tables, figures and graph, as necessary. Numerical variables were expressed as mean and standard deviation, whereas categorical variables were

count with percentage. Categorical variables were analyzed by Chi-square test. Validity test was done for the diagnostic utility of all the assessment methods. The correlation of HGS and other assessment was done with pearson's correlation test. ANOVA test was done to measure the level of significance. P value of less than 0.05 was considered statistically significant.

Results:

A total of 130 cirrhotic patients were enrolled to analyze the nutritional status in this study. Majority of the patients belong to age 48-57 years (31.5%), the mean age of patients was 45.5±13.9 years. **(Table 1)**.

Table 1: Distribution of the study patients according to age group (N=130)

Age	Frequency (%)
18 - 27	19 (14.6)
28 - 37	19 (14.6)
38 - 47	23 (17.7)
48 - 57	41 (31.5)
>57	28 (21.5)
Mean±SD	**45.5 ± 13.8**

Out of 130 patients, males were 62% and females 38% **(Figure 1)**.

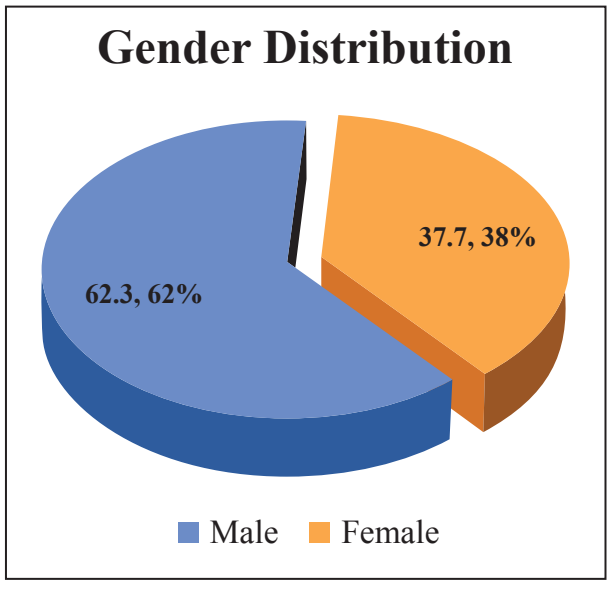


Figure 1: Pie chart showing gender distribution of the study patients.

There were 41 (31.5%) patients in Child A, 56 (43.1%) patients in Child B and 33 (25.4%) patients in Child C **(Table 2)**.

Table 2: Distribution of the patients according to Child-Turcotte-Pugh class (N=130).

Child-Turcotte-Pugh Class	Frequency (%)
Class A	41 (31.5)
Class B	56 (43.1)
Class C	33 (25.4)

There were 49 (37.7%) well-nourished patients and 81(62.3%) patients were malnourished **(Table 3)**.

Table 3: Distribution of the patients according to Subjective global assessment (N=130).

SGA	Frequency (n)
Well Nourished	49 (37.7)
Malnourished	81 (62.3)

The p value of BMI in different Child-Turcotte-Pugh class patients was 0.157. The p value of MAC, TSFT and HGS in different Child-Turcotte-Pugh class patients was 0.001, 0.024, 0.001 respectively **(Table 4)**.

Table 4: Anthropometric parameters and Hand grip strength in different Child-Turcotte-Pugh class (N=130)

Anthropometric parameters (Mean±SD)	Child-Turcotte-Pugh class			p-value
	Class A	Class B	Class C	
BMI(kg/m^2)	21.93 ± 4.34	20.62 ± 3.69	22.13 ± 4.52	0.157^{ns}
MAC(cm)	25.01 ± 3.59	22.85 ± 3.47	21.73 ± 4.43	0.001^{s}
TSFT(mm)	12.86 ± 7.06	11.16 ± 5.88	8.91 ± 5.11	0.024^{s}
HGS(kg)	28.43 ± 8.98	21.35 ± 6.60	20.69 ± 7.09	<0.001^{s}

s = significant, ns= not significant, ANOVA test was done to measure the level of significance.

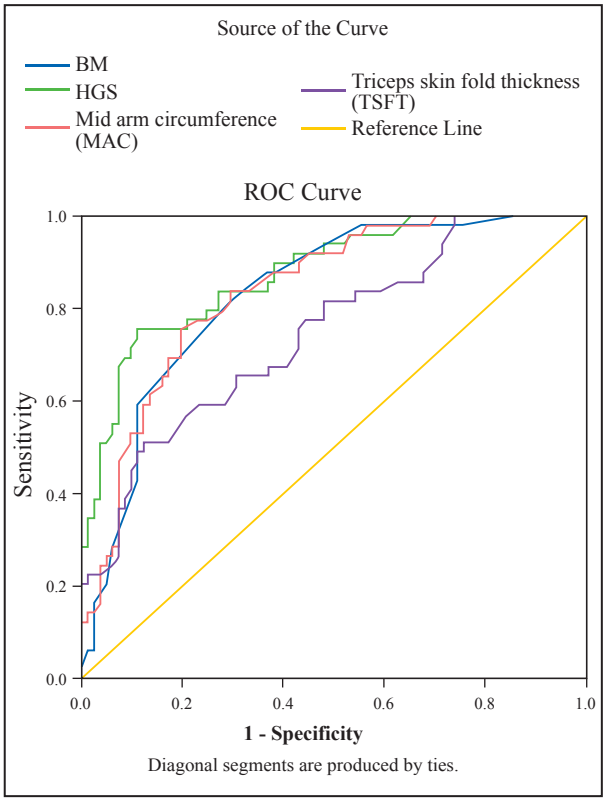
The p value of BMI, MAC, TSFT and HGS in well-nourished patients and in malnourished patients was <0.001, <0.001, <0.001 and <0.001 respectively which was statistically significant **(Table 5)**.

Table 5: Anthropometric parameter and Hand grip strength according to nutritional status (N=130)

Anthropometric parameters (Mean±SD)	Nutritional status		p-value
	Well nourished	Malnourished	
BMI(kg/m^2)	23.15 ± 4.09	20.36 ± 3.84	<0.001^s
MAC(cm)	26.04 ± 3.00	21.56 ± 3.48	<0.001^s
TSFT(mm)	14.61 ± 6.83	9.02 ± 4.78	<0.001^s
HGS(kg)	30.04 ± 7.65	19.22 ± 5.69	<0.001^s

*s =significant, Unpaired t-test was done to measure the level of significance

The AUC values were 0.830 with 95% CI (0.760-0.900) for BMI, 0.876 with 95% CI, (0.815-0.936) for HGS, 0.837 with 95% CI(0.769-0.906) for MAC, and 0.744 with 95% CI (0.658-0.831) for TSFT, with a p-value of <0.0001 **(Figure 2)**.



AUC= 0.969

Figure 2: ROC curve of BMI, HGS, MAC and TSFT in diagnosis of nutritional status.

The p value among the different child pugh class and the nutritional status of the cirrhotic patients was <0.001 **(Table 6)**.

Table 6: Association of Child-Turcotte-Pugh score with subjective global assessment (N=130)

Child-Turcotte-Pugh score	Subjective Global Assessment		p-value
	Well nourished%	Malnourished%	
Class A	33 (67.35)	8 (9.88)	
Class B	15 (30.61)	41 (50.62)	<0.001^s
Class C	1 (2.04)	32 (39.50)	
Total	49 (100)		

s = significant, Chi-square test was done to measure the level of significance

There was significant negative correlation between HGS and nutritional status with Child-Turcotte-Pugh classes. The p value was 0.002, <0.001 and 0.048 in Child-Turcotte-Pugh class A, Child-Turcotte-Pugh class B and Child-Turcotte-Pugh C respectively **(Table 7)**.

Table 7: Correlation between handgrip strength and nutritional status in cirrhotic patients of different Child-Turcotte-Pugh classes (N=130).

Child-Turcotte-Pugh class	R	p-value
Class A	-0.476	0.002
Class B	-0.833	<0.001^s
Class C	-0.347	0.048

s= significant, Spearman's correlation test was done to measure the level of significance

Discussion:

This ross-sectional observational study was conducted in the Department of Gastroenterology, BSMMU, Dhaka, with the objective of assessing hand-grip strength in the evaluation of nutritional status among cirrhotic patients.

A total of 130 patients were enrolled, including both inpatients and outpatients. Among them, 81 were male and 49 were female. The mean age was 45.5 ± 13.8 years,

with most patients belonging to the 48–57-year age group. There were 41 patients with Child-Turcotte-Pugh (CTP) class A, 56 with class B, and 33 with class C cirrhosis. According to the SGA grading, 49(37.7%) patients were well nourished and 81(62.3%) were malnourished.

Conventional nutritional assessment methods such as body weight and BMI are less reliable in patients with ascites due to artificially increased body weight.[5] This was also evident in our study, as no significant correlation was found even after calculating estimated dry body weight.

Anthropometric tests such as the MAC or TSFT have shown a good estimate of the patients' nutritional status and their efficacy had been proved by many studies.[19] Mogawer et al in 2013 had shown that TSFT and MAC was highly correlated to the degree of PEM and also considered as predictors of complications among patients with liver cirrhosis.[20] As we had found MAC and TSFT had a significant correlation with nutritional status with p value <0.0001. TSFT is a good estimate of the fat composition of the body but doesn't reflect the muscle bulk or strength that could be measured by other methods as HGS.[21]

According to ESPEN (2006) guidelines on liver disease, bedside methods such as SGA, anthropometry, or hand-grip strength are adequate for identifying undernutrition, and the use of composite scores provides no additional value.[10,22] Protein Energy Malnutrition is well known to include caloric deficiency, alteration of the fat components, muscle loss, macro, micro nutrients deficiency and even effect on bone metabolism.[23] Thus our main concern was for muscle bulk for which HGS could be its representative.[5]

Muscle bulk or strength can be an accurate estimate of protein malnutrition in cirrhotic patients.[24] A study attempted to assess muscle mass using a special body fat monitor but found insignificant results.[20] Handgrip strength is a simple, quick, and noninvasive method that can be used in clinical and epidemiological studies. It is especially useful in decompensated cirrhosis, where malnourished patients often show lean mass depletion and low muscle strength. It measures the combined action of a large number of muscles as well as the combined action of a number of different joints.[22]

Á study suggested that in early cirrhosis, muscle strength measured by HGS should be used to evaluate malnutrition, as muscle mass (measured by MAC) may not yet show changes.[19] In advanced stages, MAC may be affected by fluid retention and thus overestimated. Therefore, assessment of muscle power by HGS may overcome this limitation. In our study, 81 of 130 cirrhotic patients had impaired HGS, showing a strong correlation with the degree of malnutrition ($p < 0.001$).

HGS values differ between men and women, so sex-specific cut-offs should ideally be used. However, since 37.7% of our patients were female, both sexes were analyzed together for simplicity. When compared with other parameters, HGS had the highest diagnostic accuracy (91.8%) for detecting malnutrition compared to MAC (86.3%) and TSFT (77.8%).

Although we did not follow up the patients for complications, A study reported that HGS-but not SGA or the prognostic nutritional index-predicted clinical outcomes at one year in cirrhotic patients.[19] Our findings suggest that, since HGS strongly correlates with SGA, it can be safely used in clinical practice to assess nutritional status in cirrhosis.

Conclusion:

The prevalence of malnutrition is high among patients with cirrhosis and varies with the method used for its assessment. Malnutrition has a significant impact on the outcome of patients with liver cirrhosis. Nutritional assessment in cirrhotic patients remains a challenge for the clinicians. HGS is a non-invasive, simple, and quick method that can be used in clinical and epidemiological studies. Subjective Global Assessment (SGA) is considered the gold standard for malnutrition assessment and comparison. A combined approach using SGA, Anthropometry, and HGS can be used in a complementary manner to accurately identify the nutritional status in patients with liver disease.

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