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Original Research Article

Assessment of Nutritional Status of Liver Cirrhotic Patients by the Anthropometric Parameters (BMI, TSF, MAC, MAMC) and Their Correlation with Severity of the Disease

Sandhya Mishra[1], Vijay Laxmi Nangliya[2], Shyam Sunder[3], Anjali Sharma[4]

[1]Senior Professor and former Head, Department of Biochemistry, SMS Medical College, Jaipur

[2]Assistant Professor, Department of biochemistry, SMS Medical College, Jaipur

[3]Senior Consultant and Head, Department of Medicine, ESIC Model Hospital, Jaipur

[4] Department of Biochemistry, SMS Medical College, Jaipur

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Corresponding author: Dr. Vijay Laxmi Nangliya
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Abstract

The objective of the study was to evaluate the nutritional status of liver cirrhosis patients by the Anthropometrics measurements (Body Mass Index (BMI), Triceps Skin-fold thickness (TSF), Mid-Arm Circumference (MAC), Mid-Arm Muscle Circumference (MAMC) as an assessment method of the nutritional status. and their correlation with severity of Liver cirrhosis according to Child-Pugh classification. One hundred fifty cirrhotic subjects of either sex ranging in age from 20–70 years were included in the study, and the results were compared with 50 age- and sex-matched healthy control subjects. All cirrhotic subjects were assessed for severity of disease as mild (Child A), moderate (Child B), and severe (Child C) as per Child-Pugh classification. Among Anthropometric parameters: BMI, TSF, MAC, and MAMC were used for the assessment of Nutritional Status, measured in all the subjects. TSF, MAC, and MAMC were significantly decreased in Cirrhotic Subjects as compared to the healthy controls. Whereas BMI was not decreased significantly in Cirrhotic patients as compared to healthy control subjects. Enrolled 150 Cirrhotic patients were further segregated into three groups Child A, B & C according to the severity of their liver disease as assessed by the Child-Pugh classification. When Anthropometric parameters (BMI, TSF, MAC, and MAMC) were compared with the severity of liver cirrhosis, these measurements were decreased with the advancement of liver disease but the mean difference among Child Pugh groups was statistically not significant. However there was no significant correlation but there was a negative tendency between BMI, TSF, MAC and MAMC with the Child score. The anthropometric method used BMI, TSF, MAC and MAMC, it was observed that with increase in severity of disease severity of malnutrition also increased but the frequency of malnutrition diagnosis was less. These traditional methods under-diagnosed the nutritional depletion status of patients with cirrhosis because they are affected by edema, ascites, inter observer variation and there is no standard reference data for comparison in Indian population. Malnutrition is common in CLD patients. MAMC is efficient anthropometric parameter and is associated with severity of disease so as one single method does not serve as the only and best parameter to diagnose malnourished patients or patients with risk for malnutrition. Though not very sensitive, body mass index BMI can be used to assess malnutrition after correcting the weight for the severity of ascites and edema. Anthropometric measurements including MAMC , TSF and MAC are simple and quick to perform with good inter- observer agreement and are

probably the most practically applicable method. In addition, TSF and MAMC have demonstrated a linear relationship with mortality among cirrhotic patients.

Introduction

Chronic liver disease occurs throughout the world irrespective of age, sex, region or race. Cirrhosis is an end result of a variety of liver diseases characterized by fibrosis and architectural distortion of the liver with the formation of regenerative nodules and can have varied clinical manifestations and complications. According to WHO, about 46% of global diseases and 59% of the mortality is because of chronic diseases and almost 35 million people in the world die of chronic diseases [1]. Nutritional deficiency is common in patients with end stage liver disease (cirrhosis) and is often associated with a poor prognosis [2]. Malnutrition is a well-known complication in patients with liver cirrhosis, and its presence has important prognostic implications because it is an independent predictor of mortality and is associated with decompensation, complications (ascites,encephalopathy, spontaneous bacterial peritonitis, hepatorenal syndrome) and a poor quality of life [3 & 4]. Undernourishment in patients with cirrhosis should be of concern for the clinician and it must be considered as important as the traditional prognostic factors of chronic liver diseases. Actually, nutritional status in these patients is so important that it was part of the original Child-Turcotte scale. In 1973, Pugh replaced it with the prothrombin time [5 & 6]. Malnutrition is present in more than half of cirrhotic patients. Its prevalence varies widely depending on which definition of malnutrition is used, which tools are employed to perform the nutritional assessment, and the residual function of the liver, being more common in decompensated cirrhosis [7]. All patients with decompensated cirrhosis who are candidates for liver transplants present some grade of malnutrition [8]. Malnutrition occurs in all forms of cirrhosis [9] as shown by studies of nutritional status in different etiology and of varying degrees of liver insufficiency [10]. The prevalence of malnutrition in cirrhosis ranges from 65 to 100% depending upon the methods used for nutritional assessment and the severity of liver disease [11 & 12]. There is a direct association between PCM and poor nutritional status results in an unfavorable clinical outcome. The diagnosis of the nutritional status and the treatment of malnutrition in Cirrhotic patients can contribute to reduction in the frequency and/or severity of these complications [13]. Anthropometry involves the external measurement of morphological traits of human beings. It has a widespread and important place in nutritional assessment, and while the literature on anthropometric measurement and its interpretation is enormous, the extent to which measurement error can influence both measurement and interpretation of nutritional status is little considered [14]. Though not very sensitive, body mass index BMI can be used to assess malnutrition after correcting the weight for the severity of ascites and edema [15]. Anthropometric measurements including MAMC , TSF and MAC are simple and quick to perform with good inter-observer agreement and are probably the most practically applicable method. In addition, TSF and MAMC have demonstrated a linear relationship with mortality among cirrhotic patients [16].

Material and Method

The present cross-sectional hospital-based study was conducted in the Department of Biochemistry, in association with the Department of Gastroenterology SMS

Medical College & attached Hospitals, Jaipur, Rajasthan, India.

Subject Selection

One hundred fifty cirrhotic subjects of either sex attending the Outpatient Department (OPD) or admitted in wards of the Department of Gastroenterology SMS Medical College & attached Hospitals, Jaipur, Rajasthan, ranging in age from 20–70 years (mean±SD 43.04±8.51 years) were included in the study. Patients with hepatic encephalopathy, hepatorenal syndrome, spontaneous bacterial peritonitis, upper gastrointestinal bleeding, hepatocellular carcinoma, and sepsis (need hospitalization) and patients on albumin and diuretic and malabsorption were excluded from the study. The results were compared with 50 age- (mean±SD 43.14±9.3 years) and sex-matched healthy control subjects, and it was ensured by routine examination that all the subjects were in good health and there were no signs and symptoms or no positive history of cirrhosis and had no evidence of malnutrition and comorbid condition that lead to micronutrient malnutrition. Local institutional ethics committee approval was sought before commencement of the study. Informed written consent was obtained from all recruited subjects prior to participation.

Clinical Criteria for Diagnosis

A thorough clinical and symptomatic examination of all the patients was done under the guidance of the treating gastroenterologist. Cirrhosis was diagnosed on the basis of combination of clinical features, blood profile, and radiological imaging. Clinical features were those of portal hypertension, i.e., ascites and/or gastrointestinal varices. Blood profile included evidence of thrombocytopenia and/or coagulopathy. Radiological features, either with trans-abdominal ultrasound or computerized tomography, had to demonstrate a small shrunken liver with or without splenomegaly and intra-abdominal varices [17,18]. To assess severity of the disease, cirrhotic subjects (n= 150) were further segregated according to Child-Pugh classification: Child A, mild; Child B, moderate; and Child C, severe, indicating degree of hepatic reserve and function. Child-Pugh-Turcotte (CPT) classification [19,20]

Points	1	2	3
Encephalopathy	Absent	Medically controlled	Poorly controlled
Ascites	Absent	Controlled medically	Poorly controlled
Bilirubin (mg/dL)	<2	2-3	>3
Albumin (g/dL)	<3.5	2.8–3.5	<2.8
PT/INR	<1.7	1.7–2.2	>2.2

Interpretation: class A: 5–6 points, class B: 7–9 points, class C: 10–15 points

Fasting blood sample was drawn of each subject in plain, EDTA, and PT vials and following investigations were done: serum glucose, urea, creatinine, AST, ALT, ALP, bilirubin, total protein, albumin, A/G ratio, cholesterol, triglyceride on fully automated analyser Randox Imola .CBC was performed on Five Part XT 1800 I Sysmex and PT/INR was assessed on semiautoanalyzer (Coagulation Analyzer SPR 123).

Anthropometric measurements included the following: Body mass index (BMI), Mid arm circumference (MAC), Triceps skin- fold thickness (TSF), Mid arm muscle circumference (MAMC).BMI was estimated by dividing weight (kg) by height^2 (m^2) [21] Arakawa Y et al 2004). Individuals were considered malnourished if their BMI was less than 18.5, normal from 18.5 to 24.9 and overweight if ≥ 25 [22]. Mid Arm Circumference (MAC**)** was measured to the nearest centimeter with a measuring tape at the right arm. The NHANES skinfold thickness and circumference measures assess subcutaneous and visceral fat tissue. The arm circumference is measured on the right arm at the level of the upper arm mid-point mark. The examiner makes this mark on the posterior surface of the arm immediately after measuring the upper arm length [23]. Triceps Skin- Fold Thikness (TSF) an established measure of fat stores, was measured to the nearest millimeter at the right arm using Harpenden skinfold caliper (Baty Ltd, British Indicators) in a standard manner. Three measurements were taken for both TSF and MAC, with average values calculated and recorded. Mid-Arm Muscle Circumference (MAMC) an established measure of muscle protein mass, was calculated from MAC and TSF using a standard formula.

MAMC = MAC - (3.1415*TSF) [24].

Skinfold thicknesses were measured at the left and the right side of the body to the nearest 0.1mm with a Harpenden skinfold caliper, at the following sites: (1) triceps, halfway between the acromion process and the olecranon process; (2) biceps, at the same level as the triceps skinfold, directly above the centre of the cubital fossa [23].

Statistical Analysis

All data were recorded in a database system on a personal computer, and statistical analysis were performed by using SPSS (STATA 12.0 statistical software). All data were expressed as mean ±SD. Unpaired student t Test was used for comparison of Cirrhotic patients with healthy Controls. Comparison of parameters among the three groups (patients with Child's class A, B, or C liver disease were performed using one-way analysis of variance (ANOVA). In order to know the correlation between Anthropometrics measures with *Child-Pugh* classification (Child Score), pearman correlation test was used. We used the Pearson correlation test to know to determine the correlation between within the parameters. P < 0.05 was considered significant.

Results:

150 diagnosed patients of Cirrhosis were compared with 50 healthy Control subjects. Among 50 healthy Control subjects 64% were male and 36% were female and among 150 Cirrhotic patients 66% were Male, 34% were female with male & female ratio was 1.9:1. When the cases were compared on the basis of age, in the Control group the mean age was 43.14± 9.37 years, while in Cirrhotics the mean age was 44.04±8.57 years. On the basis of etiology of Cirrhosis, 42.6% percent of the patients had Cirrhosis of alcoholic etiology, 20% had NASH, 20.7% had HBV, 6.7% had HCV and 10 % with other etiologies (Autoimmune, PBC, PSC).

In our study Anthropometric measurements included the following: Body Mass Index (BMI), Triceps Skin fold Thickness (TSF) for fat stores and Mid -Arm Circumference (MAC), Mid -Arm Muscle Circumference (MAMC) for muscle protein mass, which was used for assessment of Nutritional Status. Among Anthropometric parameters BMI, TSF, MAC and MAMC were measured in all the subjects . TSF, MAC and MAMC were significantly decreased in Cirrhotic Subjects as Compared to the Healthy Controls (Mean ± SD in Cirrhotics v/s Controls of TSF (13.54±5.21 v/s 15.80±4.66 mm, p <0.01), MAC (275.18± 44.01 v/s 310.76±17.12 mm, p <0.001) and MAMC (232.42±43.04 v/s 261.13 ±29.95 mm, p <0.001) (Table 9 & 12). Whereas BMI was not decreased significantly in Cirrhotic patients as compare to healthy Control subjects (Mean ± SD, 21.36±2.58 in Cirrhotics and 22.08±1.58 in Controls p >0.05) (Table 1).

Table 1: Comparison of Anthropometric parameters in Controls and Cirrhotic subjects (n=200)

Anthropometric Parameters	Controls (n=50)	Cirrhotics (n=150)	Unpaired Student t Test	
	Mean±SD (Range)	Mean±SD (Range)	t Test	P Value
Height (cm)	168.28±4.82 (158-178)	170.06±10.27 (157-179)	1.181	0.238
Weight (Kg)	62.76±6.14 (51-76)	60.93±7.34 (46-83)	1.586	0.114
BMI	22.08±1.58 (19.2-26.3)	21.36±2.58 (15.8-28.4)	1.8587	0.064
TSF (mm)	15.80±4.66 (11.8-24.3)	13.54±5.21 (4.2-23.2)	2.729	0.007**
MAC (mm)	310.76±17.12 (271-339)	275.18±44.01 (163-332)	5.570	<0.001***
MAMC (mm)	261.13±29.95 (206.97-297.55)	232.42±43.04 (126.57-291.8)	4.374	<0.001***

BMI (Body mass index); TSF (Triceps skin fold thickness); MAC (Mid arm circumference); MAMC (Mid- arm muscle circumference), Comparison was done using unpaired student t test *(p < 0.05) significant,
** (P < 0.01) very significant,*** (P<0.001) indicates that groups are responsible for variance in the measured variable and is highly significant & Rest are not significant (p>0.05).

Further enrolled 150 Cirrhotic patients were segregated into three groups Child A, B & C according to the severity of their liver disease as assessed by the Child-Pugh classification. According to Child Pugh Score out of 150 Cirrhotic patients 51 (34%) belonged to Child A, 50 (33.3%) to Child B and 49 (32.7%) in Child C, category . Gender wise distribution of Cirrhotic Subjects in Child Pugh Classes, 62.7% male and 37.3% females were in Child A, 66% male and 34 % female in Child B and in Child C 69.4% male and 30.6% were female (Table 2).

Table 2: Gender wise distribution of Cirrhotic Subjects (n=150) on the basis of Child Pugh Score

Child-Pugh Score	No: of Subjects	Gender of subjects	
		Male n (%)	Female n (%)
Child –A	51 (34.0%)	32 (62.7%)	19 (37.3%)
Child-B	50 (33.3%)	33 (66%)	17 (34%)
Child-C	49 (32.7%)	34 (69.4%)	15 (30.6%)

When Anthropometric parameters (BMI, TSF, MAC and MAMC) were compared with severity of liver Cirrhosis, these measurements were decreased with advancement of liver disease but the difference among Child Pugh groups were statistically not significant (BMI p= 0.53

, TSF P=0.89 , MAC p= 0.30 and MAMC p=0.67) .However there was no significant correlation (>0.05) but there was negative tendency between BMI, TSF, MAC and MAMC with the Child score based on *Child-Pugh* classification (Table 3 &4).

Table 3: Comparison of Anthropometric parameters (Height, Weight, BMI) according to Child Pugh Score (n=150)

Parameters	**Child-A (n=51)**	**Child – B (n=50)**	**Child-C (n=49)**	**ANOVA (Analysis of variance test)**	
	Mean±SD (Range)	**Mean±SD (Range)**	**Mean±SD (Range)**	**F**	**P (Value)**
Height (cm)	168.32±4.66 (158.0-176.0)	172.78±16.10 (162.0-178.0)	169.08±5.29 (157.0-178.0)	2.764	0.066
Weight (Kg)	62.76±7.85 (50.0-83.0)	60.54±5.57 (51.0-72.0)	61.50±8.10 (46.0-74.0)	2.628	0.076
BMI	22.08±2.42 (17.5-28.4)	21.07±2.43 (16.7-26.7)	21.50±2.89 (15.8-23.9)	2.997	0.053

Comparison was done using ANOVA (Analysis of variance test) *(p < 0.05) significant, ** (P < 0.01) very significant, *** (P<0.001) indicates that groups are responsible for variance in the measured variable and is highly significant & Rest are not significant (p>0.05).

Table 4: Comparison of Anthropometric parameters (TSF, MAC, MAMC) according Child Pugh Score (n=150)

Parameters	**Child-A (n=51)**	**Child – B (n=50)**	**Child-C (n=49)**	**ANOVA (Analysis of variance test)**	
	Mean±SD (Range)	**Mean±SD (Range)**	**Mean±SD (Range)**	**F**	**P value**
TSF (mm)	14.86±4.57 (9.7-22.4)	12.97±5.31 (4.7-23.2)	12.80±5.55 (4.2-22.7)	2.455	0.089
MAC (mm)	281.90±30.83 (208.0-324.0)	275.36±49.91 (163.0-327.0)	268.30±48.51 (165.0-332.0)	1.198	0.305
MAMC (mm)	235.22±39.91 (150.85-285.69)	234.01±45.74 (126.57-286.8)	228.02±43.79 (132.03-291.8)	0.398	0.672

Comparison was done using ANOVA (Analysis of variance test) *(p < 0.05) significant, ** (P < 0.01) very significant, *** (P<0.001) indicates that groups are responsible for variance in the measured variable and is highly significant & Rest are not significant (p>0.05).

In our study severity of protein energy malnutrition was categorized into Mild, Moderate and Severe based on BMI, TSF, MAC and MAMC examination and Serum Albumin, Prealbumin and Transferrin measurement. The frequency or prevalence of diagnosis of malnutrition in patients with liver cirrhosis varied according to the different methods. **On assessment of nutritional status** by various Anthropometric measurements incidence of malnutrition decreasing order were: MAMC > TSF >MAC > BMI (Table 5 &6).

Table 5: Assessment of Nutritional Status of Cirrhotic Subjects on the basis of Various Tools of Nutritional Assessment (n=150)

Nutritional Parameters	Nutritional Status	
	Normal n(%)	Malnourished n(%)
BMI	110(73.4)	40 (26.7)
TST	77 (51.4)	73 (48.6)
MAC	80(53.3)	70 (46.7)
MAMC	71(47.3)	79 (52.7)

Table 6 Spearman Correlation (r) of Nutritional Markers with Child Pugh Score

Parameters	R	P value
BMI	-0.159	0.052
TST	-0.160	0.051
MAC	-0.146	0.072
MAMC	-0.099	0.225

Discussion:

Cirrhosis of the liver is a growing health problem in India and death from this condition is increasing rapidly among both men and women. Cirrhosis is a chronic disease of the liver in which diffuse destruction and regeneration of hepatic parenchymal cells and diffuse increase in connective tissue results in disorganization of the lobular architecture [25].

The aim of the study was to evaluate the nutritional status of liver cirrhosis patients by the Anthropometrics measurements (Body Mass Index (BMI), Triceps Skin-fold thickness (TSF), Mid-Arm Circumference (MAC), Mid-Arm Muscle Circumference (MAMC) as assessment method of the nutritional status. and their correlation with severity of Liver cirrhosis according to Child Pugh classification. Anthropometry involves the external measurement of morphological traits of human beings. It has a widespread and important place in nutritional assessment, and while the literature on anthropometric measurement and its interpretation is enormous, the extent to which measurement error can influence both measurement and interpretation of nutritional status is little considered [14]. Body measurements have a long history of use as nutritional indices. Some reflect previous nutritional conditions (for example, height), while others can reveal information about more recent status. Some measurements are able to distinguish between fat and fat-free mass, providing separate information about energy and muscle protein stores [26]. In our study Anthropometric measurements included the following: Body Mass Index (BMI), Triceps Skinfold Thickness (TSF) for fat stores and Mid -Arm Circumference (MAC), Mid -Arm Muscle Circumference (MAMC) for muscle protein mass, were used for assessment of Nutritional Status.

The Body mass index (BMI) is a simple tool for evaluating the appropriateness of weight for height. It does not involve measurement of body composition, and thus it is not an accurate method for assessing the percentage of lean body mass or fat. However, the BMI correlates well with many measures of body fat content, as well as with risk of morbidity under a variety of conditions. In addition, it is quickly and easily performed in virtually any setting [27,28]

Triceps skinfold thickness measurements are a reliable and reproducible method of assessing the nutritional status of cirrhotics. It was found that more than 50 percent of the decompensated patients were malnourished, with skinfold thickness values significantly lower than those of the controls. In comparison with skinfold thickness and arm circumference, parameters such as body weight and lean body mass are unreliable, and other indices such as muscle and/or fat arm area do not add any significant information to the evaluation of the nutritional status of cirrhotics. BMI measurements in less malnourished cirrhotic patients were not different from the general population, mainly due to the fact that ascites and peripheral oedema contributed significantly to body weight in cirrhotic patients, and true lean body mass was not taken into account. [28] There was no significant correlation between Anthropometrics measures (IBW, BMI, TSF, MAC and MAMC) and Child-Pugh score with $p > 0.05$ and severity of liver disease [28]. Among the Anthropometric parameters, only muscle reserves, evaluated by MAC and MAMC, were found to be more significantly affected in alcoholic cirrhotic patients when compared with non-alcoholic patients. This frequent reduction in muscle mass in patients with cirrhosis of alcoholic etiology is probably related to a direct effect of alcohol on skeletal muscle metabolism. [30] BMI and MAMC were not different among Child-Pugh classes A, B and C [31]. However Triceps skinfold thickness (mm) and Mid-arm circumference (cm) decreased significantly according to the Child score, a positive correlation was found between these two parameters and the severity of cirrhosis. [32]

The traditional nutritional assessment techniques especially Anthropometries are well established and are therefore widely used in clinical practice, the place of the new techniques of body composition analysis is yet to be decided. Caution is still required in the application of traditional nutritional assessment, because the measurements are subject to both intra- and interobserver error, although this error can be minimized if the method is standardized and the observer is experienced. Moreover, the calculation of percentage body fat from skinfold data relies on certain assumptions, which, though validated in healthy individuals, may not be applicable to patients with cirrhosis [33].

Anthropometry is a relatively quick, simple, and cheap means of nutritional assessment. Its limitations include the extent to which measurement error can influence interpretation, and the length of time needed to take measurements. For large studies, or for nutritional screening and surveillance, a number of anthropometrists may be needed, and this influences the degree of measurement error, especially if there is between-observer bias. In choosing the instrument to assess nutritional status, workers often elect to measure only height and weight. These measures are quick, simple and require only limited training. More comprehensive measurement sets which include skinfolds and circumferences require more training and carry different degrees of error with them [34]. Anthropometric evaluation performed by trained health workers is inexpensive, non-invasive and provides detailed information on the different components of body structure, especially muscular and fat components, and can assist in assessing the nutritional status of a population [35].

We observed in the study that according to Anthropometric methods that used BMI, TSF, MAC and MAMC, the frequency of malnutrition diagnosis was less. These traditional methods underdiagnosed the nutritional depletion status of patients with Cirrhosis. Further their relation between severity of liver disease and severity malnutrition was statistically not significant. Anthropometry measurements accurately reflect total body fat and skeletal muscle mass when used for the long term comparision of large, nutritionally stable population. However anthropometric measurements of hospitalized patients are of little value. Changes experienced during acute illness and stress may result in errors of interpretation of subcutaneous fat and weight assessment, and peripheral edema can result in inflated value of skinfold thickness and mid arm circumference [36]. Ideal body weight, even it was affected by body height, it cannot be used as determiner of nutritional status of liver cirrhosis patient as considered by total amount of liver cirrhosis patient of Child-Pugh A, B and C. Likewise BMI, which its measurement is affected by height and body weight. [37] Decreased body weight may be used as simple way to identify malnutrition condition, but this indicator is not reliable if there was any edema that caused by hypoalbuminemia. In liver cirrhosis, edema and ascites are frequently found, so we rarely could determine the real body weight measurement. Evaluation of TSF will be inaccurate result if there is fluid retention. In malnutrition condition, Triceps Skin fold Thickness will decrease in about 60 % patients. This condition indicates that TSF was cannot be used for determining the Nutritional Status. Measurement of body fat reserve will provide better evaluation if it is done at more than one site [29].

Conclusion:

Malnutrition is common in CLD patients. MAMC is efficient anthropometric parameter and is associated with severity of disease but as one single method does not serves as the only and best parameter to diagnose malnourished patients or patients with risk for malnutrition. so that appropriate nutritional intervention can be done to prevent progression of the disease process. However, further research needs to be done.

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