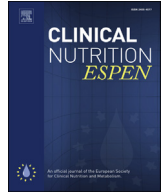




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## Hand grip strength: A reliable, reproducible, cost-effective tool to assess the nutritional status and outcomes of cirrhotics awaiting liver transplant

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### SUMMARY

**Background & aim:** Malnutrition (MN) in patients with cirrhosis awaiting liver transplant (LTx) has been shown to be an important determinant of outcomes. Hence there is an impetus on early diagnosis and stratification to guide goal directed nutritional intervention. The aim of this study was twofold; first, to assess the effect of MN on mortality in patients awaiting LTx and, second, to evaluate HGS as a reliable, non-invasive, and inexpensive tool that can be used in routine clinical practice for early diagnosis and stratification of severity of malnutrition in patients awaiting LTx.

**Methods:** Adults evaluated for LTx and accepted as suitable candidates were enrolled on a waiting list at a single centre between May 2014 and February 2016 and were prospectively included. Nutritional status was assessed by Subjective Global Assessment (SGA), anthropometry, and dominant hand grip strength (HGS). Statistical analysis was performed using Pearson correlation, t-test, and Receiver Operating Characteristic (ROC curve) in SPSS version 16.0.

**Results:** One hundred eighty patients (81% male) aged  $51.6 \pm 10$  years, (Child's C 70.6%, B 26.1%, A 3.3%) were included and followed up till LTx or end of study. Eighty seven patients (48%) who underwent LTx were excluded from the final analysis. Of the 93 patients on the waiting list, 46 (49%) were alive and revealed a high (88%) incidence of MN as assessed by SGA. There was a significant increase in MN with increasing Model End stage Liver Disease (MELD) and Child score, and decreasing HGS ( $p < 0.05$ ). As per the normative standards of Hand grip dynamometer, 99% had impaired HGS ( $< 85\%$ ). Univariate analysis showed a significant increase in mortality on the wait list with increasing MN, increasing MELD and Child score, and decreasing HGS ( $p < 0.05$ ). Binary logistic regression analysis revealed HGS as an independent factor influencing mortality with an Odds ratio of 7.8. A cut off value of 19.5 kg on HGS was found to be significant in differentiating survivors from non-survivors awaiting LTx with optimal sensitivity and specificity of 67% and 75% with area under ROC curve 0.736 (95% confidence interval, 0.63–0.85).

**Conclusions:** HGS is a reliable, non invasive and cost-effective tool to identify MN in cirrhotic patients. Low HGS ( $\leq 19.5$  kg) was a strong predictor of mortality in wait-listed patients and indicated a 7.8 times higher mortality than HGS  $> 19.5$  kg. The cut-off of HGS to stratify severity of MN and guide goal directed nutrition intervention was lower in our patient population than recommended by normative standards and likely represents the standard for the Indian population with ESLD.

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### 1. Introduction

Malnutrition (MN) is estimated to be present in 65–100% of patients with chronic liver disease (CLD) [1,2] and has been

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associated with increased morbidity, mortality and healthcare expenses in patients undergoing liver transplantation (LTx) [1,3–5]. The association of MN with adverse outcomes after LTx has increased the importance of identifying reproducible, reliable and cost-effective methods for assessing the nutritional status of patients with CLD.

Although majority of LTx performed in India and most of South East Asia are from living donors liver (LDLT), where early surgery is priority, deceased donor liver transplants (DDLT) have increased in number over the past few years. Waiting for a DDLT is often associated with deteriorating nutritional status and decompensation, leading on to hospital readmission and even death.

Prevalence of MN in end stage liver disease (ESLD) varies across populations and there is no published data documenting this in ESLD patients awaiting LTx in the Indian population. Furthermore, applying established western standards to characterize the level of MN in the Indian context may create a bias towards an over estimation of MN due to the difference in sample characteristics [6,7].

The aim of this study was twofold, firstly, to assess the effect of MN on mortality in patients awaiting LTx and secondly to identify a reliable, non-invasive, and inexpensive tool that can be used in routine clinical practice for early diagnosis of malnutrition in patients awaiting LTx in India.

## 2. Methods

This prospective observational study was performed at a tertiary care hospital. All patients >18years who enrolled for LTx and consented for the study were included and 165 patients consented for anthropometric measurement.

The study was conducted after obtaining institutional ethics committee approval.

As part of the pre-LTx evaluation at our unit, all patients undergo a detailed nutrition assessment by a qualified Clinical Dietitian and nutritional intervention was recommended based on severity of MN. Disease severity was classified according to the criteria proposed by Child-Pugh et al. [8,9] and the Model for End stage Liver Disease (MELD) [10]. The scores were noted during LTx evaluation.

Data analyzed consisted of 180 consecutive patients with ESLD who were on the wait-list for LTx. Of these 113 (62.8%) patients were admitted to hospital for pre-transplant evaluation and the rest completed in the out-patient clinic. Eighty seven patients (48%) underwent LTx and were excluded from the final analysis. Only 93 patients on the waiting list during the study period were included for analysis.

### 2.1. Nutritional assessment

Subjective Global Assessment (SGA) is a method for evaluating nutritional status based on a practitioner's clinical judgment rather than objective, quantitative measurements. Encompassing historical, symptomatic, and physical parameters, SGA aims to identify an individual's initial nutrition state and consider the interplay of factors influencing the progression or regression of nutrition abnormalities. This method of assessment has been successfully used to assess nutritional status in general medical and surgical patients, it shows good to excellent inter observer reproducibility and good convergent validity [11].

### 2.2. Anthropometric measurement

A modified body mass index (mBMI) has been proposed for patients with cirrhosis, to provide an index for underweight in patients with ascites [12]. A BMI <18.5 kg/m<sup>2</sup> is usually considered underweight, but in patients with cirrhosis, a mBMI <20 kg/m<sup>2</sup> was

associated with increased mortality. A BMI <23 kg/m<sup>2</sup> may indicate underweight in patients with mild ascites, while mBMI <25 kg/m<sup>2</sup> may be underweight for patients with severe or tense ascites [12].

After the actual body weight and BMI were assessed, the Mid-arm circumference (MAC) was measured at the midpoint between the tip of the acromion and the olecranon process on the non-dominant side of the body with a flexible tape measure with the patient sat upright with their arm flexed at 90° [13]. The triceps skinfold was measured using the Slim Guide skinfold caliper and the mean of three measurements was taken. Mid-arm muscle circumference (MAMC), was calculated using the MAC and the TSF according to standard equations given below.

$$\text{MAMC} = \text{MAC (cm)} - (0.314 \times \text{TSF (mm)}) \text{ [14].}$$

### 2.3. Functional methods

Handgrip strength (HGS) is a non-invasive, simple and quick method that has been used in clinical and epidemiological studies for the assessment of nutritional status especially because malnourished patients present with lean mass depletion and low muscle strength [15,16].

HGS was determined by the Jamar Hydraulic Hand Grip Dynamometer (Patterson Medical Ltd). HGS is considered to be a sensitive marker of body cell mass depletion [17]. HGS appears to be able to predict decline in nutrition status before other signs of clinical compromise are apparent [18].

HGS was performed after the procedure was explained to each patient. Patients sat in a chair or bed, with the arm by their side of the body and the forearm bent at the elbow to an angle of 90° and unsupported [19]. The mean value of three consecutive measurements, in which the dominant arm was used to grip the hydraulic handgrip dynamometer, was recorded.

### 2.4. Dietary intake and assessment

Assessment of individual patient's oral energy and protein intake was determined with the combined use of calorie count during hospitalization, 24 h diet recall, and probing questions to clarify intake in out-patient clinic. An average intake of estimated energy and protein intakes were recorded in calories and grams per day respectively. The objective was to determine the adequacy of caloric intake per patient with minimum reporting bias. Calculation of calories of food and beverages intake (composition of the diet) was based on local reference data [20]. As per the ESPEN guidelines, a patient was considered to have met nutritional goal if his or her intake was 35 cal/kg/d of energy and 1.2 g/kg/d of protein [21].

### 2.5. Laboratory determinants

MELD score is a useful tool to assess prognosis in critically ill cirrhotic patients [22]. The Child-Turcotte-Pugh (CTP) classification is by far the most widely applied and reported system as it is easy to use as a bedside test. CTP and MELD scores constitute the best tools to predict mortality in patients with cirrhosis [10].

### 2.6. Statistics

All data were statistically analyzed using statistical package for social science (SPSS) software version 16.0. Descriptive Data were expressed numerically and as percentiles for categorized data, mean and SD for parametric data and mean, SD and median for laboratory variables.

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