Assessment of Nutritional Status in Cirrhosis and Comparison of Severity Between Alcoholic and Non-alcoholic Aetiology – a Prospective Observational Study.

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KEYWORDS

ABSTRACT

Introduction: Malnutrition and muscle wasting in cirrhosis negatively impact survival, quality of life. Conventionally these are not entirely looked for in cirrhosis patients, as nutritional assessment can be difficult, especially if there is associated fluid retention. The cause of the morbidity and mortality in cirrhosis is multifactorial and one important contributor is malnutrition. Nutritional deficiencies are also common among these patients mainly from decreased dietary intake, but also as a result of altered metabolism, decreased nutrient storage and increased nutrient requirements. Methods to detect malnutrition early in the course of the disease may be useful in providing medical nutritional therapy and reducing the morbidity and mortality in cirrhosis.

Objective: To assess nutritional status and compare assessment methods in patients of alcoholic & non-alcoholic cirrhosis by Anthropometry, Handgrip strength (HGS), Creatinine Height Index (CHI) and Psoas Muscle, Thickness per Height (PMTH).

Methods: It was a prospective observational study of 57 consecutive admitted patients of Cirrhosis, for nutritional status assessment in a tertiary care set up in eastern Indian state, Odisha during the period from September 2018 to August 2020.

Results: Study population: 57; majority are of male and alcohol aetiology. Prevalence of malnutrition was 63.84% according to SGA score. There was significant decrease in values of HGS, CHI, PMTH with increasing malnutrition severity. CHI had highest sensitivity (94.44%) and lesser specificity (90.47%) with cut off value of 61.69%, followed by non-dominant HGS (sensitivity:87.87%; specificity: 92.85%). Malnutrition severity was not congruent with values of Dry weight BMI, Anthropometry data.

Conclusion: Handgrip strength of a nondominant hand by dynamometer appeared to be a better practical bedside objective tool in screening, diagnosis and

categorizing malnutrition compared to other significant methods like CHI, PMTH and biochemical parameters. This study also highlights fallacy of usefulness of commonly applied nutrition screening methods like anthropometry and Body Mass Index (BMI) in cirrhosis patients. And suggests an integrated approach with multiple subjective and objective tools for assessing nutrition status in cirrhosis.

Introduction

Cirrhosis is a chronic parenchymal liver disease, defined histologically as a diffuse hepatic inflammatory process characterised by necrosis, fibrosis and conversion of normal liver architecture into structurally abnormal nodules. [1]

Cirrhosis is a leading cause of mortality and morbidity across the world. It is the 11th leading cause of death and 15th leading cause of morbidity, accounting for 2.2% of deaths and 1.5% of disability-adjusted life years worldwide in 2016. [2] CLD caused 1.32 million deaths in 2017, approximately two-thirds among men and one-third among women. In India, since 1980, there has been a gradual increase in mortality due to cirrhosis, as the prevalence of risk factors of cirrhosis, i.e., alcohol intake, HBV, HCV, and diabetes is also increasing.

The cause of the morbidity and mortality in cirrhosis is multifactorial and one important contributor is malnutrition. Sarcopenia, defined as loss of muscle mass and function has been associated with increased risk of mortality, sepsis, heart failure and frequent hospitalization. [3]

There is a general tendency to limit protein intake in patients with cirrhosis to prevent encephalopathy, though recent studies contradict it. [4] However, these patients have an increased protein demand and further limiting their protein will only accelerate protein calorie malnutrition. Nutritional deficiencies are also common among patients with liver disease mainly from decreased dietary intake, but also as a result of altered metabolism, decreased nutrient storage and increased nutrient requirements. [5] Methods to detect malnutrition early in the course of the disease may be useful in providing medical nutritional therapy and reducing the morbidity and mortality in cirrhosis.

Malnutrition and muscle wasting in cirrhosis negatively impact survival, quality of life and response to stressors such as infection and surgery. [6,7] Conventionally these are not entirely looked for because nutritional assessment can be difficult, especially if there is associated fluid retention.

There is also paucity of data regarding assessment of malnutrition and its impact on morbidity and mortality in Indian patients. This study was undertaken to help address the aforesaid obstacle.

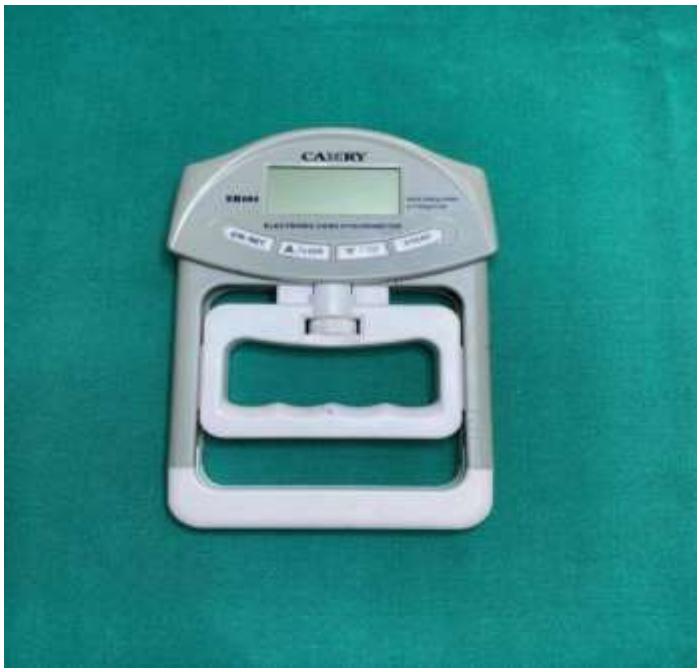
Materials & Methods

This was a two-year single-centre prospective observational study with 108 consecutive Cirrhosis patients admitted in a tertiary care hospital of eastern India. Fifty-one of these patients were excluded as per exclusion criteria. As a result, 57 patients were eventually enrolled in the study. The study was approved by the institute's research ethics committee.

The cases of cirrhosis of liver diagnosed by clinical, biochemical and imaging parameters, age more than 18 years and up to 65 years were included.

Exclusion criteria included patients with health conditions such as hepatic encephalopathy stage 1 or more, according to West Haven Criteria grading for severity of H.E, Chronic kidney disease, Malignancy, Muscular dystrophies, Neurological disorders, Heart and lung disorders, on corticosteroid therapy, Connective tissue disorders, Immunodeficiency disorders, Pregnancy & lactation.

Height was recorded in centimetre using a stadiometer, Weight was recorded in kilograms to the nearest 1 kg on a standard mechanical weighing machine with patient standing. BMI was calculated after calculating dry weight of patient in the presence of fluid retention.



Anthropometry measurements like mid arm circumference was measured with a tape at a midpoint between acromion process and olecranon in the relaxed arm in centimetres on both arms. The triceps skinfold was measured at the upper arm mid-point mark on the posterior surface of the both upper arm with a standard calliper, with a reading close to 1 mm, then Mid arm muscle circumference was calculated by using the formula MAMC in cm = MAC in cm - (TSFT in mm x 0.31415).

Hand grip Strength was assessed with Camry digital hand grip dynamometer **(Fig 1)** with upper arm kept at 0º at elbow joint. Average of three readings taken at an interval of 5 minutes was used as final value expressed in Kg/F. Patient was not allowed to know the recordings until all the recordings were obtained to eliminate subject bias from visual feedback. [8]

Psoas muscle thickness was measured by the thickness of the right psoas muscle, at the level of endplate of L4 vertebra on a single axial portal phase scan of abdominal CT examination taken within 90 days before or after assessment. Psoas muscle thickness was determined as a largest diameter perpendicular to the longest diameter of psoas muscle including both the psoas major and psoas minor on an axial CT image. The psoas muscle thickness by height (PMTH, mm/m) defined as each measured value of psoas muscle thickness divided by the height to adjust the stature of the corresponding patient. [9]

Biochemical parameters and routine lab investigations were recorded at the time of admission. 24 hour urine sample was collected in a plain container after instructing patient to collect second urine sample after waking up and subsequent samples till next day morning first sample after waking up, and during which patient had a normal diet.

CHI was calculated as creatinine/height index (CHI) = [(mg creatinine in 24hour urine from patient) / (expected mg creatinine in 24hour urine for healthy adult control)] x 100. [10-12] Where expected mg creatinine in 24hour urine for healthy adult control = (ideal body weight in kilograms for same sex, height, age) x (creatinine coefficient in mg/kg).

* For normal adult male, the creatinine coefficient = 23 mg/kg of ideal body weight.
* For normal adult women, the creatinine coefficient = 18 mg/kg of ideal body weight.

*Interpretation: Decrease in CHI are proportionate to the decrease in total body muscle mass.

**Interpretation of the obtained results were assumed and categorized into class I-IV as follows, If CHI ≥ 80%(class-I), there is normal protein status with no sarcopenia,

if CHI 60-<80%(class-II), there is mild protein depletion, if CHI 40- < 60% (class III), there is moderate protein depletion and if CHI < 40 %(class-IV), there is severe protein depletion.
Subjective Global Assessment score a well-recognised subjective status was calculated as per Hasse's modified questionnaire. [13] All patients were classified in to SGA A, SGA B, or SGA C based on the score. SGA 'A' is well nourished, 'B' is mild to moderately malnourished, 'C' is severely malnourished.
These parameters were compared with each other, with CTP score, ECOG score, CHI (classified as A, B, C&D) and the complications occurring in these patients at the index assessment. Patient performance status using ECOG Patient guided scores were recorded ranging from 0 to 4.

MELD and MELD-Na were calculated as per standard formula given below: - MELD = 3.78×ln[serum bilirubin (mg/dL)] + 11.2×ln[INR] + 9.57×ln[serum creatinine (mg/dL)] + 6.43; [10]
- MELD Na = MELD − Na − [0.025 × MELD × (140 − Na)] + 140.
**Sodium < 125 is calculated at 125. Sodium > 140 is calculated at 140

Data was analysed descriptively using the Statistical Package for Social Sciences (SPSS ® Inc., Chicago, IL), version 21, and Microsoft Office Excel Professional 2013 ®. All the quantitative data were expressed in mean ± SD. Spearman's Rank correlation coefficient was used to summarise the strength and direction (negative or positive) of a relationship between two variables. ANOVA (Analysis of variance), Independent t-test were used for variance and significance testing. Fisher's exact test used for statistical significance and in the analysis of contingency tables. ROC (Receiver Operating Characteristic) curve was used to demonstrate connection between clinical sensitivity and specificity and to choose the most appropriate cut-off for an assessment tool. considered $p < 0.05$ as significant.
Results
57 out of 108 patients of cirrhosis were included in the study with NASH being major aetiology next only to alcohol, and most of them in 4th and 5th decade of life with male predominance. All patients were right hand dominant, average duration of alcohol consumption among alcoholic cirrhosis was 192.30 ± 92.64 months, with a mean consumption of 1743.87 ± 1325.17 gm/month (approx. 58 gm/day). Diagnosis of Cirrhosis was made within a year's duration in nearly half (45.61%) of patients.
Subjective global assessment (SGA) score was used to categories patients according to nutritional status from well-nourished to severely malnourished, another subjective scale ECOG performance status was used to compare nourishment and performance status alongside disease severity and the results significantly correspond to each other **(table 1)**.

Table 1: Tabulation of patient distribution in Subjective Global Assessment class compared to Child–Turcotte–Pugh (CTP) class, ECOG performance status

CTP Class		**SGA Class**		**Total**	**p value**
		A	**B+C***		
A	**N**	**10**	**0**	10	**<0.00001** (For SGA A, B+C & CTP A, B+C)
	%	17.54	0	17.54	
B+C*	**N**	**11**	**36**	47	
	%	19.29	63.1	82.45	
ECOG Score					

0	**N**	**9**	**1**	10	**<0.0003** (for SGA A, B+C & ECOG 0, ≥1
	%	15.79	1.75	17.54	
≥1	**N**	**12**	**35**	47	
	%	21.05	61.40	82.45	

* B+C of SGA and CTP class were clubbed to compare with well-nourished counterpart to observe significant correlation

Significant correlation with good strength of association could be drawn among assessed values and disease severity on MELD and MELD-Na scores except for Dry Weight BMI and PMTH **(table 2).**

Table 2: Spearman's rank correlation of MELD and MELD-Na with Assessment parameters

Serial no.	Parameter	Spearman's Rho (p value) for MELD	Spearman's Rho (p value) for MELD – Na
1	HGS dominant	-0.242 (**0.069)**	-0.196 (0.143)
2	HGS non dominant	-0.364 (**0.005**)	-0.3(**0.023)**
3	MAC Right	-0.311(**0.018**)	-0.331(**0.011)**
4	MAC Left	-0.272 (**0.04**)	-0.331(**0.011)**
5	TSFT Right	0.014(0.913)	-0.036(0.788)
6	TSFT Left	0.062 (0.641)	0.02(0.881)
7	MAMC Right	-0.347(**0.008)**	-0.348(**0.007)**
8	MAMC Left	-0.298 (**0.023)**	-0.312(**0.017)**
9	Dry weight BMI	-0.183(0.171)	-0.271(**0.041)**
10	CHI	-0.443 (0.**0005)**	-0.403(**0.001)**
11	PMTH	-0.097 (0.614)	-0.025(0.896)

Analysis of methods for nutrition assessment in study group:

Significant variance observed only in male population which comprised of 82.4% of the study group, but not in female population with a low sample size. Hand grip strength indicated in males had significant difference in average values in both dominant and non-dominant hands in each group with a highest value in SGA A (dominant $\bar{x}$ = 31.49 ± 5.10; non dominant $\bar{x}$= 28.38 ± 5.15) to lowest in severely malnourished SGA C ($\bar{x}$ = 20.34 ± 4.55; non dominant $\bar{x}$= 16.89 ± 4.04) and mild malnutrition group SGA B observing values in between both. Females as expected had lower average values compared to their male counterpart with ample difference between malnourished group SGA B and C compared to well-nourished SGA A. Anthropometric data had significant variance in values of each group in MAMC in male patients, with decreasing average values from SGA A (Right $\bar{x}$ = 22.17 ± 2.15; Left $\bar{x}$ = 22.04 ± 2.12) to SGA B (Right $\bar{x}$ = 20.40 ± 2.56; Left $\bar{x}$ = 20.14 ± 2.39) and lowest in SGA C (Right $\bar{x}$ = 19.14 ± 3.27; Left $\bar{x}$ = 18.94 ± 3.01). MAC, TSFT and dry weight BMI values were not significantly varied between these groups in both males and females. Even the average observed values were not low in malnourished group. PMTH values of only 29 patients (50.87%) could be obtained, of these only 5 were of females and hence it would have been inappropriate to compare such a low sample size. Males with a PMTH sample size of 25 showed a good significant variance in between groups of well-nourished and malnourished

with average highest value in SGA A ($\bar{x}$ =21.68 ± 2.80), lowest in SGA C ($\bar{x}$ = 18.21 ± 3.08) **(table3)**.

Table 3: Tabulation of Hand Grip Strength (HGS) - sex specific means with SD [ANOVA analysis with F-test in males, Independent T-test in females]

Parameter	**SGA in males**				**SGA in females**		
	A	**B**	**C**	**F-ratio (p value)**	**A**	**B+C**	**t value (p value)**
HGS-dominant hand Kg/F(mean±SD)	31.49 ± 5.10	26.63 ± 4.42	20.34 ±4.55	23.78 (**<0.00001**)	21.57 ±4.51	16.62 ±6.29	1.35 (0.213)
HGS-non dominant hand Kg/F(mean±SD)	28.38 ± 5.15	21.86 ± 3.22	16.89 ±4.04	30.64 (**<0.00001**)	18.51 ±4.25	14.2 ±5.38	1.33 (0.217)
MAMC (right arm)	22.17 ±2.15	20.40 ± 2.56	19.14 ±3.27	5.32 (**0.00847**)	20.53± 3.07	18.16± 3.40	1.11 (0.295)
MAMC (left arm)	22.04 ± 2.12	20.14 ± 2.39	18.94 ±3.01	6.39 (**0.00365**)	20.15± 3.25	18.82± 3.21	0.636 (0.542)
MAC (right arm)	25.35 ± 2.57	23.54 ± 2.76	22.76 ±2.87	3.98 (0.25737)	24.5 ±3.11	20.83± 4.02	1.53 (0.163)
MAC (left arm)	25.15 ± 2.54	23.27 ±2.67	22.62 ±3.13	3.69 (0.32741)	24.00± 3.37	20.5 ±4.03	1.42 (0.191)
TSFT (right arm)	10.15 ± 2.21	10.00 ±1.87	11.53 ±3.51	1.58 (0.21637)	12.63± 1.11	8.5 ±3.39	2.31 (**0.049**)
TSFT (left arm)	9.88 ± 2.35	9.96 ±1.80	11.71±3.53	2.34 (0.10785)	12.25± 0.96	8.5 ±3.33	2.15 (0.634)
Dry weight BMI	25.06 ± 3.52	24.58 ± 3.85	22.38 ±3.94	2.38 (0.10371)	25.98± 4.38	24.27± 5.35	0.536 (0.605)
PMTH	21.68 ± 2.8	19.50 ± 1.96	18.21± 3.08	3.64 (**0.04302**)	-	-	-

Creatinine height index (CHI), a non-sex specific marker of sarcopenia per se malnutrition had significant variance between each SGA groups on ANOVA. The average value in SGA C ($\bar{x}$ = 45.16 ± 26.79) were lowest signifying severe sarcopenia, compared to moderate in SGA B ($\bar{x}$ = 53.99 ± 9.04) and mild in SGA A ($\bar{x}$ = 71.32 ± 8.26). And at a cutoff value at 80%, 91.22% patients (n=52) were diagnosed of having sarcopenia ranging from mild to severe.

Youden's index with receiver operating characteristic (ROC) curve to obtain best cutoff values for each assessment tool observed highest sensitivity at 94.44% with a specificity of 90.47% for CHI, and Handgrip strength of non dominant hand had more reliable results compared to dominant handgrip strength **(table 4)**.

Table4: Summary of significant assessment parameters

SL.NO.	Parameter	Sample size	Best cutoff value	Sensitivity %	Specificity %	p value	False positive	True positive
1	HGS (dominant hand)	47	30.7 Kg/F	84.84	85.71	<0.001	(5) 10.63	(28) 59.57
2	HGS (non dominant hand)	47	26.78 Kg/F	87.87	92.85	<0.001	(4) 8.51	(29) 61.70
3	MAMC (Right hand)	47	21.045 cm	88.00	63.63	<0.008	(3) 6.38	(22) 46.80
4	MAMC (Left hand)	47	21.045 cm	85.18	65.00	<0.003	(4) 8.51	(23) 48.93
5	PMTH	25	19.99mm/M	78.57	81.81	<0.043	(3) 12.00	(11) 44.00
6	CHI	57	61.69 %	94.44	90.47	<0.001	(2) 3.50	(34) 59.64
7	Albumin	57	2.65 g/dL	86.95	52.90	<0.001	(3) 5.26	(20) 35.08

Comparison of nutrition status between alcoholic and non alcoholic cirrhosis:
We had only 1 female patient with alcohol aetiology in our study group, hence to eliminate gender bias we studied only male population and compared nutritional status among them on basis of aetiology as alcohol and nonalcohol aetiology group. The mean values of malnourished patients in both groups when compared depicted lower average values in Handgrip strength, anthropometric data in alcoholic cirrhosis malnourished group though a significant variance between these groups could not be achieved, which may be attributed to fact that there was a high difference in the study population size with alcohol aetiology (male) sample size being 80.85%(n=38) and other aetiologies (male) accounting for only 19.14%(n=9). **(table 5)**

Table 5: Alcoholics and non-alcoholics with malnutrition- Sex specific assessment parameters analysed on Independent T test.

Parameter	Alcoholic males	Non Alcoholic males	t value (p value)
	SGA B+C	SGA B+C	
HGS(dominant hand)	22.74 ± 5.31	26.01 ± 6.95	-0.987 (0.331)
HGS(non dominant hand)	18.67 ± 4.13	22.39 ± 6.57	-1.401(0.172)
MAMC(right arm)	19.68 ± 3.13	19.75 ± 1.64	-0.040(0.967)
MAMC(left arm)	19.46 ± 2.92	19.46 ± 1.19	-0.0004(0.999)
MAC(right arm)	23.11 ± 2.94	23.00 ± 1.00	0.064(0.949)
MAC(left arm)	22.94 ± 3.06	22.50 ± 0.50	0.247(0.806)
TSFT(right arm)	10.93 ± 3.08	10.33 ± 2.08	0.322(0.749)
TSFT(left arm)	11.09 ± 3.07	9.67 ± 2.31	0.776(0.444)
Dry weight BMI	23.26 ± 4.20	23.95 ± 0.91	-0.269(0.789)
PMTH	18.85 ± 2.87	18.30 ± 0(n=1)	----------

Discussion

The most common cause of cirrhosis in the study group was alcohol (63.15%), NASH being the second major aetiology. Not to our surprise similar to other Indian studies like Mukherjee S Partha et al [14] (2017) and Madan K et al [15] (2016) men were majority in alcohol aetiology group with only 1 woman had cirrhosis related to indigenous alcoholic drink "Handia" a fermented rice beer with alcohol percentage of 1.21 ± 0.98. Our diseased population with alcohol aetiology had mean duration of consumption at about 16 years with a high range of 8yrs to 44yrs and average of 56 ± 46 gm/day of alcohol.

The prevalence of malnutrition as per Subjective global assessment score was as high as 63.84%, which is in agreement with other studies like carvalho et al [16] (75.3%), Gunsar F et

al (57%), while Goncalo nunes et al [17] (41%).35.08% of the study group were severely malnourished even though majority of our patients were of middle socio-economic status. Cirrhosis patients with alcohol as aetiology were more prone for Protein calorie malnutrition and a fact that alcohol was the major aetiology in our study group and majority of them had ascites, in addition to only inpatients being included, raised the prevalence of malnutrition similar to other studies.
ECOG performance status, which is commonly used in cancer patients including hepatocellular carcinoma is not very well studied in cirrhosis patients, was also in compliance with SGA scale, with a significant correlation and decrease in ability to performance of daily usual activities as before the diagnosis of the disease, which is analogous to study by N Bakshi et al. [18]

As like CTP, MELD and its modified version MELD-Na, have been known to predict survival rate and disease severity and our patients had a good correlation negatively with nutrition when assessed on handgrip strength, CHI, anthropometric measurements like MAMC, MAC. Muscle strength and functional quality measured on handgrip strength of a non dominant hand showed decent negative correlation compared with dominant hand, similar results were reported by Hassan et al (2016) study [19].
Hand grip strength which has been utilised by and large as a measurement tool of muscle strength and functional quality in general population had significant correlation with high variance was observed in different groups of malnourished patients in our study. And also, the mean average strength of either hands independently was less in SGA B (mild malnutrition) group and least in SGA C (severe malnutrition) group compared to well-nourished group of patients. Measurements of non-dominant hand grip strength had a better significant value and correlation in comparison to dominant hand on the scale of severity with MELD, MELD-Na scores and malnutrition status on SGA scale. This may be attributed to a fact that regional muscle strength and quantity has a multifactorial dependency, and its strength significantly affected by training and use. whereas non dominant hand is largely unaffected by persons daily activity. The average mean values in each group for hand grip strength can be very well compared to other studies by Narayan L et al, [20] Silva et al, [21] and the values were profoundly less than age and sex correlated normative values in Indian population in mild to severe malnutrition.

The anthropometric values except for TSFT elucidated significant variation in different SGA groups with average values lowest in SGA C, reinforcing the fact that hypoalbuminemia and skin oedema are “part and parcel” of cirrhosis, and which would inherently alter the skin calliper readings. BMI which is a simple, most widely and commonly used index for screening nutritional status in general population failed to command any meaningful results in our study population, in spite of deducting proportionate weight to commensurate ascites and oedema, as was applied in by Campillo et al(2003), Huisman et al (2011). [22,23] This highlights the intention of this study to identify additional parameters which can be more reliable to diagnose malnutrition in cirrhosis.
24 hr urine creatinine height index values have been used as early as 1960’s as a method to indirectly quantify somatic protein (muscle) mass, though its accuracy is still not strongly validated in cirrhosis let alone normal population.
Imaging studies have proven its robustness in reproducibility, prediction and diagnosis in many diseases since the era of introduction of X-ray. Our study included CT scan imaging to estimate “Psoas muscle thickness per height”, a new approach for quantifying muscle mass which has not yet strongly established its usefulness. Our study proved significant contrast values among different groups of nutrition classes on SGA scale with lowest mean values in SGA C

group(severely malnourished). Though our study beholds its effectiveness in detecting malnutrition, further population specific larger studies are needed to validate its usefulness. To mention, our patient group had a higher sex specific cut off values for diagnosing sarcopenia per se malnutrition, compared to earlier studies by Dae Hoe Gu et al, [25] Francois Durand et al, [26] which can be attributed for being a study of different region, race and also our analysis included a low sample size of only male cirrhosis patients.

Malnutrition is more pronounced in cirrhosis with alcohol as an aetiology compared to other aetiologies, this being congruent with earlier studies like Panagaria et al (2006). [27] Our study detected a low average values of hand grip strength, MAMC in alcoholic cirrhosis. Though a significant variation could not be proved due to high variation in sample size between alcoholic and non alcoholic cirrhotics.

This study reinforces our understanding about anthropometric measurements though being useful in general population, can vary with patient's volume overload status and can produce distorted results. Imaging studies like measurement of Psoas muscle thickness on CT scan are sophisticated, costly and can put patient at risks of radiation, hence could only be used if patient anyway requires an abdominal CT scan study for other purposes. Others like hand grip strength particularly of nondominant hand which is easy cost effective bedside procedure had given promising results in our study and could very well be useful as a screening tool for nutrition status.

Conclusions

There is a high prevalence of malnutrition in cirrhosis, more pronounced in alcohol aetiology. Creatinine height index in our study had a high tenacity on sensitivity and specificity, but cost, accessibility and tedious process stand to its disadvantage.

ECOG performance status, an easy patient guided subjective tool can be useful for as an adjunct for screening malnutrition and grading disease severity in cirrhosis. Psoas Muscle Thickness per Height (PMTH) as a objective tool for malnutrition diagnosis and categorization requires larger population specific studies. In cirrhosis anthropometric measurement including dry weight BMI cannot be relied upon as a screening tool for diagnosis of malnutrition status. Hand grip strength of a nondominant hand by dynamometer is one of the easiest, cost effective, bed side, objective tool available to diagnose and grade malnutrition.

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Legends for the figures

Fig 1: Digital Hand dynamometer