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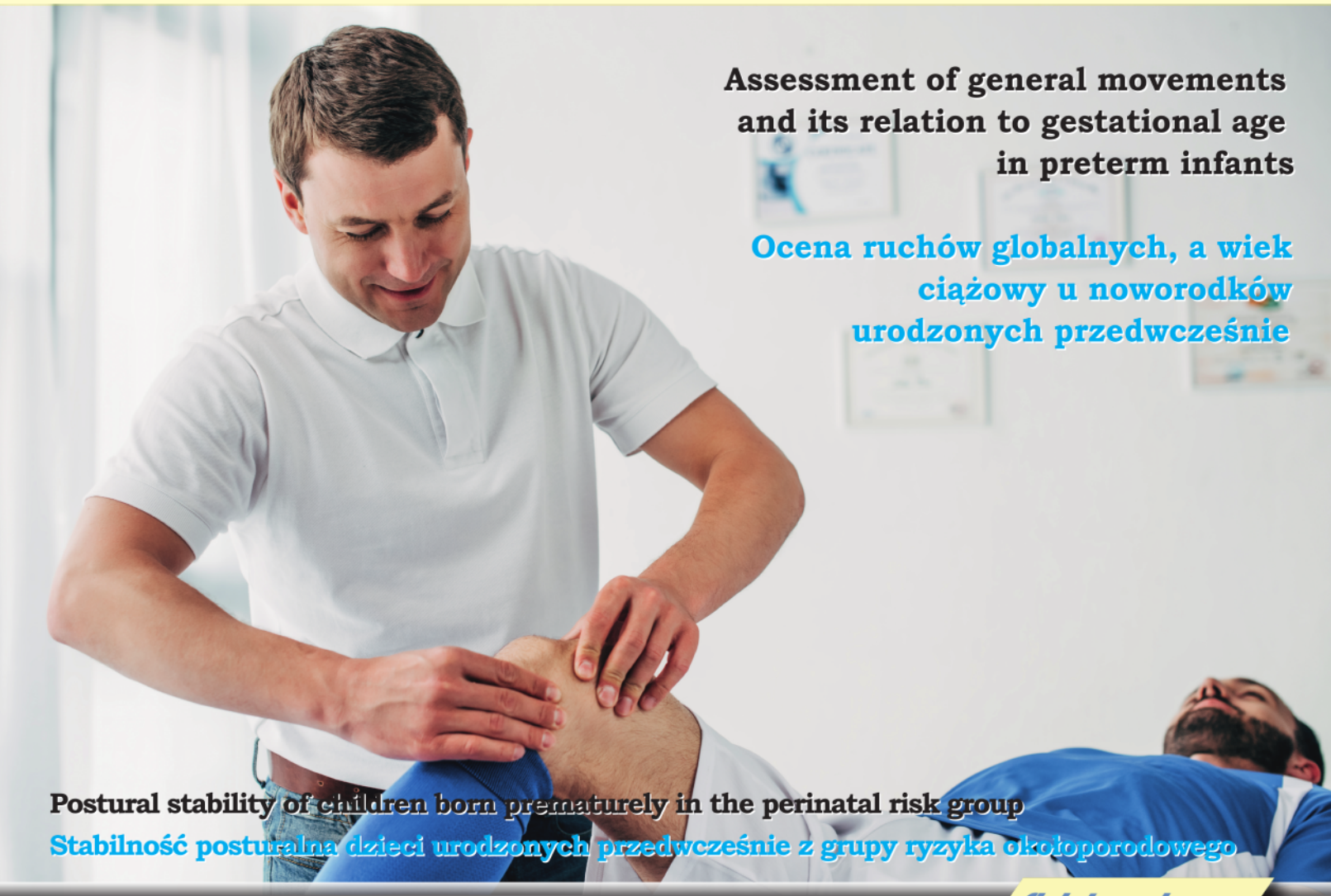

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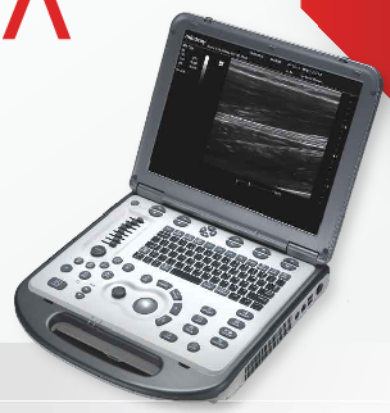

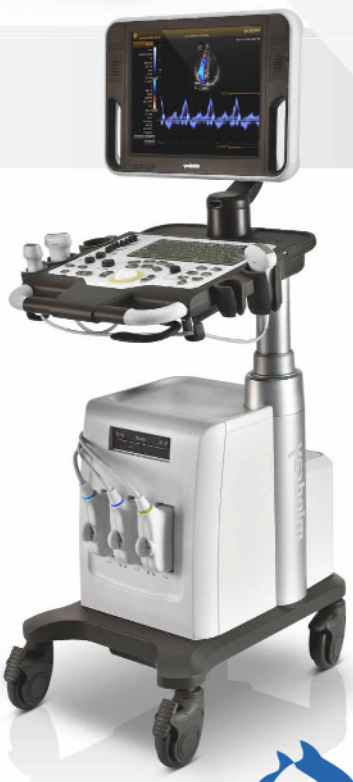

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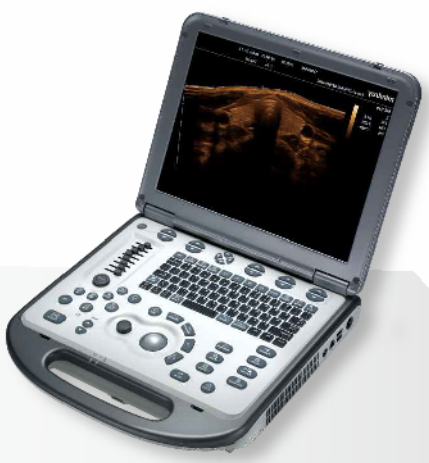

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Assessing the severity of sarcopenia in cirrhotic patients independent to conventional prognostic scores

Ocena nasilenia sarkopenii u pacjentów z marskością wątroby niezależnie od konwencjonalnej punktacji prognostycznej

Elham Mohamed Sobhy[1(A,E,F)], Heba Mahmoud Mohamed[1(B,C,D,E,F)], Heba Ahmed Kamal[2(A,E,F)], Nevien Ezzat Elliethy[2(A)], Mohammed Sayed Hassan[1(A,E,F)]

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Abstract

Purpose. To assess the severity of sarcopenia in liver cirrhosis patients by comparing them to control participants and determining its relation to conventional prognostic scores for liver cirrhosis, such as (CTP and MELD) scores.

Methods. This prospective observational study was conducted on 101 cirrhotic patients and 30 healthy participants aged (40–70 y.o.). Mid upper arm circumference (MUAC) and HGS were measured. BMI, Nutrition risk sore (NRS), Child-Pugh and MELD scores were calculated. CT L3 psoas volume, surface area and psoas muscle index (PMI) were measured. Ultrasonography was used to assess mid-upper arm and mid-thigh. Quadriceps muscle index (QMI) was calculated. It was determined how long the patient would be admitted to the hospital.

Results. According to the HGS cutoff established by the Foundation for the National Institutes of Health (FNIH), 87 percent of the patients were sarcopenic. Psoas muscle index (PMI) was (4.6 for male, 3.19 cm/m for female) and Quadricepes muscle index (QMI) cutoff was (1.67 for male, 1.58 cm/m^2 for female) based on the FNIH HGS cutoff. CT L3 Psoas and ultrasound parameters showed significant negative correlation with (Child and MELD) scores, duration of hospital stay and NRS. Also, they showed a significant positive correlation with HGS. We found a positive correlation between PMI and QMI with ($p < 0.001$). AUC in Roc analysis for QMI considering sarcopenia by PMI was 0.9.

Conclusion. Sarcopenia, as measured by CT psoas, ultrasonography, and HGS in cirrhotic patients, is an independent predictor of liver disease severity. USG and HGS are bedside methods that are as sensitive as CT for assessing sarcopenia.

Key words:

Sarcopenia, cirrhosis, CT L3 psoas, ultrasonography, HGS

Streszczenie

Cel. Ocena nasilenia sarkopenii u pacjentów z marskością wątroby poprzez porównanie ich z grupą kontrolną i określenie jej związku z konwencjonalnymi skalami prognostycznymi marskości wątroby, takimi jak (CTP i MELD).

Metody. Niniejsze prospektywne badanie obserwacyjne przeprowadzono na 101 pacjentach z marskością wątroby i 30 zdrowych osobach w wieku 40–70 lat. Mierzono obwód ramienia środkowego (MUAC) i HGS. Obliczono BMI, oceniono ryzyko związane ze stanem odżywienia (NRS), oraz obliczono wyniki w skali Child-Pugh i MELD. Mierzono objętość i powierzchnię mięśnia lędźwiowego CT L3 oraz wskaźnik mięśnia lędźwiowego PMI (psoas muscle index). Do oceny ramienia środkowego i uda wykorzystano ultrasonografię. Obliczono wskaźnik mięśnia czworogłowego (QMI). Ustalono, na jak długo pacjent będzie przyjmowany do szpitala.

Wyniki. Według wartości granicznej HGS ustanowionej przez Fundację na rzecz Narodowych Instytutów Zdrowia (FNIH), 87% pacjentów miało sarkopenię. Wskaźnik mięśnia lędźwiowego (PMI) wyniósł 4,6 dla mężczyzn, 3,19 cm/m^2 dla kobiet, a wartość graniczna wskaźnika mięśnia czworogłowego (QMI) wyniosła 1,67 dla mężczyzn, 1,58 cm/m^2 dla kobiet na podstawie wartości granicznych FNIH dla HGS. CT L3 mięśnia lędźwiowego i parametry USG wykazały istotną ujemną korelację z wynikami w skali Child i MELD, czasem pobytu w szpitalu i NRS. Wykazały również istotną pozytywną korelację z HGS. Stwierdziliśmy dodatnią korelację między PMI a QMI przy $p < 0,001$. Krzywa AUC w analizie Roc dla QMI z uwzględnieniem sarkopenii wg PMI wyniosła 0,9.

Wniosek. Sarkopenia mierzona za pomocą tomografii komputerowej mięśnia lędźwiowego, ultrasonografii i HGS u pacjentów z marskością wątroby jest niezależnym predyktorem nasilenia choroby wątroby. USG i HGS to metody przyłóżkowe, które są równie czułe jak TK do oceny sarkopenii.

Słowa kluczowe

sarkopenia, marskość wątroby, CT L3 mięśnia lędźwiowego, USG, HGS

Introduction

Sarcopenia is common feature of malnutrition in patient with liver cirrhosis and is an independent predictor of morbidity and mortality in this setting [1-2]. Sarcopenia in cirrhosis is multifactorial, including inadequate dietary intake, metabolic disturbance and malabsorption [3]. Conventional prognostic scores for patients with cirrhosis, such as the Child-Turcotte-Pugh (CTP) score or the model for end-stage liver diseases (MELD) scores have limitations, including the lack of nutritional assessment [4]. It was suggested that sarcopenia adds to the prognostic value of (MELD) scoring system [5]. Numerous tools of nutritional assessment have been introduced, such as body mass index (BMI), anthropometric measurement and subjective global assessment have been introduced, but their utility is limited due to the impact of body composition in cirrhotic patients with edema or ascites [6]. The Recent European consensus Statement has identified computerized tomography (CT) as a gold standard technique for detection of sarcopenia [7].

Measuring psoas muscle or total abdominal muscle area on single abdominal CT cross section at L3 is associated with whole body muscle mass and is an impressive noninvasive marker of sarcopenia in patients with cirrhosis [8]. Ultrasound is a non-invasive, portable and safe imaging technique [9]. Ultrasound has been shown to be an excellent method of determining appendicular lean muscle mass (aLM) [10]. HGS has been found to be a promising screening tool for malnutrition and an indicator of sarcopenia [11].

Patients and methods

Design

An observational prospective study was conducted to assess the severity of sarcopenia in liver cirrhosis patients who were admitted to our hospital from November 2017 to December 2018. Research Ethics Committee before study commencement [No. I-171016].

Participants

One hundred and one liver cirrhosis patients and 30 healthy participants ageds (40–70 years) were classified according to Child score into 2 groups: (Child A 6, Child B 20) and Child C (75). Because the majority of the patients admitted to our hospital were Child C patients (Child score ≥ 10), data from Child A and Child B patients (Child score 6–9) were analyzed as a single group in comparison to the Child C patients. Thirty control participants who were recruited based on the Malnutrition Universal Screening Tool (MUST) to compare all parameters of the patients with healthy participants for ethnic consideration. Inclusion criteria included adult patients who had previously been diagnosed with liver cirrhosis via biopsy or abdominal ultrasound, were admitted to our hospital for any liver cirrhosis complications. We assessed all patients after stabilization of general condition. Exclusion criteria included history of other end organ failure that interferes with nutritional status, as well as malignancies. Informed consent was obtained from every patient about the research. The patients were subjected to the following clinical and laboratory assessments: History taking and a full physical examination (including BMI, and anthropometric measurements) were done. Body Mass Index (BMI): The dry weight was taken into consideration while calculating the BMI. Dry weight is subjective estimation of a patient's weight without ascites or lower limb edema [12]. It was calculated based on the degree of ascites and existence of LL edema (any level) as following: In the presence of mild ascites we subtracted 5% of actual body weight, while in moderate ascites we subtracted 10% the of actual body weight and tense ascites, 15% of the actual bodyweight was subtracted. In the presence of lower limb edema with any degree of ascites, additional 5% of actual weight was subtracted. Laboratory investigations, including liver function, were (alanine aminotransferase (ALT), aspartate aminotransferase (AST), albumin, total bilirubin, direct bilirubin, INR), and renal function (urea, creatinine). The Child and MELD scores were calculated. The Nutritional risk score (NRS) is calculated to assess its ability to identify the nutritional risk of hospitalized patients with chronic liver disease [13].

Imaging Assessment of sarcopenia by measurement of muscle mass

Computed tomography (Figure 1)

We used Siemens emotion 16 CT scan and cross sectional CT images of psoas muscle at L_3 region was assessed, psoas muscle is quantified using tube voltage of 130 kV, tube current 50-200 mA, exposure time: 100-300 mAs, slice thickness 10 mm, tissue-specific Hounsfield unit thresholds of −30 to +200 to separate muscle tissue from fat tissue or bone. Volume of psoas muscle (cm^3) at CT at L_3 was assessed. Furthermore, using the Ultima programme, cross-sectional area (cm^2) was computed automatically by summing tissue pixels and multiplying them by the pixel surface area. L_3 psoas muscle Index (PMI) was calculated as sum of both Rt and Lt cross-sectional psoas muscle area/height^2 (m^2) [14].

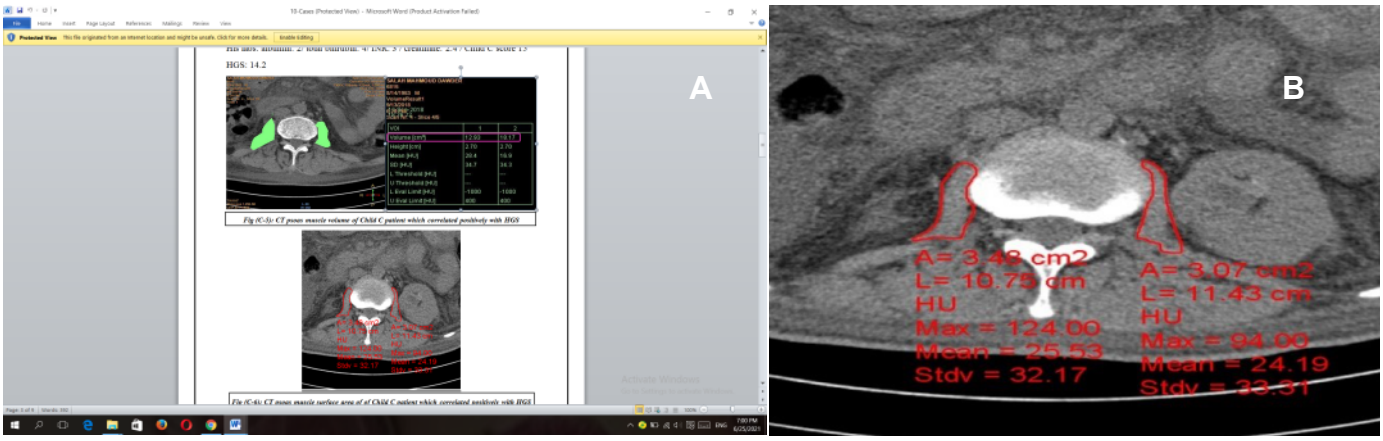

Figure 1. CT psoas volume (A) a surface area (B) of Child C patient

Ultrasonography (Figure 2)

It was measured using a B-mode HDI-5000 ultrasound machine (Philips HD11XE) with a broadband linear array transducer and at a frequency of 5–7.5 MHz. Muscle thickness was measured on both sides without compression 15. While the patient is relaxed and supine at the following two points: Anterior mid arm point: the point was determined at the flexor surface of the arm while the forearm is supinated, corresponding to the point midway between the tip of the acromion and tip of the olecranon. The thickness of the flexor compartment was measured between the superficial fat-muscle interface and the humerus. Anterior mid-Thigh point: with the knee extended, the midway point between the anterior superior iliac spine and the upper border of the patella was identified and the thickness of the quadriceps muscle group between the superficial fat-muscle interface and the femur was measured anteriorly. Also quadriceps muscle index (QMI) was calculated as sum of both muscle thickness RT and LT cm/height^2 (m^2).

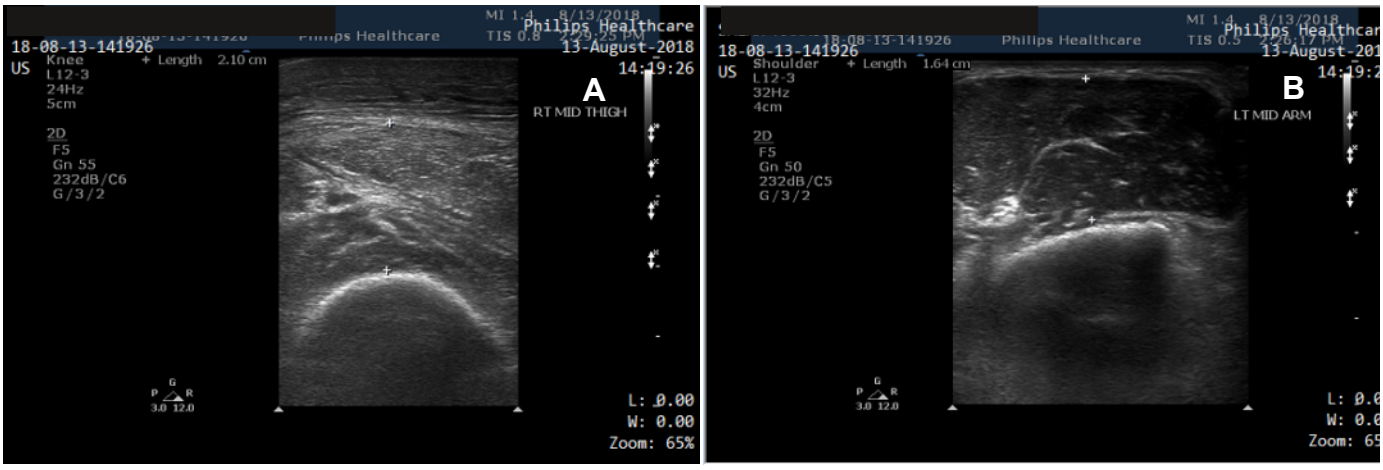

Figure 2. USG mid -upper arm A and mid –thigh B of Child C patient

Assessment of muscle function

Hand Grip strength (HGS)

It was measured using hand grip dynamometry. The test was repeated 3 times for each hand separately, and then the highest record value was used as an indicator of patient's performance. Then the results were compared with the normal values for age and sex. Using FNIH HGS cutoff, we divide patients into weak and non-weak to assess cutoff value of PMI and QMI.

Statistical methods

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 25 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired t test when comparing 2 groups and analysis of variance (ANOVA) with multiple comparisons post hoc test when comparing more than 2 groups. For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. Correlations between quantitative variables were done using Pearson correlation coefficient. P-values less than 0.05 were considered as statistically significant. ROC curve was constructed with area under curve analysis performed to detect best cutoff value of QMI, using cut off value of HGS and PMI for detection of sarcopenia.

Results

Patient characteristics: Baseline demographic, clinical and laboratory data of studied groups is shown in Table 1. A total of 101 LC patients who met the inclusion and exclusion criteria were enrolled for the final analysis. The average age was 61.81 ± 5.82 years in Child A,B group and 58.63 ± 7.33 in Child C group. The average BMI was 20.59 ± 1.69 in Child A,B group and 18.27 ± 0.80 in Child C group. HCV was the most common cause of underlying liver disease (86 patients). Hematemsis was the most common cause of admission in our group of patients (72 patients). The anthropometric measurements of Child-Pugh groups (dry weight, BMI, MUAC) differed significantly between patients and control as well as between both groups of patients (P value $<$ 0.001). The average calculated NRS was 2.42 ± 0.86 in Child A,B group and 4.05 ± 0.77 in Child C group. The average MELD score was 11.58 ± 3.19 in Child A,B group and 22.41 ± 6.71 in Child C group.

Table 1 demographic, clinical and laboratory data

	Child A,B N (26)	Child C N (75)	Control N (30)
Age:			
< 60	8	46	14
> 60	18	29	16
Sex [Male/Female]	19/7	36/39	16/14
Cause of admission:			
Hematemesis	24	48	
Hepatic coma	2	21	
SBP	0	5	
Hepto-renal	0	1	
Etiology:			
Hemochromatosis	0	1	
HCV	21	65	
HBV	0	5	
Bilharziasis	5	3	
Autoimmune	0	1	
Ascites:			
Tense	0	55	
Moderate	20	20	
Non	6	0	
ll edema:	20	74	
Present	6	0	
Non			
Age	61.81 ± 5.82	58.63 ± 7.33	59.67 ± 8.01
Albumin [mg/dl]	2.70 ± 0.34	2.06 ± 0.32	
INR	1.71 ± 0.16	2.35 ± 0.44	
Bilirubin [mg/dl]	0.97 ± 0.47	3.59 ± 2.97	
Creat [mg/dl]	0.97 ± 0.12		
dry wt [kg]	61.69 ± 7.54	51.73 ± 5.22	84.52 ± 12.45
BMI	20.59 ± 1.69	18.27 ± 0.80	28.21 ± 4.89
MUAC	28.31 ± 3.16	21.28 ± 3.47	33.45 ± 2.52
Hand grip	22.78 ± 6.36	14.88 ± 5.13	29.15 ± 7.50
NRS	2.42 ± 0.86	4.05 ± 0.77	
MELD	11.58 ± 3.19	22.41 ± 6.71	

Mean Psoas CT L_3 volume was 25.44 ± 6.96 cm^3 in Child A,B group while it was 15.85 ± 6.02 cm^3 in Child C group. Furthermore, Mean Psoas CT L_3 surface area was 7.97 ± 2.23 cm^2 in Child A,B group, whereas it was 5.02 ± 1.80 cm^2 in Child C group CT PMI was 4.58 ± 1.21 in Child A,B group while it was 2.96 ± 1.00 in Child C group, indicating that all Psoas CT L_3 parameters in Child groups were significantly lower in patients when compared to control and it was worst in Child C patients compared to Child A, B patients (P value < 0.001) (Table 2), Moreover they had a significant negative correlation with (Child, MELD, and NRS) scores and length of hospital stay with (P value < 0.001) (Table 3). We found that CT L_3 psoas volume on both sides showed significant positive correlation (p value < 0.001) with CT L_3 psoas surface area and CT PMI.

Table. 2. CT psoas at L3 volume, surface area and psoas muscle index in Child groups

	Child A,B Mean ± SD	Child C Mean ± SD	Control Mean ± SD	P value
RT CT Psoas Volume	25.12 ± 6.87	15.64 ± 6.03	30.06 ± 9.85	< 0.001
LT CT Psoas volume	25.76 ± 7.11	16.06 ± 6.09	30.69 ± 10.52	< 0.001
Mean RT &LT CT Psoas Volume	25.44 ± 6.96	15.85 ± 6.02	30.38 ± 10.17	< 0.001
RT CT Psoas surface area	7.84 ± 2.15	4.99 ± 1.78	10.25 ± 2.32	< 0.001
LT CT Psoas surface area	8.11 ± 2.34	5.06 ± 1.89	10.50 ± 2.41	< 0.001
Mean RT&LT CT Psoas surface area	7.97 ± 2.23	5.02 ± 1.80	10.37 ± 2.34	< 0.001
CT PMI	4.58 ± 1.21	2.96 ± 1.00	5.94 ± 1.24	< 0.001

Table. 3. Ultrasound mid upper arm, mid-thigh muscle thickness and quadriceps muscle index

	Child A,B Mean ± SD	Child C Mean ± SD	Control Mean ± SD	P value
RT mid arm USG	1.98 ± 0.30	1.51 ± 0.26	2.69 ± 0.47	< 0.001
LT mid arm USG	2.02 ± 0.30	1.54 ± 0.25	2.73 ± 0.51	< 0.001
Mean RT&LT mid arm USG	2.00 ± 0.29	1.53 ± 0.25	2.71 ± 0.49	< 0.001
RT mid-thigh USG	2.89 ± 0.34	2.29 ± 0.45	3.81 ± 0.50	< 0.001
LT mid-thigh USG	2.96 ± 0.34	2.30 ± 0.46	3.86 ± 0.56	< 0.001
Mean RT &LT mid-thigh USG	2.93 ± 0.33	2.30 ± 0.45	3.83 ± 0.53	< 0.001
USG QMI [cm/m^2]	1.69 ± 0.17	1.36 ± 0.26	2.20 ± 0.28	< 0.001

It was interesting that CT L_3 psoas and ultrasound parameters showed a significant positive correlation with (p value < 0.001) (Table 4).

Table. 4 Correlations between USG and CT

		RT mid arm USG	LT mid arm USG	Mean RT& LT mid arm USG	RT mid-thigh USG	LT mid–thigh USG	Mean RT&LT mid–thigh USG	USG Quadriceps thickness index
RT CT Psoas Volume	R	0.920	0.897	0.917	0.909	0.861	0.896	0.823
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101
LT CT Psoas volume	R	0.918	0.914	0.925	0.905	0.885	0.906	0.832
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101
Mean RT&LT CT Psoas Volume	R	0.923	0.909	0.925	0.911	0.877	0.905	0.831
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101
RT CT Psoas surface area	R	0.907	0.887	0.905	0.901	0.857	0.890	0.824
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101
LT CT Psoas surface area	R	0.901	0.904	0.911	0.895	0.893	0.905	0.845
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101

		RT mid arm USG	LT mid arm USG	Mean RT& LT mid arm USG	RT mid-thigh USG	LT mid–thigh USG	Mean RT&LT mid–thigh USG	USG Quadriceps thickness index
Mean RT&LT CT Psoas surface area	R	0.913	0.905	0.917	0.907	0.884	0.907	0.843
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101
CT PMI	R	0.911	0.901	0.915	0.905	0.889	0.908	0.861
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101	101

Correlation with HGS: According to our finding, hand grip had a significant negative correlation with Child, MELD and NRS scores with (P value < 0.001) (Table7). All CT and ultrasound parameters had significant positive correlation with HGS. (Table 5, 6)

Correlation of CT, ultrasound and HGS with anthropometric measurements: CT L_3 psoas, ultrasound muscle thickness parameters on both sides and HGS showed significant positive correlation with anthropometric measurements (dry weight, BMI, and MUAC), with (p value < 0.001) (Table 5, 6).

Table. 5. Correlations between ultrasound parameters, (Child, MELD, and NRS) scores, hand grip, and length of hospital stay

		Child	MELD	NRS	MUAC	Hand grip	Length of hospital stay [days]
RT mid arm USG	R	−0.629	−0.516	−0.737	0.960	0.905	−0.522
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
LT mid arm USG	R	−0.654	−0.529	−0.756	0.944	0.893	−0.553
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
Mean RT&LT mid arm USG	R	−0.647	−0.528	−0.753	0.961	0.908	−0.543
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
RT mid-thigh USG	R	−0.597	−0.500	−0.707	0.893	0.890	−0.523
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
LT mid-thigh USG	R	−0.613	−0.534	−0.691	0.874	0.863	−0.568
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
Mean RT&LT mid- thigh USG	R	−0.613	−0.524	−0.707	0.894	0.887	−0.553
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
USG QMI	R	−0.602	−0.532	−0.661	0.838	0.812	−0.553
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101

Table. 6. Correlations between CT parameters, (Child, MELD, and NRS) scores, hand grip, and length of hospital stay

		Child	MELD	NRS	MUAC	Hand grip	Length of hospital stay [days]
RT CT Psoas Volume	R	−0.570	−0.488	−0.674	0.898	0.964	−0.498
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
LT CT Psoas volume	R	−0.582	−0.495	−0.678	0.899	0.971	−0.520
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
Mean RT&LT CT Psoas Volume	R	−0.578	−0.494	−0.679	0.902	0.971	−0.511
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
RT CT Psoas surface area	R	−0.555	−0.478	−0.638	0.886	0.951	−0.481
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
LT CT Psoas surface area	R	−0.570	−0.495	−0.644	0.883	0.960	−0.519
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
Mean RT&LT CT Psoas surface area	R	−0.568	−0.492	−0.648	0.893	0.965	−0.506
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101
CT PMI	R	−0.580	−0.516	−0.656	0.892	0.960	−0.521
	P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101

Sarcopenia defined by appendicular muscle thickness and PMI in our liver cirrhosis patients and its prevalence: We divided our patients into weak and non-weak according to muscle function using Foundation for National Institutes of Health (FNIH) cutoff value of hand grip (< 26 kg in male and < 16 kg in female) on ROC curve 16 Figure 3. 87% of patients were sarcopenic and cutoff value of muscle thickness assessed by ultrasonography (MUAC was (1.9 cm in male, 1.58 cm in female), mid-thigh muscle thickness was (2.9 cm in male, 2.6 cm in female) and QMI was (1.67 (cm/m^2) in male, 1.58 (cm/m^2) in female). Males had an AUC sensitivity of 79.5% and a specificity of 90.9%, while females had an AUC sensitivity of 97.7% and a specificity of 100%. Also, the cutoff value of PMI was detected using the FNIH cutoff value of hand grip and it was (4.66 (cm^2/m^2) in males, 3.19 (cm^2/m^2)) in females. Males had an AUC sensitivity of 84.1% and a specificity of 100%, while females had an AUC sensitivity of 93.7% and a specificity of 100%.In our group of patients, HGS revealed that roughly 86.1% of our patients were sarcopenic. Also we used CT L_3 psoas index cutoff value of Hamaguchi Y et al (6.36 cm^2/m^2 for males and 3.92 cm2/m2 for females) 17. to detect cutoff value of ultrasound muscle thickness (QMI) to detect sarcopenic patients which was (1.67 (cm/m^2) in male 1.58 (cm/m^2)) in female. Males had an AUC sensitivity of 79.5% and a specificity of 90.9%, while females had an AUC sensitivity of 97.7% and a specificity of 100%.

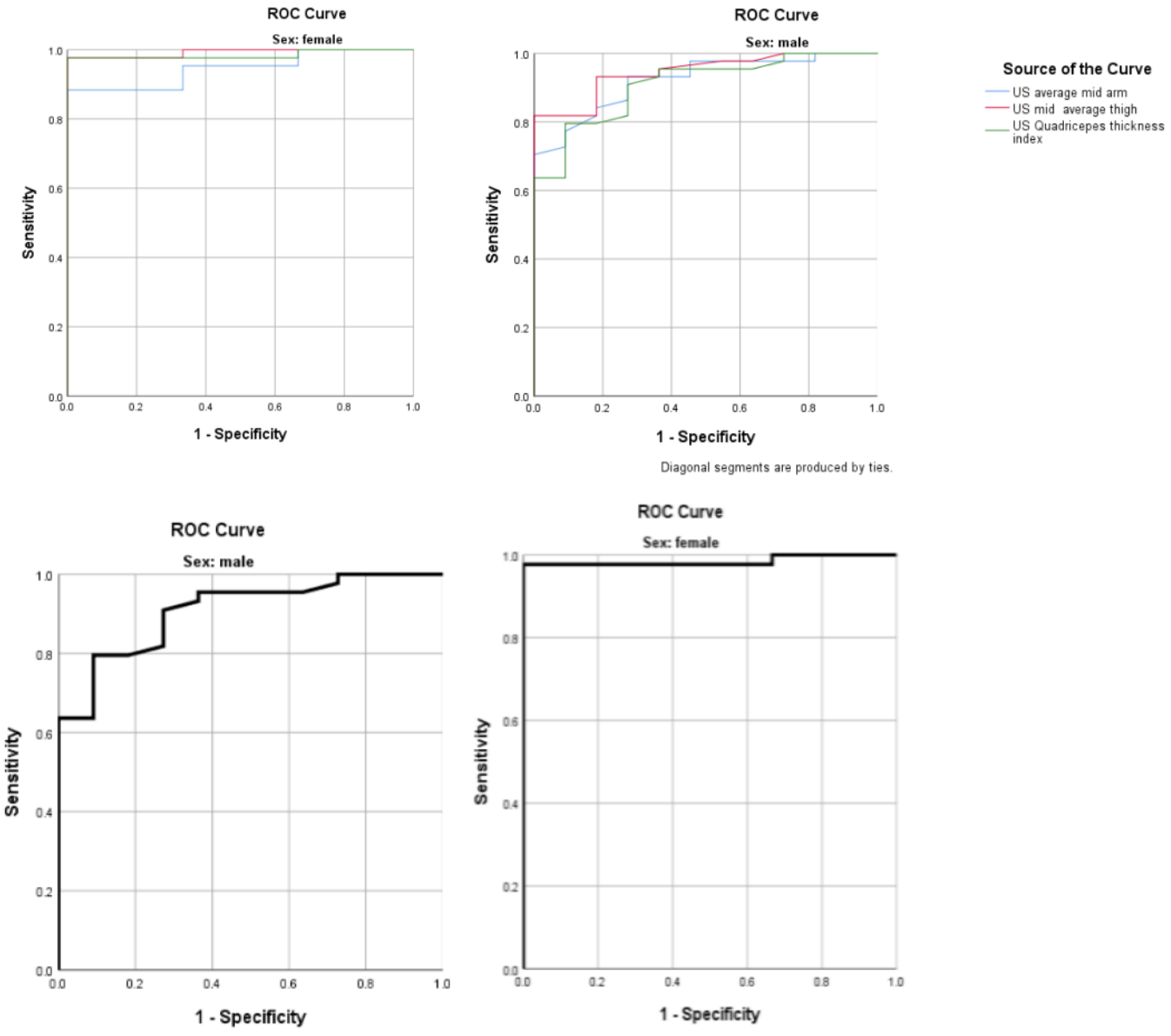

Figure 3. (A): Cut off value of male and female quadriceps index using cut off value of HGS (B):Cut off value of male and female quadriceps index using cut off value of CT L_3 psoas index

Correlation between methods which are used to assess severity of sarcopenia in liver cirrhosis and conventional prognostic score (Child and MELD scores): CT L_3 psoas, ultrasound muscle thickness parameters on both sides and HGS showed significant positive correlation with anthropometric measurements (dry weight, BMI, and MUAC), with (p value < 0.001) (Table 5, 6, 7).

Table 7. Correlation between handgrip, MAUC, BMI, MELD, Child, and NRS scores

		Hand grip MELD Child	NRS MUAC BMI				
RT CT Psoas Volume	Pearson Correlation	1	−0.463	−0.542	−0.645	0.878	0.726
	P value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	N	101	101	101	101	101	101

Discussion

Sarcopenia is one of the most common complications in patients with cirrhosis, which affects morbidity, mortality, and duration of hospital stay [18,19].

In our study, mean BMI and MUAC were lower in Child C with higher MELD than in Child A, B who had lower MELD score (P value < 0.001). Our study agrees with Teiusanu A, et al 20. which was a prospective analysis conducted on 176 hospitalized patients with cirrhosis, which found BMI, MUAC significantly positive correlation with disease severity score (Child and MELD scores).

Muscle mass quantification with CT cross-sectional imaging studies is an impressive index of nutritional status in cirrhosis as it is not biased by the fluid overload status that is frequently present in decompensated cirrhosis [21]. In our study, we were aiming at assessing the correlation between sarcopenia using CT Psoas, USG of appendicular muscle thickness, HGS and Child & MELD scores As a result, we found that CT Psoas muscle volume, surface area and psoas index were negatively correlated with (Child& MELD) scores, and length of hospital stay, while being positively correlated with BMI, MUAC and HGS.Our results are consistent with those of Gajula U and Murugan N [22] who conducted their study on 95 liver cirrhosis patients. CT L_3 PMI was assessed and compared with (Child, MELD) scores. PMI was significantly low in correlation with chronic liver disease severity as determined by Child score (P-value < 0.05) and with MELD score (P-value < 0.005). In addition, Kalafateli M, et al [23] had results that were similar to our study which included 232 cirrhotic patients who were transplanted at the Royal Free Hospital using L_3-PMI on CT. L_3-PMI was positively correlated with dry weight ($r = 0.403$, $P < 0.001$), BMI ($r = 0.34$, $P < 0.001$), MAC ($r = 0.396$, $P < 0.001$), HGS ($r = 0.382$, $P < 0.001$), and negatively correlated with MELD score ($r = 0.18$, $P = 0.007$). Patients with the lowest L3-PMI had longer ICU and hospital stays ($P = 0.006$).

In our study, ultrasound mid upper arm, thigh and quadriceps muscle index showed significant negative correlation (p value > 0.001) with disease severity assessed by (Child, MELD) scores and with NRS. Moreover, ultrasound parameters showed positive correlation with muscle function assessment by HGS. Mandill J, et al [24] had results similar to ours which was a prospective study conducted on 93 adult patients assessed for liver transplantation using ultrasound measurement of quadriceps muscle layer thickness (QMLT). These measures were correlated to Na-MELD and HGS. QMLT in male patients had significant negative correlation with Na-MELD ($p = 0.001$). In our study, we had significant negative correlation between QMLT and MELD, however we didn't evaluate their gender. Also they concluded that a Lower QMLT was associated with a lower HGS, with ($p = 0.001$).

Interestingly, in our study, there was a significant positive correlation (p value < 0.001) between CT psoas index at L_3 and ultrasound quadriceps muscle index. Similar to our finding, Gioia S, et al. [25] conducted a study on eighty-three cirrhotic patients who were evaluated for the role of quadriceps thickness pressure index (TPI) in the detection of sarcopenia in contrast to CT skeletal muscle index of cross sectional imaging of abdominal muscle at L3. They found a positive correlation between SMI and TPI ($p < 0.001$). TPI considering sarcopenia by SMI had an AUC of 0.79).This is similar to our study, we found AUC for QMI considering sarcopenia by PMI was 0.9, however the discrepancy between the two studies we didn't apply pressure on quadriceps muscle and we just examined PMI rather than entire all skeletal muscle in cross section.

Álvares-da-Silva MR and Silveira TR [26] suggested that in compensated and early decompensated cirrhosis, muscle strength measured by HGS should be used to evaluate for malnutrition and sarcopenia. In our study, HGS was positively correlated with CT L3 psoas parameters with (P value > 0.001). Michela G, et al. 27 conducted a study on fifty-nine patients listed for LT aimed to verify the association between muscle wasting, determined by CT scan and HGS. HG dynamometer failed to correlate significantly with CT (SMI) at L_3. It was in men (p value 0.73) and in women (p value 0.69), which contradicted our findings.

Strength

All previous research on sarccopenia evaluated CT psoas surface area and we also measured CT psoas volume, as well as correlating the two. We achieved the definition of sarcopenia by using methods which assess both muscle thickness and function and correlating them.

Limitations

This study requires a larger number of patients, particularly Child A and B, to confirm all of the cutoff values we concluded. Additionally, more researches are required to follow up the patients after they have been discharged from the hospital and to evaluate them for liver transplantation.

Conclusion

We found that sarcopenia in cirrhotic patients assessed by CT psoas, ultrasonography and HGS is an independent predictor of liver disease severity, and we met our study's goal when we discovered a significant correlation between these methods with Child and MELD scores. Moreover, it was impressive to correlate USG and HGS significantly with CT as these are simple, safe bedside techniques and to avoid radiation exposure.

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Piśmiennictwo/ References

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