ORIGINAL ARTICLE

The role of maximum compressed thickness of the quadriceps femoris muscle measured by ultrasonography in assessing nutritional risk in critically-ill patients with different volume statuses

Uğur Özdemir[1]
Merve Özdemir[2]
Gulbin Aygencel[3]
Burcu Kaya[4]
Melda Türkoğlu[5]

1 Internal Medicine specialist, Fellow of Critical Care Medicine. Division of Critical Care Medicine, Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Turkey
2 Department of Nutrition and Dietetics, Başkent University Faculty of Health Sciences, Ankara, Turkey
3 Professor of Internal Medicine, Critical Care Specialist . Division of Critical Care Medicine, Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Turkey
4 Internal medicine specialist, Fellow of Critical Care Medicine. Division of Critical Care Medicine, Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Turkey
5 Associate Professor of Internal Medicine, Critical Care Specialist .Division of Critical Care Medicine, Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Turkey

http://dx.doi.org/10.1590/1806-9282.65.7.952

SUMMARY

PURPOSE: *In this prospective observational study, we aimed to investigate the role of the maximum compressed (MC) and uncompressed (UC) thickness of the quadriceps femoris muscle (QFMT) measured by ultrasonography (USG) in the detection of nutritional risk in intensive care patients (ICPs) with different volume status.*

METHODS: *55 patients were included. Right, left, and total ucQFMT and mcQFMT measurements were obtained by a standard USG device within the first 48 hours after ICU admission. Clinical examination and the USG device were used to determine the volume status of the patients. SOFA, APACHE II, modified NUTRIC scores, and demographic data were collected.*

RESULTS: *There was a significant difference between the nutritional risk of patients in terms of left, right, and total mcQFMT measurements (p=0.025, p=0.039; p=0.028, respectively), mechanical ventilation requirement (p=0.014), presence of infection (p=0.019), and sepsis (p=0.006). There was no significant difference between different volume statuses in terms of mcQFMT measurements. In the multi-variance analysis, mcQFMT measurements were found to be independently associated with high nutritional risk (p=0.019, Exp(B)=0.256, 95%CI=0.082-0.800 for modified NUTRIC score ≥ 5), and higher nutritional risk (p=0.009, Exp(B)=0.144, 95%CI=0.033-0.620 for modified NUTRIC score ≥ 6). a Total mcQFMT value below 1.36 cm was a predictor for higher nutritional risk with 79% sensitivity and 70% specificity (AUC=0.749, p=0.002, likelihood ratio=2.04).*

CONCLUSION: *Ultrasonographic measurement of total mcQFMT can be used as a novel nutritional risk assessment parameter in medical ICPs with different volume statuses. Thus, patients who could benefit from aggressive nutritional therapy can be easily identified in these patient groups.*

KEYWORDS: *Ultrasonography. Quadriceps Muscle. Malnutrition. Intensive Care Units.*

DATE OF SUBMISSION: 14-Apr-2019
DATE OF ACCEPTANCE: 19-Apr-2019
CORRESPONDING AUTHOR: Uğur Özdemir,
Internal medicine specialist, Fellow of Critical Care Medicine – Division of Critical Care Medicine, Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Turkey – Phone number: +90 312 202 4201
E-mail: ugureuzdemir@gmail.com

INTRODUCTION

Malnutrition occurs in 20-50% of the patients admitted to hospitals[1]. Early nutritional screening and detection of malnutrition and its treatment can reduce the requirement of mechanical ventilation, duration of hospitalization, and mortality in critically-ill patients[2,3]. However, there is no gold standard method to detect malnutrition in intensive care unit (ICU) patients. Therefore, we can use the "modified Nutrition Risk in the Critically ill" (mNUTRIC) score to assess nutritional risk in intensive care units (ICU)[4]. The mNUTRIC score can determine which patients can benefit from increased nutritional intake in ICU. Thus, early and more aggressive nutritional support in ICU patients with a high mNUTRIC score may improve their nutritional status and outcome. Another important aspect of the mNUTRIC score is that it is correlated with skeletal muscle loss of ICU patients[5]. This is an expected condition as skeletal muscle tissue is adversely affected by systemic inflammation and sepsis[6]. However, skeletal muscle tissue is also affected by different factors such as immobilization, hypervolemia, advanced age, length of ICU stay, and duration of mechanical ventilation in ICU patients[7]. Furthermore, skeletal muscle mass measurements are affected by fluid changes such as overhydration or dehydration[8]. Therefore, it is a research topic to examine how muscle mass measurements change in ICU patients with different nutritional status (mNUTRIC), volume status, and other clinical settings. The muscle mass of ICU patients can be quantified by using ultrasonography (USG). Furthermore, quadriceps femoris muscle thickness (QFMT) can be measured by using USG as an indicator of lean body mass as it has been found to correlate with CT measurements[9,10]. In addition, the swelling effect of hypervolemia on muscle mass may be corrected by maximum compression during USG measurement. Therefore, it is not known how uncompressed (UC) and maximal compressed (MC) QFMT measurements will change in ICU patients with different nutritional status, volume status, and other clinical settings. For this purpose, we aimed to determine the effect of different volume, nutritional risk, and other clinical settings of critically-ill patients on QFMT measurements by USG. Furthermore, we hypothesized that measurement of QFMT can help determine nutritional risks of ICU patients, like the mNUTRIC score.

METHODS

Patient population

All patients who were older than 18 years and hospitalized in the medical ICU of Gazi University Hospital between August 01, 2017 and March 01, 2018 were included in this study. The first admissions of the patients were evaluated. Patients who had muscular atrophy in lower extremities due to cerebrovascular accident, neuromuscular disease, or trauma were excluded from the study. Patients who stayed in the ICU for less than 48 hours were not included in this study. Approval was obtained from the local ethics committee on December 25, 2017, under number 616. Written informed consent was obtained from the patients and/or their relatives.

Clinical information of patients

Demographic data, ICU admission diagnostics, comorbidities, APACHE II (Acute Physiology and Chronic Health Evaluation) scores, SOFA (Sequential Organ Failure Assessment) scores, mNUTRIC (modified Nutrition Risk in the Critically Ill) scores[4], mechanical ventilation requirements and total fluid balances of the patients were recorded. The mNUTRIC score was calculated at ICU admission to determine the nutritional risk of patients and to identify which patients would benefit from aggressive nutritional support therapy. Interleukin 6 levels were not used when calculating mNUTRIC scores. The presence of mNUTRIC score ≥ 5 was considered evidence of high nutritional risk. mNUTRIC score ≥ 6 was considered evidence of higher nutritional risk. Total fluid balances of the patients were obtained from daily patient follow-up sheets noted by nurses. Maximal compressed QFMT (mcQFMT) and uncompressed QFMT (ucQFMT) measurements of both legs of the patients were recorded within 48 hours of ICU admission. The maximum (VCImax) and minimum (VCImin) diameters of the vena cava inferior (VCI), collapsibility of the VCI (VCIcol), pleural, hepatorenal, splenorenal and intraabdominal free fluid presence, and total fluid balances of the patients were recorded to evaluate their volume status. In patients who were not mechanically ventilated, the presence of two or more criteria was accepted as hypervolemia. These criteria were VCImax > 2.1 cm, VCIcol < 50%, presence of free fluid in the third space (pleural or intra-abdominal) or total fluid balance above 2000 cc in the last 48 hours of ICU stay. In mechanically ventilated patients, the VCIcol criteria changed to <20%. These criteria were obtained from the results of previous studies and used in this study to distinguish the volume statuses of the patients[11-14].

USG device and probe

GE brand S7 model ultrasonography device (GE Healthcare, General Electric Company, USA) and 5 megahertz (MHz) convex probe were used to measure mcQFMT and ucQFMT.

Measurement methods

Measurements were performed by an intensive care physician with adequate practical and theoretical training about ultrasonography and 2 years of experience. It was known that mcQFMT and ucQFMT measurements by USG were a reproducible technique with high Intraclass correlation coefficient[10,15]. Patients were placed in the supine position before measurement. During the measurement, the physician ensured the patella could move freely and that the quadriceps femoris muscle was relaxed. QFMT measurements were obtained at the midpoint of the line between the anterior superior iliac spine and the upper point of the patella by using USG[15]. At this point, measurements were carried out in transverse section by not applying compression at first and by applying maximal compression the second time (Figure 1). Maximum compression is an amount of pressure applied with the probe, which can minimize the muscle thickness observed during ultrasound B mode imaging, and it is a limit of pressure that cannot achieve a thinner muscle thickness with more pressure. QFMT measurements were obtained from the upper margin of the femur bone to the lower margin of the deep fascia of the quadriceps femoris muscle perpendicularly to the femur surface. Both mcQFMT and ucQFMT measurements were calculated as the average of three separate measurements in each leg. Especially in some obese and edematous patients, a convex probe was used for QFMT measurements due to the insufficiency of depth of the linear probe. VCI measurements were performed in accordance with the definition in the literature[16]. The presence of pleural or intra-abdominal free fluid was investigated by using a convex probe.

STATISTICAL ANALYSIS

Statistical analysis was performed using the IBM SPSS statistics program version 22 (IBM, NY, USA). The distributions of continuous variables were examined using the Kolmogorov-Smirnov normality test. Continuous variables without normal distribution were described as median (interquartile range). Categorical variables were described as frequencies and percentages. Comparison between survivors and non-survivors, hypervolemic and normovolemic patients and high nutritional risk and low nutritional risk patients were made by using the Mann-Whitney U test for continuous variables and the χ^2 test for qualitative data. The correlation between the data was investigated using Spearman's correlation test. The parameters which had a significant difference in terms of nutritional risk in the univariate analysis were subjected to logistic regression analysis as multivariate analysis. Logistic regression analysis was performed to determine independent risk factors related to nutritional risk. After the determination of independent risk factors for mortality and nutritional status, ROC (Receiver Operating Characteristic) curve analyses were performed. P values lower than 0.05 were considered statistically significant.

RESULTS

55 patients were included in the study. The demographic data of the patients are presented in Table 1. Nutritional risk was high in 37 patients (mNUTRIC

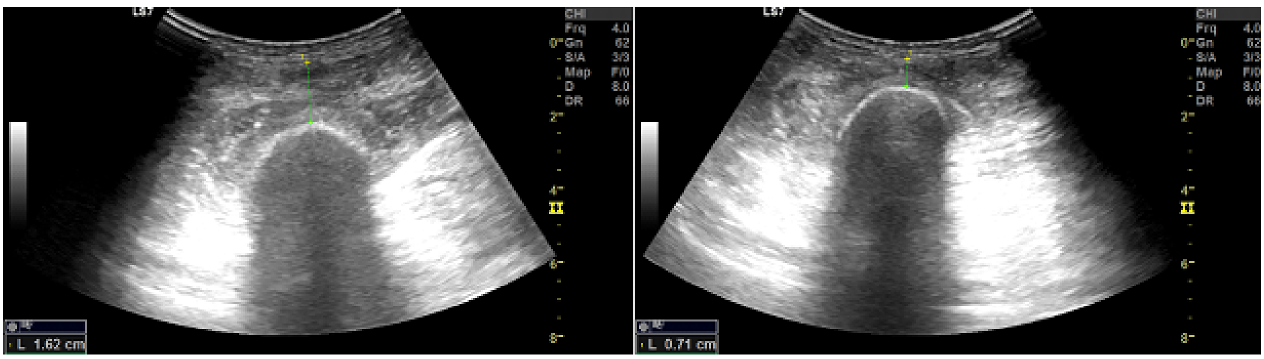
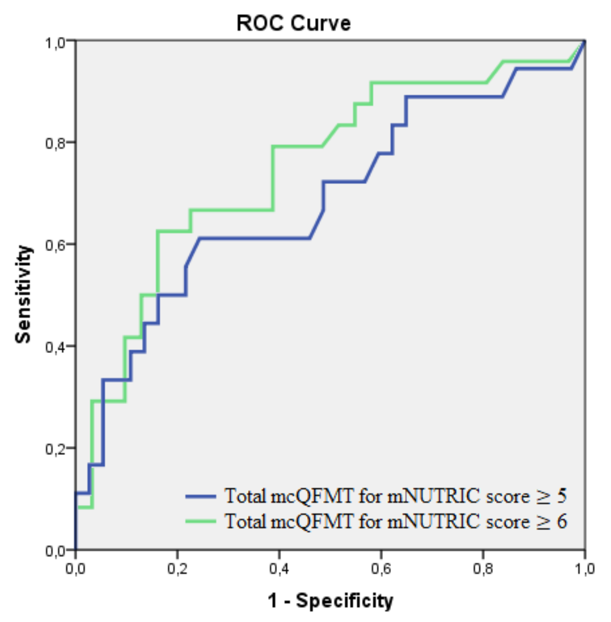


FIGURE 1

FIGURE 2



score ≥ 5); 27 patients were hypervolemic. All data with statistically significant differences in terms of volume and nutrition risk are presented in Table 2. There was a moderate correlation between total mcQFMT measurements and mNUTRIC score (p = 0.001, r = -0.425), APACHE II score (p = 0.007, r = -0.359), SOFA score (p = 0.005, r = -0.371), mortality (p=0.012, r=-0.338), duration of ICU stay (p=0.018, r=-0.319), invasive mechanical ventilation requirement (p = 0.006, r = -0.367), and sepsis (p=0.008, r=-0.356). When logistic regression analysis was performed, it was revealed that total mcQFMT was independently associated with high nutritional risk (mNUTRIC score ≥ 5) (Table 3). When the effect of mcQFMT on high nutritional risk (mNUTRIC score ≥ 5) was investigated by ROC analysis, AUC was calculated as 0.684 (p = 0.028) (Figure 2). It was determined that a total mcQFMT value below 1.69 cm was a predictor for high nutritional risk (mNUTRIC score ≥ 5) with 61% sensitivity and 71% specificity (Likelihood ratio = 2.05).

The mNUTRIC score was also ≥ 6 in 31 patients, as the majority of these 37 patients with high nutritional risk. In addition to this higher nutritional risk defined by the mNUTRIC ≥ 6, there was also a statistically significant difference in right mcQFMT (p=0.015), left mcQFMT (p=0.0001), total mcQFMT (p=0.002), APACHE II score (p = 0.0001), SOFA score (p=0.0001), presence of infection (p = 0.017), sepsis (p = 0.001), shock (p = 0.003) at ICU admission, invasive mechanical ventilation requirement (p=0.002), and mortality (p=0.0001). It was also revealed that the total mcQFMT was independently associated with higher nutritional risk (mNUTRIC score ≥ 6) (Table 3). When the effect of mcQFMT on higher nutritional risk (mNUTRIC score ≥ 6) was investigated by ROC analysis, AUC was calculated as 0.749 (p = 0.002) (Figure 2). It was determined that a total mcQFMT value below 1.36 cm was a predictor for higher nutritional risk (mNUTRIC score ≥ 6) with 79% sensitivity and 70% specificity (Likelihood ratio = 2.04).

TABLE 1. DEMOGRAPHIC DATA AND ADMISSION DIAGNOSIS OF THE PATIENTS INCLUDED IN THE STUDY

Parameters	All patients (n=55)
Age (Years)*	72 [57-83]
Gender, F/M, n	25 / 30
APACHE II score*	24 [18-30]
SOFA score*	6 [4-9]
mNUTRIC score*	6 [4-7]
High Nutritional risk (mNUTRIC ≥ 5), n (%)	37 (67)
Total fluid balance for all days (mL)*	425 [(-460) – (2370)]
Total fluid balance for last 48 hours (mL)*	660 [(-433) – (3419)]
Hypervolemic volume status, n (%)	27 (49)
Invasive mechanical ventilation, n (%)	22 (40)
Mortality, n (%)	22 (40)
Length of ICU stay (day)*	5 [3-11]
Admission diagnosis	
Infection, n (%)	48 (87.3)
Sepsis, n (%)	38 (69.1)
Pulmonary, n (%)	31 (56.4)
Renal, n (%)	20 (36.4)
Neurological, n (%)	18 (32.7)
Cardiovascular, n (%)	13 (23.6)
Shock, n (%)	13 (23.6)
Malignancy, n (%)	11 (20.0)

*Data are presented as median and [interquartile range]. N, n: number; F: female; M: male; APACHE-II: Acute Physiology and Chronic Health Evaluation Score; SOFA: Sequential Organ Failure Assessment; ICU: Intensive Care Unit; mNUTRIC: modified Nutrition Risk in the Critically Ill

DISCUSSION

Hypervolemia is a condition frequently observed in critically-ill patients[17]. In one study, one-third of patients who were followed-up in ICU for sepsis had hypervolemia, and almost all of them had positive fluid balance[18]. Similarly, hypervolemia was detected in half of the patients in our study. Hypervolemia adversely affects nutritional status detection methods. For example, the presence of hypervolemia during

TABLE 2. CLINICAL PARAMETERS ACCORDING TO VOLUME STATUS AND NUTRITIONAL RISK OF THE PATIENTS INCLUDED IN THE STUDY

Parameters	All patients n=55	Normovolemia n=28	Hypervolemia n=27	P-value
APACHE II score	24 [18-30]	22 [16-26]	28 [21-33]	0.010**
Mortality, n (%)	22 (40)	8 (28.5)	14 (51.8)	0.078
High nutritional risk, n (%)	37 (67.3)	16 (29)	21 (38)	0.103
TFB for all days*, (mL)	425 [(-460)-(2370)]	-150 [(-524)-(965)]	2285 [(150)-(3545)]	0.001**
TFB for last 2 days*, (mL)	660 [(-433)-(3419)]	-300 [(-935)-(749)]	3419 [300-5700]	0.001**
VCImax* (cm)	1.47 [1.28-1.75]	1.41 [1.19-1.73]	1.51 [1.31-1.97]	0.186
VCIcol* (%)	37 [16-61]	51 [35-63]	18.7 [11-39]	0.0001**
Right ucQFMT* (cm)	2.06 [1.34-2.80]	2.28 [1.55-3.20]	1.93 [0.95-2.47]	0.038**
Left ucQFMT* (cm)	2.10 [1.49-2.75]	2.40 [1.60-2.88]	1.80 [1.07-2.46]	0.037**
Total ucQFMT* (cm)	4.39 [2.66-5.60]	4.82 [3.20-5.67]	4.02 [2.27-4.68]	0.016**
Right mcQFMT* (cm)	0.70 [0.47-1.15]	0.85 [0.54-1.14]	0.55 [0.43-1.15]	0.150
Left mcQFMT* (cm)	0.71 [0.54-1.09]	0.80 [0.59-1.09]	0.65 [0.41-1.00]	0.080
Total mcQFMT* (cm)	1.50 [0.99-2.12]	1.69 [1.24-2.15]	1.28 [0.86-2.12]	0.070
	All patients N=55	Low nutritional risk n=18	High nutritional risk n=37	P-value
IMV, n (%)	22 (40)	3 (16.6)	19 (51.3)	0.014**
mNUTRIC score	6 [4-7]	3.5 [2.0-4.0]	6 [6-8]	0.0001**
Mortality, n (%)	22 (40)	2 (11.1)	20 (54.0)	0.002**
Hypervolemic patients, n (%)	27 (49)	6 (33.3)	21 (56.7)	0.103
VCIcol* (%)	37 [16-61]	51.0 [38.0-62.5]	29 [13-50]	0.012**
Right ucQFMT* (cm)	2.06 [1.34-2.80]	2.41 [1.72-3.20]	1.80 [1.26-2.58]	0.094
Left ucQFMT* (cm)	2.10 [1.49-2.75]	2.42 [1.56-3.49]	1.96 [1.48-2.64]	0.123
Total ucQFMT* (cm)	4.39 [2.66-5.60]	4.80 [3.47-6.57]	4.08 [2.55-5.34]	0.097
Right mcQFMT* (cm)	0.70 [0.47-1.15]	1.00 [0.58-1.31]	0.63 [0.45-0.95]	0.039**
Left mcQFMT* (cm)	0.71 [0.54-1.09]	0.95 [0.63-1.33]	0.65 [0.47-0.97]	0.025**
Total mcQFMT* (cm)	1.50 [0.99-2.12]	2.00 [1.21-2.59]	1.34 [0.91-1.76]	0.028**

*Data are presented as median and [interquartile range]; ** There was statistically significant difference; n: number; IMV: Invasive mechanical ventilation; APACHE II score: Acute Physiology and Chronic Health Evaluation II score; TFB: Total Fluid Balance; SOFA score: Sequential Organ Failure Assessment score; mNUTRIC: modified Nutrition Risk in the Critically Ill; VCImax: Maximum vena cava inferior diamater; VCIcol: Vena cava inferior collapsibility index; QFMT: quadriceps femoris muscle thickness; ucQFMT: Uncompressed QFMT; mcQFMT: Maximum compressed QFMT;

TABLE 3. LOGISTIC REGRESSION ANALYSIS FOR DETERMINING INDEPENDENT RISK FACTORS FOR HIGH NUTRITIONAL RISK IN THE STUDY POPULATION

Logistic regression analysis for high nutritional risk (mNUTRIC score ≥ 5)			
Parameters	P-value	Exp (B)	CI 95% (Confidence Interval)
Total mcQFMT	0.019	0.256	0.082-0.800
VCIcol	0.177	0.972	0.932-1.013
Requirement of IMV	0.214	3.143	0.516-19.160
Volume status	0.902	0.904	0.183-4.462
Length of ICU stay	0.136	0.939	0.865-1.020
Logistic regression analysis for higher nutritional risk (mNUTRIC score ≥ 6)			
Parameters	P-value	Exp (B)	CI 95% (Confidence Interval)
Total mcQFMT	0.009	0.144	0.033-0.620
VCIcol	0.029	0.947	0.901-0.994
Requirement of IMV	0.158	3.770	0.598-23.779
Volume status	0.266	0.389	0.074-2.052
Length of ICU stay	0.075	0.911	0.823-1.009

QFMT: quadriceps femoris muscle thickness; mcQFMT: Maximum compressed QFMT; IMV: Invasive mechanical ventilation; mNUTRIC: modified Nutrition Risk in the Critically Ill; VCIcol: Vena cava inferior collapsibility index;

DEXA measurements causes errors in the detection of lean body mass[19]. Body mass index, which is a simple measurement method, cannot predict malnutrition, especially in patients with volume overload[20]. The presence of edema, especially in ICU patients, is a serious problem for the use of anthropometric measurements for evaluation of malnutrition[21]. Serum levels of biochemical markers used to detect malnutrition such as prealbumin, albumin, and transferrin vary with the intravascular volume excess and infection or inflammation[22]. For these reasons, it may be helpful to use nutritional risk assessment tools to assess nutritional status in ICU patients. In fact, the mNUTRIC score is a nutritional risk assessment tool developed specifically for ICU. However, a significant limitation of usage of the mNUTRIC score is that it does not include anthropometric or body composition parameters. Therefore, as the results of this study suggest, the use of total QFMT measurements may be more useful in assessing the nutritional risk of ICU patients. However, QFMT measurements with the use of USG may be false since the capacity of the skeletal muscles to contain fluids is quite high[8]. In our study, ucQFMT values measured by USG had a statistically significant difference when compared to hypervolemic patients and normovolemic patients. However, the effects of excess fluid volume on maximal compressed muscle thickness are unknown. In our study, there was no statistically significant difference between hypervolemic and normovolemic patients in terms of mcQMFT. Therefore, it can be thought that excess fluid volume has less effect on the mcQFMT measurement when compared to the ucQFMT measurement in ICU patients.

In a previous study, QFMT measurements by USG and without compression were found to be negatively correlated with malnutrition[23]. In addition, in this study, thinner QFMT measurements were obtained in malnourished dialysis patients compared to healthy and well-nourished individuals. In another study, it was found that uncompressed QFMT measurements by USG could be high in ICU patients with better nutritional support[24]. In one study, it was found that maximal compressed QFMT measurements obtained by USG showed moderate correlation with abdominal wall muscle section in abdominal CT images of ICU patients[10]. Therefore, we can conclude that QFMT measurements are directly related to nutritional status because they contain data related to body composition. Thus, this feature of QFMT measurement can provide an advantage in evaluating nutritional status compared to the mNUTRIC score. We noticed that the relationship between the maximum compressed QFMT measurements and nutritional status has not been previously investigated in ICU patients. Therefore, this study is very important for nutrition literature. Also in our study, when uncompressed and maximal compressed QFMT measurements were evaluated in terms of their ability to detect nutritional risk, mcQFMT measurements were found to be very precious for determining nutritional risk in ICU patients. We also understood that the total mcQFMT measurements (total mcQFMT measurements of right and left legs) can be used to detect the nutritional risk in ICU patients with different volume statuses.

CONCLUSION

The total maximum compressed QFMT measurements obtained by the sum of the maximum compressed QFMT measurements of left and right legs can be used as a novel ultrasonographic nutritional risk assessment parameter in medical ICU patients with different volume statuses. Thus, patients who have nutritional risk or who can benefit from aggressive nutritional therapy can be easily identified in these patient groups.

Conflicts of Interest:

The authors declare no conflict of interest.

Acknowledgments

No financial support or grant was received for this study.

Author's Contrıbuıtıons

1. Uğur Özdemir, Contribution: Obtaining clinical data from patients, detecting appropriate patients, collecting ultrasonography measurement data and images, analyzing data, researching literature, writing the article.
2. Merve Özdemir, Contribution: Researching literature, writing the article.
3. Gulbin Aygencel Contribution: Analyzing the data, researching literature, writing the article.
4. Burcu Kaya, Contribution: Obtaining clinical data from patients, detecting appropriate patients, researching literature
5. Melda Türkoğlu, Contribution: Obtaining clinical data from patients, detecting appropriate patients, researching literature

RESUMO

OBJETIVO: *Neste estudo observacional prospectivo, objetivamos investigar o papel da espessura do músculo quadríceps femoral (QFMT) comprimido (mc) e não comprimido (uc) medida pela ultrassonografia (USG) na detecção do risco nutricional em pacientes de terapia intensiva (ICPs) com status de volume diferente.*

MÉTODOS: *Cinquenta e cinco pacientes foram incluídos. As medidas direita, esquerda e total de ucQFMT e mcQFMT foram obtidas por um dispositivo USG padrão nas primeiras 48 horas após a admissão na UTI. O exame clínico e o dispositivo USG foram usados para determinar o status volumétrico dos pacientes. Sofa, Apache II, escores Nutric modificados e dados demográficos foram coletados.*

RESULTADOS: *Houve diferença significativa entre o risco nutricional dos pacientes em termos de medidas da QTFMT esquerda, direita e total (p=0,025, p=0,039; p=0,028, respectivamente), necessidade de ventilação mecânica (p=0,014), presença de infecção (p=0,019) e sepse (p=0,006). Não houve diferença significativa entre os diferentes status de volume em termos de medidas de mcQFMT. Na análise de variância múltipla, verificou-se que as medidas da FCFMT estavam independentemente associadas a alto risco nutricional (p=0,019, Exp (B)=0,256, 95%CI=0,082-0,800 para escore Nutric modificado ≥ 5) e maior risco nutricional (p=0,009, Exp (B)=0,144, 95%CI=0,033-0,620 para o escore Nutric modificado ≥ 6). O valor total de mcQFMT abaixo de 1,36 cm foi um preditor de maior risco nutricional com sensibilidade de 79% e especificidade de 70% (ASC=0,749, p=0,002, razão de verossimilhança = 2,04).*

CONCLUSÃO: *A medida ultrassonográfica do mcQFMT total pode ser usada como um novo parâmetro de avaliação de risco nutricional em ICPs médicas com diferentes status de volume. Assim, pacientes que podem se beneficiar de uma terapia nutricional agressiva podem ser facilmente identificados nesses grupos de pacientes.*

PALAVRAS-CHAVE: *Ultrassonografia. Músculo quadríceps. Desnutrição. Unidades de Terapia Intensiva.*

REFERENCES

1. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clin Nutr. 2008;27(1):5-15.
2. Middleton MH, Nazarenko G, Nivison-Smith I, Smerdely P. Prevalence of malnutrition and 12-month incidence of mortality in two Sydney teaching hospitals. Intern Med J. 2001;31(8):455-61.
3. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr. 2003;22(3):235-9.
4. Rahman A, Hasan RM, Agarwala R, Martin C, Day AG, Heyland DK. Identifying critically-ill patients who will benefit most from nutritional therapy: further validation of the “modified NUTRIC” nutritional risk assessment tool. Clin Nutr. 2016;35(1):158-62.
5. Mukhopadhyay A, Tai BC, Remani D, Henry J, Kowitlawakul Y, Puthucheary ZA. Nutritional risk assessment at admission can predict subsequent muscle loss in critically ill patients. Eur J Clin Nutr. 2018;72(8):1187-90.
6. Jonghe B, Lacherade JC, Sharshar T, Outin H. Intensive care unit-acquired weakness: risk factors and prevention. Crit Care Med. 2009;37(10 Suppl):S309-15.
7. Kizilarslanoglu MC, Kuyumcu ME, Yesil Y, Halil M. Sarcopenia in critically ill patients. J Anesth. 2016;30(5):884-90.
8. Mayans D, Cartwright MS, Walker FO. Neuromuscular ultrasonography: quantifying muscle and nerve measurements. Phys Med Rehabil Clin N Am. 2012;23(1):133-48.
9. Thomaes T, Thomis M, Onkelinx S, Coudyzer W, Cornelissen V, Vanhees L. Reliability and validity of the ultrasound technique to measure the rectus femoris muscle diameter in older CAD-patients. BMC Med Imaging. 2012;12:7.
10. Paris MT, Mourtzakis M, Day A, Leung R, Watharkar S, Kozar R, et al. Validation of bedside ultrasound of muscle layer thickness of the quadriceps in the critically ıll patient (VALIDUM Study). JPEN J Parenter Enteral Nutr. 2017;41(2):171-80.
11. Miller JB, Lee A, Suszanski JP, Tustian M, Corcoran JL, Moore S, et al. Challenge of intravascular volume assessment in acute ischemic stroke. Am J Emerg Med. 2018;36(6):1018-21.
12. Rudski LG, Lai WW, Afilalo J, Hua L, Handschumacher MD, Chandrasekaran K, et al. Guidelines for the echocardiographic assessment of the right heart in adults: a report from the American Society of Echocardiography endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography. J Am Soc Echocardiogr. 2010;23(7):685-713.
13. Stawicki SP, Braslow BM, Panebianco NL, Kirkpatrick JN, Gracias VH, Hayden GE, et al. Intensivist use of hand-carried ultrasonography to measure IVC collapsibility in estimating intravascular volume status: correlations with CVP. J Am Coll Surg. 2009;209(1):55-61.
14. Stawicki SP, Adkins EJ, Eiferman DS, Evans DC, Ali NA, Njoku C, et al. Prospective evaluation of intravascular volume status in critically ill patients: does inferior vena cava collapsibility correlate with central venous pressure? J Trauma Acute Care Surg. 2014;76(4):956-64.
15. Tillquist M, Kutsogiannis DJ, Wischmeyer PE, Kummerlen C, Leung R, Stollery D, et al. Bedside ultrasound is a practical and reliable measurement tool for assessing quadriceps muscle layer thickness. JPEN J Parenter Enteral Nutr. 2014;38(7):886-90.
16. Levitov A, Frankel HL, Blaivas M, Kirkpatrick AW, Su E, Evans D, et al. Guidelines for the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically ıll patients-part ıı: cardiac ultrasonography. Crit Care Med. 2016;44(6):1206-27.
17. Bagshaw SM, Bellomo R, Kellum JA. Oliguria, volume overload, and loop diuretics. Crit Care Med. 2008;36(4 Suppl):S172-8.
18. Mitchell KH, Carlbom D, Caldwell E, Leary PJ, Himmelfarb J, Hough CL. Volume overload: prevalence, risk factors, and functional outcome in survivors of septic shock. Ann Am Thorac Soc. 2015;12(12):1837-44.
19. Roubenoff R, Kehayias JJ, Dawson-Hughes B, Heymsfield SB. Use of dual-energy x-ray absorptiometry in body-composition studies: not yet a “gold standard”. Am J Clin Nutr. 1993;58(5):589-91.
20. Campillo B, Paillaud E, Uzan I, Merlier I, Abdellaoui M, Perennec J, et al. Comité de Liaison Alimentation-Nutrition. Value of body mass index in the detection of severe malnutrition: influence of the pathology and changes in anthropometric parameters. Clin Nutr. 2004;23(4):551-9.
21. Jeejeebhoy KN. Nutritional assessment. Nutrition. 2000;16(7-8):585-90.
22. Fuhrman MP, Charney P, Mueller CM. Hepatic proteins and nutrition assessment. J Am Diet Assoc. 2004;104(8):1258-64.
23. Sabatino A, Regolisti G, Delsante M, Di Motta T, Cantarelli C, Pioli S, et al. Noninvasive evaluation of muscle mass by ultrasonography of quadriceps femoris muscle in end-stage renal disease patients on hemodialysis. Clin Nutr. 2019;38(3):1232-9.
24. Fetterplace K, Deane AM, Tierney A, Beach LJ, Knight LD, Presneill J, et al. Targeted full energy and protein delivery in critically ıll patients: a pilot randomized controlled trial (FEED Trial). JPEN J Parenter Enteral Nutr. 2018;42(8):1252-62.