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Adductor Pollicis Muscle Thickness Mesurement – A New Reliable Method for Nutritional Status Assessment

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Introduction: Malnutrition in hospital patients is a worldwide problem. The incidence of malnutrition in critically ill patients varies from 40 to 100%, and leads to increased morbidity and mortality rate. [1]

It is very important to assess the nutritional status of the patient at hospital admission in order to determine the presence or absence of malnutrition and provide an early and individualized diet plan, minimizing the risk of complications.[2]

Subjective global assessment (SGA) is a useful tool for malnutrition screening. According to SGA patients could be classified into three categories: well nourished (SGA "A") patients, patients with suspected or moderate malnutrition (SGA "B") and patients with severe malnutrition (SGA "C").

For malnutrition assessment different anthropometric measurements are used. Most important of them include measurement of: body mass index (BMI), mid-arm circumference (MAC), triceps skinfold thickness (TSFT), mid-arm muscle circumference (MAMC), calf circumference.

So far, the known screening devices and anthropometric measures are considered variables susceptible to the impact of the critical illness. Throughout the years, numerous attempts for identification and development of new possibilities for determination of malnutrition have been made concerning critically ill patients, but consensus has not yet been reached.

Among the different methods for nutritional assessment a new technique that enables a measurement of the thickness of adductor pollicis muscle (TAPM) has become popular in the last years.This method identifies changes of the whole body, and can be useful in detection of early changes associated with malnutrition, as well as in estimation of nutritional recovery. [3]

Aim: To determine the validity of the measurement of adductor pollicis muscle thickness (TAPM) for nutritional status assessment and to assess the correlation with other anthropometric measurements.

Material and Methods: In our pilot study were included 24 critically ill polytraumatized patients hospitalized at the University Clinic for Anesthesiology, Reanimation and Intensive Care in Skopje, North Macedonia. Only hemodynamically stable patients older than 18 years of age, who were evaluated during the first 24 to 48 hours after their admission to the hospital were include in the study.

Exclusion criteria were: pregnancy, current injury or deteriorated mobility from a previous injury, upper limb fracture in the last six months, and degenerative disease.

The nutritional status was evaluated by determinating:

- Subjective Global Assessment
- Body Mass Index
- Mid Arm circumference
- Triceps skinfold thickness
- Mid Arm Muscle Circumference
- Calf circumference and
- Adductor pollicis muscle thickness (TAPM)

Subjective Global Assessment, except information (data) for weight loss, also included physical examination in order to determine the loss of subcutaneous fat and muscle tissue, and to determine the presence of sacral edema, ankle edema and ascites. Weight and height values were obtained from the escort and BMI was calculated by dividing the weight (kg) by squared height (m^2) and the data obtained were analyzed according to the references suggested in the literature. Mid arm circumference (MAC) was measured using inelastic and inextensible tape measure in the middle point between the lateral point of the acromion and the lowest point of the olecranon. Triceps skinfold thickness (TSFT) was measured on the same place as MAC with adipometer positioned at 1 cm depth of the skin using pressure of $10 g/mm^2$. Mid Arm Muscle Circumference (MAMC) was calculated from the previous measurements of MAC and TSFT by the equation:

$$MAMC = MAC - (3.1415 \times TSFT)$$

Calf circumference was determined using an inelastic tape positioned horizontally around the maximum circumference of the calf.

The adductor pollicis muscle thickness was measured on the dominant and non-dominant hand, on the ventral side of the hand using adipometer with a continuous pressure of 10 g/mm2. The muscle was clamped at the vertex of the imaginary triangle formed by thumb extension and index finger. The meausrement was repeated three times, and the mean value of the measurements was calculated and presented.

In order to determine the validity of the measurement of adductor pollicis muscle thickness (TAPM) for nutritional status assessment, the obtained values of the measurements of TAPM were compared with data obtained for SGA. Comparison with the data from the other anthropometric measurements was also performed.

Statistical analyses: All data were expressed as mean ± standard deviation and analyzed by SPSS 12.0 software. Group comparison was performed with t test (student) and $P < 0.05$ was considered statistically significant. The one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the means of three or more independent (unrelated) groups.

Results: According to the subjective global assessment, in our study there were 15 well-nourished patients (SGA "A"), 6 patients with suspect/moderate malnutrition (SGA "B"), and 2 patients with severe malnutrition (SGA "C"). The mean values of TAPM were highest in group A patients (16.93 ± 2.16) and smallest in group C (12.50 ± 2.56) for both the dominant and the non-dominant hand. With the ANOVA test we found that the difference between the groups is statistically significant (Table 1)

		N	Mean ± Std. Deviation	Significance (p)
TAPM_DOMINANT	A	15	16,93 ± 2,154	0.009
	B	6	14,33 ± 2,251	
	C	2	12,50 ± ,707	
	Total	23	15,87 ± 2,564	
TAPM_NON-DOMINANT	A	15	15,69 ± 2,064	0.001
	B	6	12,92 ± 1,686	
	C	2	10,00 ± ,000	
	Total	23	14,47 ± 2,615	

The correlation between the TAPM and other anthropometric measures showed significance only with MAMC ($p = 0.003$) and CALF($p = 0.046$) for the dominant hand and with MAC ($p = 0.017$), MAMC ($p = 0.002$) and CALF ($p = 0.009$) for the non-dominant hand (Table 2)

		MAC	TST	MAMC	CALF	TMAP_DOMINANT	TMAP_NON-DOMINANT
MAC	Pearson Correlation	1	,709**	,838**	,737**	,384	,493*
	Sig. (2-tailed)		,000	,000	,000	,070	,017
	N	23	23	23	23	23	23
TSFT	Pearson Correlation	,709**	1	,214	,618**	-,049)	,127
	Sig. (2-tailed)	,000		,327	,002	,825	,565
	N	23	23	23	23	23	23
MAMC	Pearson Correlation	,838**	,214	1	,545**	,588**	,602**
	Sig. (2-tailed)	,000	,327		,007	,003	,002
	N	23	23	23	23	23	23
CALF	Pearson Correlation	,737**	,618**	,545**	1	,421*	,533**
	Sig. (2-tailed)	,000	,002	,007		,046	,009
	N	23	23	23	23	23	23
TMAP_DOMINANT	Pearson Correlation	,384	-,049)	,588**	,421*	1	,914**
	Sig. (2-tailed)	,070	,825	,003	,046		,000
	N	23	23	23	23	23	23
TMAP_NON-DOMINANT	Pearson Correlation	,493*	,127	,602**	,533**	,914**	1
	Sig. (2-tailed)	,017	,565	,002	,009	,000	
	N	23	23	23	23	23	23

Discussion

The majority of critically ill patients, in general, do not receive proper nutrition during hospitalization in intensive care units. Nutritional assessment carried out immediately after admission of the patient allows to make a plan to start nutritional therapy in order to improve nutritional status and minimize the risk of complications. Evaluation of the nutritional status in hospital conditions comprises the history of the disease with habits and changes in respect to nutrition, evaluation of biochemical values and body composition with physical examination. [4]

Shakir and Waterlow are pioneers in the use of anthropometry and thanks to their hard work measuring of the body compartment is a part of a routine physical examination. [5, 6] The protein compartment is represented by muscle mass, subjected to the influence of malnutrition, which can lead to its reduction. Changes in muscle mass are a good indicator of the patient's diet and the outcome of the current disease. [7]

For the evaluation of the body compartment, several methods have been developed, adapted for use in different scenarios. The results obtained with dual energy X-ray absorptiometry (DXA) and air-displacement plethysmography proved to be realistic in the epidemiological scenario. The high cost, technical compatibility, and low availability limit their use in clinical practice. [8]

Assessment of the thickness of the adductor pollicis muscle (APM) has been reported for evaluating the muscle compartments of the body. It is a muscle of the hand with two heads that adducts the thumb by bringing it toward the palm. Anatomically, the APM is the only muscle in the body that could be directly measured. Measurement of the thickness of APM is fast, easy, low cost and non-invasive.[9]

Measurement of the thickness of adductor pollicis muscle on the dominant hand is superior to the non-dominant one and the values are always higher. There is evidence that the muscle of the dominant hand starts to weaken first with reduced daily activity and shows more expressed atrophy in malnutrition. In order to avoid misrepresentation of the nutritional status it is recommended to measure the adductor pollicis muscle on the non-dominant hand. [10]

Subjective global assessment is a gold standard for subjective evaluation of malnutrition. Subjective global assessment (SGA) scores, determined by medical history on seven items and clinical findings on four items, is a well-validated tool for screening for malnutrition [11-13]. Although the SGA scores are determined in a subjective manner, it is the only screening tool recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN). Rezende et al., examined 168 surgical patients and established a reasoned correlation between subjective and objective methods of nutritional assessment in the perioperative period. [14] In their study in which the thickness of adductor pollicis muscle was used as a predictor of the outcome of a critical illness, it has been determined that 25% of patients were severely undernourished. The value of TAPM in the left (12.3 ± 5.5 mm) and in the right hand (12.9 ± 5.3 mm) was significantly lower ($p<0.001$) in severe malnourished patients (SGA-C) compared to patients scored as patients with mild malnutrition (SGA-B) (right hand = 16.8 ± 5.7 mm and left hand = 15.9 ± 5.9 mm) or being nourished (SGA-A) (right hand = 17.2 ± 5.4 mm and left hand = 15.8 ± 4.6 mm). Thus, results showed a significant correlation between SGA and TAPM but only in patients who are undernourished. [15] According to the SGA, in our study there were 15 well-nourished patients (SGA "A"), 6 patients with suspect/moderate malnutrition (SGA "B"), and 2 patients with severe malnutrition (SGA "C"). The mean values of TAPM were highest (16.93 ± 2.16 mm) for the dominant and (15.69 ± 2.064 mm) for the non-dominant hand in group A , and lowest in the group C with values (12.50 ± 2.56 mm) for the dominant and (10,00 ± ,000 mm) for the non-dominant hand. That meant that there was a significant positive correlation between the SGA scores and values of TAPM as an anthropometric measurement.

Caporossi, examining the patients in intensive care units, found that there is significant positive correlation between the values of TAPM and values of MAC, AMA and TSFT measurements. [16,17] Similar results were obtained in the study by Rosalie et al. , with included 124 patients who underwent large digestive surgery where the values of TAPM on both hands correlated positively with the values from the other anthropometric measurements. [18] Lameu et al, in his study found a significant positive correlation between the values of TAPM and anthropometric parameters, but only in those patients that show muscle mass and not in those who calculate fat. [19] It is important to note that this study does not investigate critically ill or surgically ill but only healthy persons. In our study in critically ill patients the values from TAPM measurements on the dominant hand were in correlation with those from the MAMC 0.588 (p = 0.003) and CALF circumference measurements 0.421 (p = 0.046), while the data show no correlation with MAC, 0.384 (p = 0.070), and TSFT , 0.049 (p = 0.825). The obtained statistical results indicated that TAPM in the non-dominant hand has a positive correlattion with MAC, 0.493 (p = 0.017), MAMC 0.602 (p = 0.002) and CALF, 0.533 (p = 0.009), and there is no correlation with TSFT, 0.127 (p = 0.565).

The determination of TAPM has its limitations. It is considered that it does not represent only the muscle body mass, but can be influenced by other factors. Lameu et al. emphasized the body frame as a variable that influenced TAPM and determined a progressive increase in TAPM in individuals with a small, medium or large body frame, evaluated by the wrist circumference. The previous muscle activity and water body compartment are other moments of great importance.

Conclusion: Proper nutritional assessment is a challenge. All methods for nutritional assessment show differences in results. The measurement of the thickness of adductor pollicis muscle presents a reliable method for nutritional status asesessement and it correlates with other anthropometric measurements used in clinical practice in critically ill patients.

Key words: critically ill patient, nutritional assessment, thickness of adductor pollicis muscle

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