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Adductor pollicis muscle: potential anthropometric parameter in hospitalized individuals

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ABSTRACT. This study evaluated the measurement of adductor pollicis muscle thickness as a parameter for the assessment of nutritional status in patients admitted to a University Hospital in Campo Grande, Mato Grosso do Sul State. This is a prospective cross-sectional study with 64 adults and elderly patients. We evaluated the percentage of weight loss based on the usual weight, arm circumference, triceps skinfold thickness, arm muscle circumference, laboratory parameters and measurement of adductor pollicis muscle thickness. The measurements were performed only once, in the first 72 hours of hospitalization. Data were analyzed using statistical software BioEstat 5.0, with a significance level of 0.05. The average thickness of the adductor pollicis muscle was 17.5 $\pm$5.3 mm. We found a significant negative association of muscle with age. There was a significant association between the measure of muscle and parameters such as body mass index, arm circumference, arm muscle circumference, albumin and nutritional status assessed by physical examination. The adductor pollicis muscle allows easy measurement, direct assessment, fast results, low cost and good correlation with anthropometric parameters. However, further studies should be conducted to validate this new method.

Keywords: anthropometry. nutrition assessment. patient care.

Músculo adutor do polegar: potencial parâmetro antropométrico em indivíduos hospitalizados

RESUMO. Este estudo avaliou a medida da espessura do músculo adutor do polegar como parâmetro de avaliação nutricional em pacientes admitidos em Hospital Universitário de Campo Grande, Estado do Mato Grosso do Sul. Trata-se de estudo transversal prospectivo que incluiu 64 pacientes adultos e idosos. Avaliou-se o percentual de perda de peso com base no peso habitual, circunferência do braço, dobra cutânea tricipital, circunferência muscular do braço, parâmetros laboratoriais e a espessura do músculo adutor do polegar. As medidas foram realizadas uma única vez, nas primeiras 72 h de internação. Os dados foram analisados segundo programa estatístico BioEstat 5.0, com nível de significância de 0,05. A espessura média do músculo adutor do polegar foi 17,5 + 5,3 mm. Observou-se associação negativa significativa do músculo com a idade. Houve associação significativa entre a medida do músculo e os parâmetros como Índice de Massa Corporal, circunferência do braço, circunferência muscular do braço, albumina e estado nutricional avaliado por meio de exame físico. A medida do músculo adutor do polegar é fácil condução, baixo custo, permitindo avaliação direta, rapidez nos resultados e boa correlação com parâmetros antropométricos. No entanto, estudos adicionais deverão ser conduzidos para validação deste novo método.

Palavras-chave: antropometria. avaliação nutricional. polegar.

Introduction

The prevalence of malnutrition in hospital settings ranges from 20 to 50% in several studies, according to the criteria used, being considered a public health issue associated with significantly increased morbidity and mortality, and so nutritional assessment is crucial to diagnose and correct the nutritional status, thus reducing hospital costs and mortality (WAITZBERG et al., 2001; ANDRADE et al., 2005; FREITAS et al., 2010; RASLAN et al., 2011).

A set of anthropometric and laboratory measures was validated for the assessment and monitoring of hospitalized patients. Despite the limitations of anthropometric measurements, they are frequently used and express a relative ability to predict nutritional depletion. There is no method of nutritional assessment able to accurately and separately diagnose changes in nutritional status (RASLAN et al., 2010; 2011; BARKER et al., 2011). Technology innovations led to the development of many instruments for the assessment of body composition. However, they present a high cost, which limits their use in clinical practice (LAMEU et al., 2004a; GONZALEZ et al., 2010).

A study conducted in the 1970s assessed the adductor pollicis muscle (APM) with regard to function and muscle contraction (LAMEU et al., 2004b). Later, Lameu et al. (2004a), in a study with healthy patients, used adductor pollicis muscle thickness (APMT) and related its values with variables such as age, sex, physical structure and race. The author proposed its subsequent use as an anthropometric parameter, since the APM is the only muscle that allows appropriate assessment of its thickness because it is well-defined, flat and located between two skeletal structures and, particularly, because of its reproducibility. Thus, APMT is a direct measurement, i.e., no formulas are required for the calculation of its value, although few studies have been conducted with the purpose of assessing the efficiency of this measurement as a parameter of nutritional evaluation in hospitalized patients (FREITAS et al., 2010; CAPAROSSI et al., 2012).

Therefore, the present study aimed to assess the measurement of adductor pollicis muscle thickness and correlate it with other parameters validated in the identification of the nutritional status.

Material and methods

This was a prospective cross-sectional study conducted with 64 patients (32 adults and 32 elderly patients) of both sexes aged over 18 years old and admitted to a medical ward of a university hospital of Campo Grande, Mato Grosso do Sul State, Brazil. The patients agreed to participate in the study by signing the Free Informed Consent. Patients under 18 years old, indigenous people, quilombolas, prison inmates, individuals with diseases affecting muscle trophism, except malnutrition per se and/or changes associated to the underlying pathology, patients with edema that prevented measurement and those who refused to participate were excluded.

The study was approved by the Research Ethics Committee of the Federal University of Mato Grosso do Sul (UFMS) under protocol 62134.

Data collection occurred in September-October 2012. The patients were assessed in the first 72 hours of admission to the clinic by classical anthropometry that included percentage of weight loss (% WL), arm circumference (AC), triceps skinfold thickness (TST) and arm muscle circumference (AMC), as well as laboratory parameters such as lymphocytes and albumin, physical examination to investigate the presence of physical signs of malnutrition according Blackburn and Bistrian (1977) recommendations and measurement of adductor pollicis muscle thickness (APMT).

Weight was measured on a digital scale with capacity of 150 kg and 50 gram-graduation in patients able to walk. In bedridden patients weight was estimated according to the formula of Chumlea et al. (1985). The usual weight was reported by patients or their escorts. The Percentage of Weight Loss (% WL) was calculated and assessed according to a proposal by Blackburn and Bistrian (1977).

Height was measured with a portable stadiometer in patients able to walk, and it was estimated according to the formula of Chumlea et al. (1985) for bedridden patients.

The Body Mass Index (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 for adults and elderly. Patients aged 18 – 59 years old were considered adults and those aged $\geq$ 60 were considered elderly (LIPSCHITZ, 1944; WHO, 1995; FAGUNDES et al., 2004; OEHLSCHLAEGER et al., 2015).

Arm circumference (AC) was measured using inelastic and inextensible tape measure, and triceps skinfold thickness (TST) was measured with an adipometer that exerts continuous pressure of $10 g/mm^2$, followed by calculation of Arm Muscle Circumference (AMC) (ANDRADE et al., 2005; HOLLANDER et al., 2013).

The APMT was measured in the non-dominant side, with the patient seated, the arm flexed to approximately 90°, the forearm and the ventral side of the hand resting on the ipsilateral lower limb, the hand relaxed, and using the adipometer at a continuous pressure of $10 g mm^{-2}$. The muscle was clamped at the vertex of the imaginary triangle formed by thumb extension and index finger. The procedure was performed three times, and the average was calculated (LAMEU et al., 2004a).

Information about diagnosis, length of hospitalization, clinical outcome and levels of serum albumin and lymphocytes in routine tests were obtained from the records of patients. Data on physical activity and occupation were informed by the participants. The level of physical activity and occupation reported by patients was analyzed according to Decree 3214/78 the Ministry of Labor (BRASIL, 1978).

The statistical comparison was analyzed using the Mann-Whitney Test for non-parametric variables. The correlation between age, length of hospitalization, BMI, AC, AMC, TST, lymphocytes, albumin and APMT was determined by Spearman correlation test. Data were analyzed using the BioEstat 5.0 statistical software, with a significance level of 0.05.

Results and discussion

During the study period, 129 patients were admitted in the medical ward: 64 met the inclusion criteria and participated in the study. Of these, 50% (n = 32) were adults and 50% (n = 32) were elderly; 65.6% were male and 34.4% were female. The average age of adult patients was 45.8 ± 10.6 years, and 72.8 ± 11.2 years for the elderly.

The average times of hospitalization of elderly and adult patients was 15.8 ± 11.9 and 17.5 ± 16.1 days, respectively. Regarding the clinical outcome, 96.8% (n = 62) of the patients were discharged, 1.6% (n = 1) were transferred and 1.6% (n = 1) died. Regarding the pathologies of the patients, 42.2% (n = 27) presented Cardiovascular Diseases, 15.6% (n = 10) had strokes (Cerebrovascular Accident), 6.3% (n = 4) presented Chronic Kidney Disease, and 6.3% (n = 4) presented Pneumonia, among others.

Regarding physical activity, most patients (78.1% (n = 25) of the elderly and 71.8% (n = 23) of the adults) had a sedentary lifestyle, and regarding occupation, 37.5% (n = 24) were retired or out of work due to disability, 51.6% (n = 33) performed heavy manual labor activities and 10.9% (n = 7) performed light activities.

The average APMT of the assessed patients was 17.5 ± 5.3 mm. However, since the reference values of some parameters vary according to the age, the sample was divided into two groups – adults and elderly, for data analysis, as shown in Table 1.

Table 1. Association between the average values of the study variables and the adductor pollicis muscle thickness (APMT) in Adults and Elderly.

Variables	Average values	
	Adults	Elderly
Age (years)	45.8 ± 10.6	72.8 ± 11.2*
Length (days)	17.5 ± 16.1	15.8 ± 11.9
BMI (kg m^{-2})	26.6 ± 9.1*	26.4 ± 5.1
AC (cm)	30.3 ± 6.3*	29.3 ± 4.4
AMC (cm)	25.1 ± 4.3*	24.6 ± 3.4*
TST (mm)	16.7 ± 9.3	14.7 ± 7.5
Lymphocytes (N mm^{-3})	2094 ± 972	1964 ± 1375
Albumin (g dl^{-1})	3.7 ± 0.7*	3.6 ± 0.8*

Spearman Correlation Test.: *$p < 0.05$. Length: Hospitalization Time; BMI: Body Mass Index; AC: arm circumference; AMC: arm muscle circumference; TST: triceps skinfold thickness.

Regarding the physical activity, the average APMT of elderly patients was 16.7 ± 4.9 and for those who were not physically active, the average AMTP was 16.0 ± 5.1, i.e., there was no statistically significant difference between the groups. Also, there was no statistically significant difference (p = 0.51) in the comparison of AMTP between physically active adults (19.8 ± 6.5) and those who were not physically active (18.5 ± 4.8).

The comparison of AMTP for the group of elderly with signs of malnutrition presented an average value lower than reported for the group who did not show malnutrition signs, though without statistically significant difference (p = 0.08). However, there was a significant difference in the comparison of these groups (p = 0.02), with an average APMT of 16.3 ± 5.4 for adults with clinical signs of malnutrition and an average APMT of 20.2 ± 4.9 for adults who did not show these clinical signs.

In addition, no statistically significant difference was found in the comparison of APMT between elderly who did not present severe weight loss (p=0.48), as well as in the group of adults (p = 0.24).

Anthropometry is an important tool for the assessment of nutritional status, and anthropometric indicators are predictors of survival and health of individuals and populations. These measures are applicable in all life cycles, making it possible to classify individuals/groups according to the nutritional status, promoting standardization in healthcare services (BARKER et al., 2011; BAGNI; BARROS, 2012).

Classic indicators such as BMI and skinfolds, as well as albumin, have been associated to the clinical evolution of chronic diseases, infections and after surgical interventions, hence the importance of making comparisons between well-accepted methods and the APM, which has been proposed as an anthropometric parameter (DONALISIO et al., 2012).

The APMT can be used to estimate the loss of muscle mass, or be correlated to other anthropometric, biochemical and inflammatory parameters. Adequate muscle mass is considered a good prognostic indicator in critically ill patients. The APMT may indicate changes in the composition of the whole body, and therefore may be useful to detect early changes related to malnutrition and assess nutritional recovery. The method is fast, simple, non-invasive and can be used in both bedridden patients and those able to walk (CAPAROSSI et al., 2012; MELO; SILVA, 2014).

A study with healthy subjects was the first to suggest APM as an anthropometric parameter, obtaining an average APMT of 11.50 ± 2.76 mm (LAMEU et al., 2004b). Other studies were conducted with oncology, surgical, cardiac and chronic renal patients (ANDRADE et al., 2005; BRAGAGNOLO et al., 2009; FREITAS et al., 2010; OLIVEIRA et al., 2012; PEREIRA et al., 2013; MELO; SILVA, 2014). The average APMT in our study was 18.8 ± 5.2 mm in adults and 16.2 ± 4.9 mm in the elderly, and Spearman correlation test showed significant decrease in this measure with aging in the elderly ($p = 0.004$), corroborating the study of Pereira et al. (2013), where the APMT also inversely correlated with age.

No statistically significant association was found between the variables when time of hospitalization was correlated with APMT, although there was a tendency of negative correlation, that is, the longer the stay in hospital, the lower the APMT value. Previous studies also found no correlation between APMT and length of hospitalization in cancer and/or surgical patients (FREITAS et al., 2010; CAPAROSSI et al., 2012). Andrade et al.(2005) , in turn, found a statistically significant difference when they correlated APMT of the dominant hand with length of hospitalization, demonstrating that the lower the APMT, the longer the patient remained hospitalized ($p = 0.028$), and Oliveira et al. (2012) found a risk of hospitalization 3.3 times greater for individuals with APMT $\leq$10.6mm.

Although different studies found no statistical association between APMT and mortality, the negative predictive power of APM for mortality is arguable, since 94.7% of the patients with average APMT higher than 14 mm ($p = 0.028$) did not die during hospitalization and Bragagnolo et al. (2011) considered APMT a predictive parameter of mortality in the postoperative period (ANDRADE et al., 2005; FREITAS et al., 2010; OLIVEIRA et al., 2012; CAPAROSSI et al., 2012). Only one patient died during the postoperative period in our study. Thus, correlation of this finding and APMT has not been possible.

An interesting finding is that although no association was found between the presence of physical signs of malnutrition and APMT in the elderly, there was a correlation between the variables in the adults ($p = 0.02$), where APMT was higher in the individuals who did not show malnutrition signs. This may be associated to the greater depletion of APMT observed in the elderly, since this group usually has age-related physiological muscle alterations (LANDI et al., 2014; VERAS, 2012). Therefore, a higher APMT in the adults would be related to a better nutritional status, characterized by the absence of physical signs of malnutrition.

Regarding the BMI, the present study did not find a significant association between this parameter and APMT in the elderly. On the other hand, there was a significant association between the measurement and BMI in adults ($p = 0.02$). Other studies report a positive significant association between BMI and APMT ($p < 0.01$), although they have not established differences by age group (BRAGAGNOLO et al., 2009; 2011; OLIVEIRA et al., 2012).

Regarding laboratory parameters, which are frequently related to the nutritional status, there was no association between the total number of lymphocytes and APMT in the present study. On the other hand, the albumin levels presented significant association with APMT values ($p = 0.03$ in the elderly and $p = 0.005$ in the adults). Bragagnolo et al. (2009) did not find association between APMT and laboratory tests. Nevertheless, Oliveira et al. (2012) and Pereira et al. (2013) mentioned a correlation between this parameter and albumin, suggesting that APMT may reflect the state of visceral protein depletion.

Laboratory parameters should not be separately analyzed, although the association between hypoalbuminemy and morbimortality is widely discussed. However, this protein has a short half-life and therefore may not be a sensitive indicator to identify acute malnutrition, and rather chronic nutritional imbalance (DONALISIO et al., 2012). In this sense, the APM could be related to chronic malnutrition, requiring a longer recovery time, unlike the values of lymphocytes that recovered fast.

Muscle assessment in the characterization of the nutritional status is still limited because of the high cost of procedures for direct analysis of body composition, as well as due to the difficulty in obtaining measurements as AMC, AMA, AFA and skinfolds that require calculations for the estimate of their measures and subsequent analysis in tables. Thus, the APM is the only muscle that allows appropriate assessment of its thickness and direct measurement, i.e. no formulas are required for the calculation of its value (LAMEU et al., 2004a; FREITAS et al., 2010).

Some authors suggest a good correlation between APMT and usual measurements such as AC, AMC, AMA and skinfolds and affirm that the parameter can be used to assess the muscle mass, corroborating the present study that found significant association between AC in adults ($p = 0.008$) and APMT, and between AMC in both groups with the measurement $p = 0.03$ in the elderly and $p = 0.008$ in the adults) (LAMEU et al., 2004; BRAGAGNOLO et al., 2009, 2011; OLIVEIRA et al., 2012;). On the other hand, TST did not correlate with APMT in none of the groups, which was also reported by Lameu et al. (2004a).

The APM, as well as other skeletal muscles, are depleted during stages of catabolism and atrophy, if not used. Long periods of hospitalization and the occurrence of malnutrition may interfere with muscle trophicity, and indirectly in its thickness. The changes in the muscle function secondary to malnutrition appear before changes in anthropometric and laboratory changes. This fact deserves attention, since there are few methods for measuring muscle strength in nutritional assessment. The combination of methods that allow early detection of structural and functional modifications in the muscle, as well as the diagnosis of malnutrition and the monitoring of patient response following nutritional intervention, might be useful (LAMEU et al., 2004a; OLIVEIRA et al., 2012).

One study showed that all classical anthropometric measures studied correlated significantly with dominant and non-dominant APMT (BRAGAGNOLO et al., 2009). In another study, though, there was no association between APMT and the prognostic indicators studied (FREITAS et al., 2010). However, the authors claim that the short time of hospitalization and the good nutritional status of patients prior to the study might have contributed to the maintenance of this parameter.

Gonzalez et al. (2010) conducted a study with 300 healthy and eutrophic patients, and established standard values for APMT. However, the values obtained in the present study are relatively lower than the ones suggested by the referred author, which can be explained by the fact that we assessed hospitalized patients, most of them suffering from chronic diseases.

Thus, there is a discussion regarding the difficulty in establishing a standardization of APMT values for comparison among the population, although some studies have reported the usefulness of APMT in the assessment of the nutritional status of healthy and hospitalized individuals. Besides, periodical assessment of this measure might become a parameter to monitor the evolution of the nutritional status of the patient (ANDRADE et al., 2005; LAMEU et al., 2004a; LAMEU et al., 2004b, BRAGAGNOLO et al., 2009, 2011; FREITAS et al., 2010; GONZALEZ et al., 2010; OLIVEIRA et al., 2012; CAPAROSSI et al., 2012; PEREIRA et al., 2013).

The maintenance of an adequate nutritional status is important for the preservation and restoration of health. The early identification of factors that may have a negative impact on nutritional status allows a better nutritional management. The causal relationship between malnutrition and hospital clinical outcomes remains unclear, although worse clinical outcomes are more frequent in malnourished patients (BARKER et al., 2011; BRAGAGNOLO et al., 2011).

Nutritional assessment is the main tool for diagnosis of nutritional disorders and will provide guidance on the appropriate intervention and assist in the monitoring of recovery and/or maintenance of the individual's health (MUELLER et al., 2011).

The need to establish parameters for the nutritional assessment of hospitalized patients seems unquestionable for ensuring clinical and epidemiological surveillance, the anticipation of future complications and particularly for early interventions. Therefore, initiatives aimed to the development and validation of scores are welcome. The best method has the following features: easy access, low cost, good prognosis and clinical relevance for each institution (RASLAN et al., 2010; BARKER et al., 2011).

Conclusion

The APM was found to provide easy measurement, direct assessment, fast results, low cost and good correlation with anthropometric parameters such as BMI, AC and AMC, besides albumin and age.

Considering that the aging process is associated to physiological and body composition changes, and that men generally have higher anthropometric measures than women, additional studies on the APMT value considering age and gender should be conducted to improve understanding of this new method of nutritional assessment and establish the validation of its use.

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