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Is adductor pollicis skinfold an accurate tool when checking local muscle improvement in malnourished patients with anorexia nervosa?



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ABSTRACT

Objectives: Anorexia nervosa (AN) is a complex disease that involves malnutrition and a profound depletion in muscle mass. The thickness of the adductor pollicis muscle (APM) has been proposed as a new anthropometric technique to estimate muscle mass, check early changes, and assess its evaluation. This study aimed to evaluate the accuracy and validity of the APM thickness in a cohort of malnourished patients with AN when checking local mass gain. The Doppler ultrasound maybe an affordable and useful method to discriminate all tissues around the APM area.

Methods: A prospective cohort study was conducted of 31 malnourished patients with AN who were admitted to the Regional Eating Disorders Unit for treatment, including re-alimentation. Anthropometric measurements were taken, including arm circumference, triceps skinfold thickness, arm muscle circumference, body mass index, and APM thickness of both hands. Simultaneously, a Doppler ultrasound was performed in the same area, measuring and discriminating fat, skin, and muscle tissues around the APM.

Results: Nutritional improvement is accompanied by fat, but not muscle gain in the hand in the adductor pollicis area of patients with AN. A Doppler ultrasound can accurately discriminate between tissues around the APM.

Conclusions: APM thickness reflects the addition of two different muscles plus fat and skin; therefore, this tool is not reliable to assess APM mass.

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Introduction

Anorexia nervosa (AN) is an eating disorder characterized by chronic, self-induced, severe weight loss that leads to protein-energy malnutrition. The condition involves significant alterations in body composition that cause a profound depletion in muscle mass (MM) and marked depletion of fat stores [1–3]. To identify malnutrition and its recovery, knowing body composition and identifying not only fat mass (FM), but also MM, is necessary. In clinical practice, several anthropometric measurements are usually

used to indirectly estimate MM, such as arm-muscle circumference and the muscle area of the arm. However, these measures are doubly indirect and have been found to overestimate MM [4]. In addition, previous studies have suggested that that arm muscle area does not improve in patients with AN who are re-fed [5].

The adductor pollicis muscle (APM) is located between the index and thumb finger and has been described as the only muscle that can be almost directly measured due its accessible location in the hands and its well-defined anatomic position [6]. A positive correlation between APM and anthropometric measures that estimate MM has been demonstrated [7]. Measuring the thickness of the APM has been proposed as a new anthropometric technique to assess the muscle compartment [7], estimate muscle loss, detect early changes in malnutrition status, and assess its evaluation [8]. Previous studies have identified this thickness as a predictor of outcomes in critically ill patients [9,10], a useful tool to detect changes in the MM of patients with chronic renal failure [11] and surgical patients [12], and even a suitable method to confirm a diagnosis of malnutrition [13]. APM thickness has

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been assumed to have a minimal thickness of surrounding subcutaneous adipose tissue [6,7].

The aim of the present study was to evaluate the accuracy and validity of the thickness of the APM in a cohort of malnourished patients with AN when checking the local MM gain (accrued). The Doppler ultrasound may be an affordable and useful method to discriminate between all tissues surrounding the APM area.

Methods

The study was approved by the research ethics committee of the Burgos University Hospital. This was a prospective cohort study of 31 malnourished female patients with AN who were admitted to the Regional Eating Disorders Unit for treatment, including re-alimentation, for 37 consecutive months. Patients were voluntarily and consecutively admitted to the study.

In all cases, patients met the Diagnostic and Statistical Manual of Mental Disorders, 5th edition, diagnostic criteria for AN [14] and suffered malnutrition (<80% expected body weight or body mass index [BMI] <18 kg/m²). Written informed consent was obtained from each participant. Patients with another illness were excluded.

Measurements

Anthropometric measurements were taken per the established protocols [4,15], and the data collected included height, weight, triceps skinfold, biceps skinfold, and APM thickness. BMI as well as arm muscle circumference and area were calculated. Simultaneously, a Doppler ultrasound (DU) was performed in the same area to measure and discriminate fat, skin, and the muscle tissues around the APM.

All tests were performed both in the first 5 d at the time of admission and in the last 5 d before discharge by the same observer.

Thickness of adductor pollicis muscle

APMT was measured in mm with a Holtain skinfold calliper that exerted continuous pressure of 10 g/m² with ±0.2 mm accuracy. Measurements were taken per the standardized position, whereby subjects sat with both hands resting on the correspondent knee and the elbow flexed to 90° over the homolateral lower limb. The caliper was applied across the APM in the triangle vertex formed by the extended thumb and forefinger. The average of three consecutive measurements was considered the measurement of the APM thickness [6,16]. APM thickness was assessed in both hands on both the dorsal and palmar sides.

Hand muscle Doppler ultrasound

A DU was performed in the same anatomical point. The DU technique constitutes the first choice to determine a diagnosis and evaluate muscular pathology. The DU discriminates fat, skin, and muscle tissues around the APM to allow for these areas to be measured and calculated (cm²) in a reproducible, safe, dynamic, and cost-effective way.

Patients were seated with the palm of the hand resting on the couch to the dorsal side and up to the palmar side. The elbow was flexed at an angle of approximately 90° with the abduction of the thumb and an approximate angle between thumb and index finger of 70° to 100°. The probe was placed in the dorsal triangle between the metacarpal of the thumb and the forefinger to obtain a cross section.

APM thickness and the first dorsal interosseous muscle were measured, as well as fat and skin (in mm) in the dominant and nondominant hands. The measurements were confirmed with ultrasound dynamic movement of the adductor muscle of the thumb. The mean of three consecutive measurements was considered the valid value. A DU was done by an experienced musculoskeletal radiologist, and the ultrasound device used was a General Electric Logiq 500 MD multifrequency linear probe (8.2–11 MHz).

Data analyses

The parametric distribution of the variables was determined with the Kolmogorov-Smirnov test (Lilliefors correction), and a bilateral statistical significance was reached at $P < .05$. Data were compared and statistically analyzed with a paired t test. The Wilcoxon test was used for nonparametric variables. The variables were introduced into a database and subsequently exported for statistical analysis using the IBM-SPSS-Statistics software package, version 19.

Results

A total of 31 patients, from admission to discharge, were included in the study (Fig. 1). The median age was 30.5 years (P_{25-75} 21.5–40.3). All patients had the restrictive form of AN,

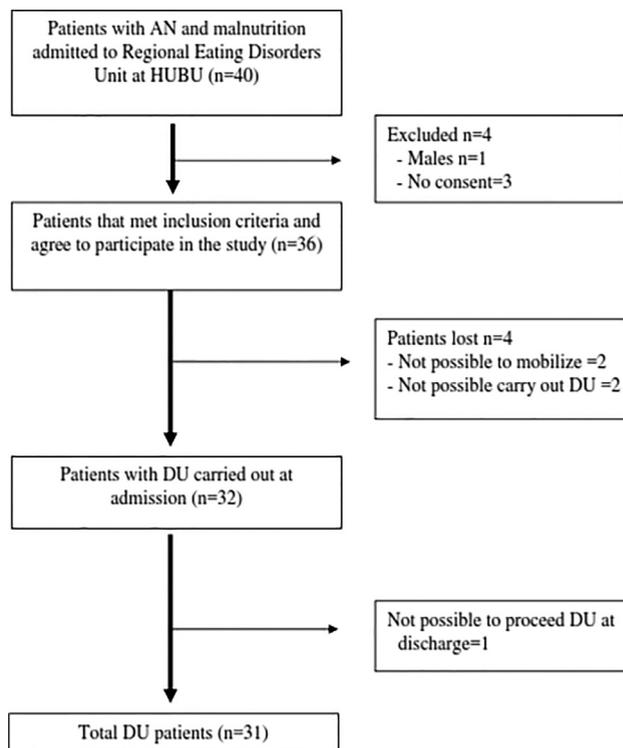


Fig. 1. Participant flow chart.

AN, anorexia nervosa; DU, Doppler ultrasound; HUBU, Burgos University Hospital.

and all were suffering from malnutrition. The mean length of hospital stay was 40 days (confidence interval [CI] 95%, 9–71 days). The general and anthropometric characteristics are shown in Table 1.

The DU examination of the APM thickness area as measured by the caliper determined that the APM thickness included not only the adductor pollicis, but also the interosseus and flexor pollicis muscles and subcutaneous fat and skin (Fig. 2). The appendicular values obtained by the skinfold and by the image technique are shown in Tables 2 and 3. Data of both hands and positions at the time of admission and discharge were registered. The DU allowed for us to differentiate all anatomical sections of the layer (i.e., skin, fat, and muscles). The DU technique showed that the muscle region not only belongs to the APM, but also to the dorsal interosseous muscle, with MM found in the sum of both.

As shown in Table 4, an increasing trend of the mean difference (admission vs. discharge) was observed in the APM area when checked by APM thickness. Conversely, when the APM area was measured by DU, a significant increase in FM was evidenced with MM unaltered.

Table 1

Anthropometric measurements data from patients with anorexia nervosa patients before and after hospitalization

Anthropometric variables	Admission	Discharge	P -value
Weight, kg	41.3 (39.1–43.5)	46.2 (44.8–47.7)	< .01
Body mass index, kg/m ²	15.7 (15.1–16.3)	17.6 (17.2–18.1)	< .01
Arm circumference, cm	18.7 (17.7–19.7)	20.4 (19.7–21.0)	< .01
Tricipital skinfold, mm	6.1 (4.9–7.3)	8.1 (7.1–9.2)	< .01
Bicipital skinfold, mm	3.4 (2.9–4.0)	4.2 (3.7–4.7)	< .05
Arm muscle area, cm ²	5.7 (2.5–8.8)	7.3 (2.2–12.4)	NS

Data were collected from 31 patients, and expressed as mean (confidence interval 95%).

P -values obtained by paired t test.

NS, not significant.

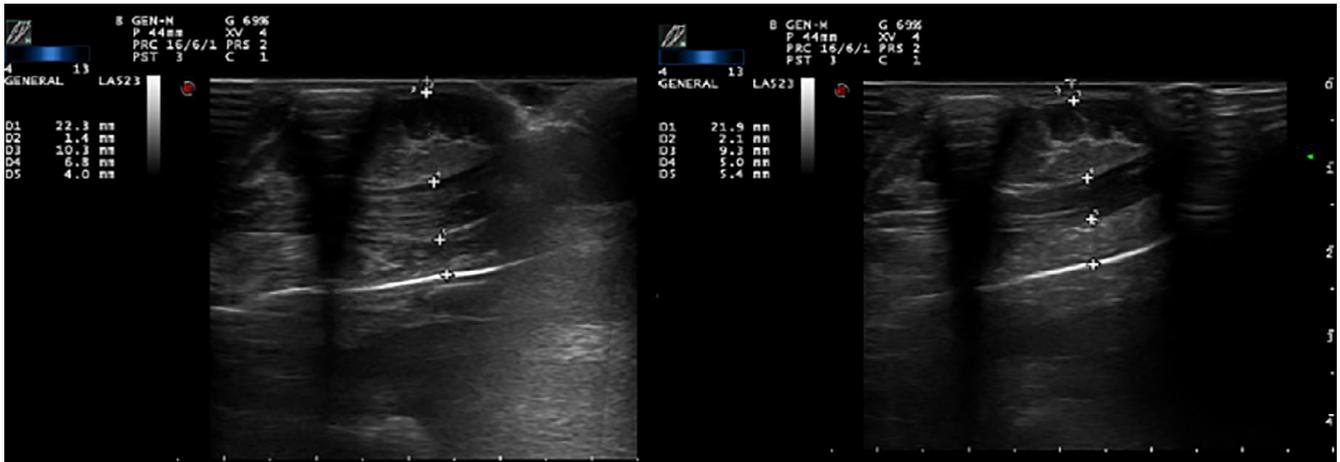


Fig. 2. Right hand in the prone position at the time of admission (left) and discharge (right), respectively. Doppler ultrasound at the time of admission (left) and discharge (right). Measures show from the surface to the deepest layer: skin subcutaneous fat dorsal, dorsal interosseous muscle, adductor pollicis muscle dorsal of the first finger, and palmar skin subcutaneous fat. An increase in fat mass and skin is observed, but not in both muscles.

Table 2
Descriptive analysis of adductor pollicis muscle, measured by skinfold at the time of admission and discharge in both hands, both in the supine and prone positions

		Adductor pollicis muscle thickness, mm	
		Admission	Discharge
Right hand	Supine	8.3 (7.4–9.2)	9.8 (9.0–10.7)
	Prone	11.6 (10.4–12.7)	13.3 (12.3–14.2)
Left hand	Supine	8.0 (7.1–8.8)	10.1 (9.1–11.0)
	Prone	11.5 (10.3–12.7)	13.4 (12.4–14.4)

Data were collected from 31 patients and are expressed as mean (confidence interval 95%).

Discussion

APM thickness was proposed as an adequate nutritional anthropometric parameter because of its presentation as a well-defined and easily accessible [6] anatomic reference [9,12], and its measurements are easily reproducible [6–8]. APM thickness has been used in different clinical conditions as a nutritional assessment parameter [9–12,17] and in muscle function tests [16,18–19], and was considered a good method to diagnose muscle depletion [11].

To our knowledge, this is the first study to contrast APM thickness with image diagnosis with an ultrasound technique in the thenar area. A DU is used to diagnose several pathologies [20–24], but this method has not been previously described in the literature in this anatomical area for this purpose. In addition, we evaluated this method in a typical kind of malnutrition that results from chronic starvation, such as AN [25]. Although this condition involves significant alterations in body composition and a reduction in anthropometric measures, we have not found any research about APM thickness and AN.

A positive association between anthropometric variables to estimate MM and APM thickness in healthy adults was found by Lameu et al [7]. Other studies also found a significant correlation between APM thickness and anthropometrics indicators [10,13,17,26,27]. APM thickness has been found to be a useful tool to evaluate nutritional risks in cardiac intensive patients when compared with subjective global assessments [28] to predict both mortality and postoperative complications in patients after major surgery of the gastrointestinal tract [29], to determine both risk of death and malnutrition in patients with stomach cancer [30], and to detect malnutrition in surgical patients [13,31]. In fact, APM thickness has been suggested to be added to the screening process of hospitalized patients [31] to assess MM, and confirm a diagnosis of malnutrition [13].

All these results and differences with our findings could probably be due to the fact that the caliper was not able to discriminate the composition of the fold.

Measuring APM thickness with a DU allows for us to locate exactly the anatomical position where the caliper is placed and verify the anthropometric data. The short flexor of the thumb does not intervene in the fold measurement; thus, the flexor has been avoided in the DU. The image shows an overlay of the APM and the first dorsal interosseous muscle space occupying the first intermetacarpal–thenar space (i.e., first dorsal interosseous muscle in the most superficial dorsal location and APM in the deepest palmar location). This position corresponds to the caliper measurement (placed between the imaginary vertex between the first and second finger extension), which means that the fold is the sum of muscle, skin, and fat and its differentiation is impossible by using the caliper. As a result, we consider that in a strictly anatomical point of view, calling this thickness of APM would be wrong.

Table 3
Descriptive analysis of appendicular body composition, found by ultrasound at the time of admission and discharge in both hands, both in the supine and prone positions

		Total mass DU, mm		Fat mass and skin DU, mm		Muscle mass DU, mm	
		Admission	Discharge	Admission	Discharge	Admission	Discharge
Right hand	Supine	20.2 (18.1–21.3)	20.5 (19.2–21.6)	5.7 (5.1–6.1)	6.2 (5.7–6.8)	14.1 (12.6–15.3)	13.8 (12.8–15.4)
	Prone	20.6 (18.6–22.2)	21.3 (19.4–23.1)	6.1 (5.6–6.6)	6.4 (5.8–7.7)	14.2 (12.9–15.7)	14.7 (13.3–15.5)
Left hand	Supine	19.0 (17.3–19.9)	19.5 (18.2–20.4)	5.7 (5.3–6.2)	6.2 (5.4–7.0)	13.0 (12.0–14.1)	13.3 (12.3–14.3)
	Prone	19.9 (18.7–21.7)	20.0 (18.6–21.6)	5.9 (5.5–6.7)	6.3 (5.7–7.3)	13.6 (13.0–14.9)	13.7 (12.0–14.7)

Data were collected from 31 patients and are expressed as median (P₂₅–75). DU, Doppler ultrasound.

Table 4
Mean difference in the adductor pollicis muscle area at the time of discharge versus admission in both hands, both in the supine and prone positions

	Position	APMT, mm	Total mass DU, mm	Fat mass and skin DU, mm	Muscle mass DU, mm
Right	Supine	0.7 (-0.2–1.5) NS	0.2 (-0.5–1.4) NS	0.5 (0.0–1.1)**	-0.1 (-0.9–0.4) NS
	Prone	0.7 (-0.4–1.8) NS	0.1 (-0.6–1.1) NS	0.2 (-0.3–0.8)*	-0.1 (-0.7–0.4) NS
Left	Supine	0.8 (-0.3–1.9) NS	0.9 (-0.3–1.8) NS	0.3 (0.0–0.8)**	0.3 (-0.4–0.8) NS
	Prone	1.1 (-0.1–2.2) NS	-0.1 (-0.8–1.0) NS	0.3 (0.1–0.6)**	-0.3 (-0.7–0.1) NS

Data were collected from 31 patients. Values from skinfold are expressed as mean (confidence interval 95%). *P*-values obtained by paired *t* test. Values obtained from Doppler ultrasound are expressed as median (P_{25-75}). *P*-values obtained by Wilcoxon test.

APMT, adductor pollicis muscle thickness; DU, Doppler ultrasound; NS, not significant.

**P* < .05.

***P* < .01.

The ultrasound also allowed us to differentiate and isolate the changes in this anatomical area and clearly show that the increase with re-feed was due to subcutaneous FM instead of muscle. All together, this strengthens the concept that the structural accrued gain detected by the caliper is mostly due to FM, parallel to that observed at the general level by anthropometry in our patients.

A systematic review showed the limitations of using APM thickness as a component of nutritional screening in a hospital setting [32], and more studies and cutoff values are needed to establish the reliability of APM thickness as a nutritional tool. A recent study [33] found little predictive capacity in APM thickness to estimate lean mass when BMI is also considered, but not as a single predictor. In line with this, Melo and Silva [11] found APM thickness a good method to diagnose muscle depletion and malnutrition in surgical patients. However, their research found a positive association between APM thickness and BMI or triceps skinfold, but not with circumference or arm muscle area. These data suggest that there is no straight forward linear relationship between APM thickness and MM in that study, which is just the opposite of the linearity and reproducibility of our data, and to our understanding reflects the consistency and internal validity of our research.

The new addition of appendicular ultrasound suggests that APM thickness in the diagnosis of nutritional status, at least in AN, may drive to false positive results in the improvement of cell mass. Because of that, performing further studies to detect the specificity and the predictive value of this tool would be of interest.

Conclusions

Nutritional improvement is accompanied by fat, but not muscle gain, in the hand adductor pollicis area in patients with AN. Carrying out a standard imaging technique in body composition has allowed us to differentiate local structural changes. APM thickness reflects the addition of two different muscles plus fat and skin; therefore, this tool is not reliable to assess adductor pollicis MM. In summary, the increase in APM thickness in patients with AN during re-alimentation is due to an increment in FM and not MM; thus, not a good method to assess MM when diagnosing malnutrition in these patients.

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