Nutrición Hospitalaria

ARÁN

Trabajo Original

Nutrición artificial

Clinical use of metal and plastic calipers for nutritional assessment of patients under long-term enteral feeding through endoscopic gastrostomy

Utilización clínica de adipómetros metálicos y plásticos para la evaluación nutricional de pacientes en nutrición enteral de larga duración por gastrostomía endoscópica

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Abstract

Background: Endoscopic gastrostomy (PEG) fed patients, including those with neurologic disorders (ND) or head and neck cancer (HNC) present high malnutrition risk and speech difficulties. Teams taking care of these patients need to rely on anthropometric data. Skinfold thickness (TSF) is used to assess nutritional status, but the use of heavy, large and expensive metal calipers may become a limitation. This study aimed to compare and correlate TSF measurements using a metal caliper and a plastic caliper in PEG fed patients.

Methods: Prospective observational study on adult PEG fed patients. TSF was measured using plastic Ross and Lange metal calipers. Paired measurements were compared and correlated.

Results: Fifty-one patients, 37 men (72.5%), 14 women (27.5%): 28 (54.9%) ND patients; 23 (45.1%) with HNC. In total, 94 TSF measurements were performed using both plastic and metal calipers. Significant association was found between TSF measurements with the two equipments (rs = 0.94; p < 0.001). High correlation was observed between TSF measurements using both calipers for both genders (men: rs = 0.93; p < 0.001; women: rs = 0.96; p < 0.001), age (< 65 years: rs = 0.98; p < 0.001; ≥ 65 years: rs = 0.88; p < 0.001), underlying condition (ND: rs = 0.91; p < 0.001; HNC: rs = 0.95; p < 0.001) and time of TSF evaluation (before PEG: rs = 0.95; p < 0,001; after PEG: rs = 0.92; p < 0.001).

Conclusions: TSF measurements obtained with small, light and cheap plastic Ross caliper were equivalent to those obtained with larger, heavier and more expensive metal caliper. For everyday clinical practice, plastic calipers may be suitable for teams taking care of PEG fed patients in hospital wards, outpatient clinic and home visits.

Resumen

Introducción: los pacientes alimentados por gastrostomía endoscópica (PEG), incluyendo aquellos con enfermedades neurológicas o cáncer de cabeza y cuello, presentan un riesgo elevado de desnutrición. Los equipos que cuidan a estos pacientes se basan frecuentemente en datos antropométricos. El pliegue cutáneo del tríceps (TSF) se utiliza para evaluar el estado nutricional, pero la utilización de adipómetros metálicos pesados, grandes y costosos puede convertirse en una limitación. El presente estudio pretende comparar y correlacionar las mediciones de la TSF usando un adipómetro metálico y de plástico en pacientes alimentados por PEG.

Métodos: estudio observacional prospectivo en pacientes alimentados por PEG. La TSF se midió utilizando el adipómetro metálico de Lange y el adipómetro plástico de Ross. Las mediciones emparejadas se compararon y correlacionaron.

Resultados: cincuenta y un pacientes, 37 hombres (72,5%), 14 mujeres (27,5%): 28 (54,9%) pacientes neurológicos; 23 (45,1%) con cáncer de cabeza y cuello. En total, se efectuaron 94 mediciones utilizando ambos los adipómetros (de plástico y metálico). Se encontró una asociación significativa entre las mediciones de TSF con los dos tipos de adipómetros (rs = 0,94; p < 0,001). Se observó también una correlación fuerte entre las mediciones de TSF utilizando ambos adipómetros para ambos los géneros (hombres: rs = 0,93; p < 0,001; mujeres: rs = 0,96; p < 0,001), edad (< 65 años: rs = 0,98; p < 0,001; ≥ 65 años: rs = 0,88; p < 0,001), enfermedad de base (neurológicos: rs = 0,91; p < 0,001, cáncer: rs = 0,95; p < 0,001) y tiempo de evaluación (antes de PEG: rs = 0,95; p < 0,001; después de PEG: rs = 0,92; p < 0,001).

Conclusiones: las mediciones de TSF obtenidas con adipómetros de plástico Ross, pequeños, ligeros y menos costosos, fueron equivalentes aquellos en que se utilizaron adipómetros metálicos grandes, pesados y más caros. Los adipómetros de plástico pueden ser más adecuados para la práctica clínica diaria de los equipos que abordan pacientes alimentados por PEG en régimen de ambulatorio o internamiento.

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BACKGROUND

Long term dysphagic patients, including those suffering from head or neck cancer and neurologic disorders, present a very high risk of malnutrition, with major impact on clinical outcome (1-5). Percutaneous endoscopic gastrostomy (PEG) is the preferred nutritional access method for prolonged enteral nutrition. PEG feeding prevents weight loss, maintains and improves nutritional status in several clinical contexts (6-10). In this setting, it is essential to use nutritional assessment tools that prove to be practical and trustworthy. Although our team had previously demonstrated that patient generated subjective global assessment (PG-SGA) is practicable in PEG fed head and neck cancer patients (11), part of these cancer patients and most of neurological patients present severely impaired speech capacities. Often, our team and most enteral feeding teams must rely on objective data, as anthropometric and laboratory parameters, to evaluate the nutritional status of gastrostomy fed patients. (8,12-14) Therefore, it is important that health practitioners could rely on valid tools to identify malnutrition and to evaluate the need for nutritional intervention and its results (15,16).

Anthropometry is a useful method for assessing nutritional status. Skinfold thickness measurement is one of the most common anthropometrical techniques. It is used to estimate body fat and the distribution of subcutaneous adipose tissue. It is based on the two-compartment model, which divides the body into fat mass and fat-free mass, and on the assumption that subcutaneous adipose tissue layer is representative of total body fat (16,17). The skinfold thickness technique is non-invasive, pain-free, convenient to use and a portable bedside tool which has been providing validity and reliability. However, the operator dependence and the type of caliper selected may constitute significant limitations for this technique (17,18). Anthropometry and, particularly, skinfold thickness measurement is useful to access long-term nutritional evolution when patients present speech difficulties as in the case of most patients under endoscopic gastrostomy (PEG) feeding (8,12).

The skinfold caliper is a tool specifically designed to measure subcutaneous adipose tissue thickness from specific body sites. A wide variety of different skinfold caliper types, from precision engineered to plastic ones, are available. Metal skinfold calipers are very precise but present several handicaps. They are expensive, heavy and large. The metal calipers of our team (Lange) weights circa 204 g and, being a flat tool, occupies circa 250 cm^2. In our country, it costs around 280 euros. Size and weight may become a limitation, when dieticians need to carry metal skinfold calipers in the everyday hospital setting, to evaluate a large number of patients in several hospital wards and in outpatient clinic. Each Ross plastic calipers cost 2 euros, weights circa 18.4 g and, flat, occupies circa 160 cm^2. These plastic calipers are inexpensive, accessible, simple, light weight, very portable and do not require extensive training for their correct use. Also, they are extremely suitable for being carried around in the hospital but they are said to be susceptible to scale or pressure problems. Nevertheless, it has been showed that when compared with other types of calipers they produce valid results (15,19). However, there are few studies comparing metal and plastic calipers and, to the best of our knowledge, they were never compared in a clinical setting like the one of our team, evaluating PEG fed patients with a wide range of disorders, in multiple wards of nine hospital floors and in the Artificial Feeding Outpatient Clinic, during the real life everyday hospital practice.

The present study aims are: a) to compare triceps skinfold (TSF) thickness measurements using a metal caliper and a plastic caliper in PEG fed patients; and b) to evaluate the possibility of using a plastic caliper for everyday hospital practice, avoiding the heavy, large and expensive calipers, unpractical to carry around in a hospital setting.

MATERIAL AND METHODS

STUDY DESIGN

An observational and prospective study was performed and undertaken in a hospital setting. This study was designed and conducted according to the declaration of Helsinki and approved by the Ethics Committee of our hospital. His purpose and procedures were explained to all patients and/or their families and caregivers, who accepted to participate and signed an inform consent.

PATIENTS

This study was conducted in adult patients that underwent endoscopic gastrostomy for long term enteral feeding and attended the Artificial Feeding Outpatient Clinic of our hospital, from February 1st to July 31th, 2016. Exclusion criteria were inability or refusal to perform the proposed tools. From each patient the following data was collected:

1. Age: young adults (18-64 years old) or older adults (65 years or older).
2. Gender: male or female.
3. Underlying disorder causing dysphagia: neurological or head and neck cancer.
4. Body mass index (BMI): low or normal/high. For young adults BMI was considered low if it was under 18.5 kg/m^2. For older adults BMI was considered low if it was under 22 kg/m^2 (20). BMI was obtained in most patients using the equation weight/height^2. If patients were unable to easily stand up for weight and height evaluation, BMI was estimated using the mid-upper-arm circumference and regression equations described by Powell-Tuck and Hennessy (21) which are proven to provide a reliable BMI estimation in PEG fed patients (22).

TRICEPS SKINFOLD THICKNESS

TSF was measured on the non-dominant harm according to the procedures described on the ISAK manual by the Internation-

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al Society for the Advancement of Kinanthropometry (23). Paired triceps skinfold thickness was measured using two types of calipers: a Ross plastic caliper and a Lange aluminum caliper, both with a resolution of 1mm. In order to minimize the inter-observer variability, all measurements were taken by the same researcher in each patient. No more than 50 measurements were obtained using each Ross plastic caliper. After 50 measurements, the Ross caliper was disposed. The measure was taken three times and the recorded value corresponds to the average of the three values obtained. For the present study, TSF was evaluated at the day of the gastrostomy, just before the endoscopic procedure (T0) and later during the PEG feeding follow-up, 4 weeks (T1, circa one month) and 12 weeks (T3, circa 3 months) after the gastrostomy. Each patient could have the TSF evaluated in one or more of these three moments. Paired metal and plastic caliper measurements were obtained and compared globally, using all the measurements and according with patients characteristics: men *versus* woman, young adults *versus* older adults, neurological dysphagia *versus* head and neck cancer, low BMI *versus* normal/high BMI and initial (T0) evaluation *versus* later (T1+T3) evaluation.

STATISTICAL ANALYSIS

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL), version 21, and Microsoft Office Excel Professional 2013.

After a descriptive analysis of all the variables, performed in order to describe baseline patient characteristics, we applied the Spearman correlation test to establish the association between measurements obtained using the metal and the plastic calipers globally in all measurements and in the previously described subgroups. Scatter diagrams were displayed according with the obtained results. Inferential tests were performed at the 5% level of statistical significance.

RESULTS

PATIENTS

Fifty-one patients were included in this study, 37 men (72.5%) and 14 women (27.5%), with a mean age of 65,7 ± 15,0 years, ranging from 20 to 96 years. Twenty-four patients (47%) had less than 65 years and 27 patients (53%) had 65 or more years. Dysphagia due to neurological disorders was present in 28 patients (54.9%) and 23 (45,1%) patients suffered from head and neck cancer (Table I).

Regarding the nutritional status prior to PEG placement and looking by age group, the mean BMI was 20.03 kg/m² ± 4.24 in the elderly and was 19,25 kg/m² ± 3.61 in patients aged less than 65 years. Most elderly patients had a low BMI (67%, n = 20) and in the non-elderly group most patients had a normal to high BMI (67%, n = 14) (Fig. 1).

TRICEPS SKINFOLD MEASUREMENTS

Ninety-four triceps skinfold paired measurements were obtained with the plastic and with the metal caliper, 68 performed in men and 26 in women. Forty-five measurements were performed in patients with neurological dysphagia and 49 in head and neck cancer patients. Considering the age, 39 measurements were performed in patients under 65 years and 55 measurements were performed in patients with 65 or more years.

Looking globally to all paired evaluations, a significant association was found between the triceps skinfold measurements using a metal caliper and a plastic caliper (rs = 0.94; p < 0.001) (Fig. 2). Mean values obtained using metal and plastic caliper were 7.7 mm and 8.1 mm, respectively. The difference between the two tools was minimal in each measurement (mean: 0.4 mm and standard deviation: 1 mm).

Analyzing by gender, there is a significant correlation between the measurements obtained with the two calipers for both genders (rs = 0.93; p < 0.001 for men and rs = 0.96; p < 0.001 for women).

Table I. Patients baseline characteristics

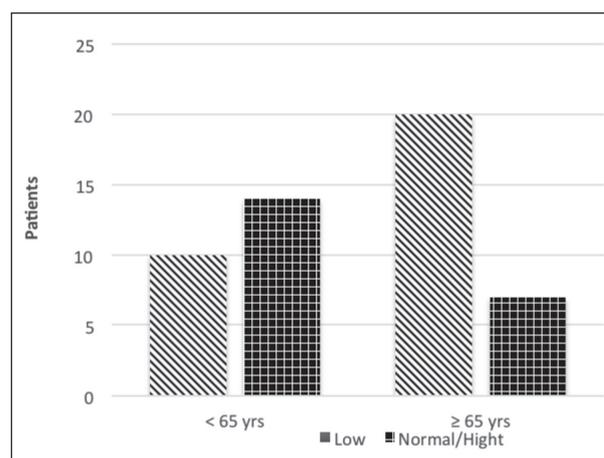| Age		
Max		96
Min		20
Mean		65.7
Standard deviation		15.0
Gender	*n*	*%*
Female	14	27.5
Male	37	72.5
Cause of dysphagia	*n*	*%*
Neurologic	23	45.1
Head and neck cancer	28	54.9

Figure 1.

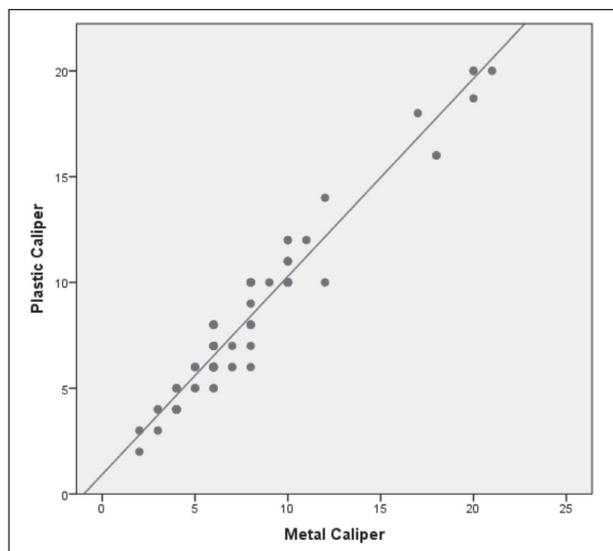Body mass index distribution according to age at the time of PEG placement.

Figure 2.

Scatter diagram showing correlation between plastic caliper and metal caliper global measurements.

Figure 3.

A. Scatter diagram: Plastic caliper *vs.* metal caliper in men. B. Scatter diagram: Plastic caliper *vs.* metal caliper in women.

According with age, we also found a significant correlation between the measurements obtained using the two calipers for the non-elderly and the elderly patients (rs = 0.98; p < 0.001 for age < 65 years and rs = 0.88; p < 0.001 for age ≥ 65 years).

Taking into account the underlying disorders, there was a significant correlation between the measurements made with both calipers in neurological patients (rs = 0.91; p < 0.001) and in head and neck cancer patients (rs = 0.95; p < 0.001).

Analyzing by BMI, 46 measurements were perform in patients with a low BMI and 48 in patients with a normal to high BMI. There was also a significant association between the triceps skinfold measurements performed using both calipers (rs = 94; p < 0.001 for low BMI and rs = 0.94; p < 0.001 for normal to high BMI).

Looking at the moments in which the measurements were performed, a significant association was found between the values obtained with the two different calipers in the two periods under analysis, namely prior to PEG placement (T0) when 47 measurements were performed for each caliper (rs = 0.95; p < 0.001) and after PEG placement (T1+T3) when also 47 measurements were performed for each caliper (rs = 0.92; p < 0.001) (Fig. 3 A and B).

The correlation between the values obtained with the two different types of calipers was statistically significant for measurements performed both in patients under 65 years and in patients with 65 or more years before and after PEG placement (rs = 0.97; p < 0.001 for T0 and age < 65 years and rs = 0.89; p < 0.001 for T0 and age ≥ 65 years, also rs = 0.97; p < 0.001 for T1+T2 and age < 65 years and rs = 0.87; p < 0.001 and age ≥ 65 years). The correlation between the values obtained with the two calipers was also significant for measurements performed both in patients with low BMI and in patients with normal to high BMI, before and after PEG placement (rs = 0.94; p < 0.001 for T0 and low BMI
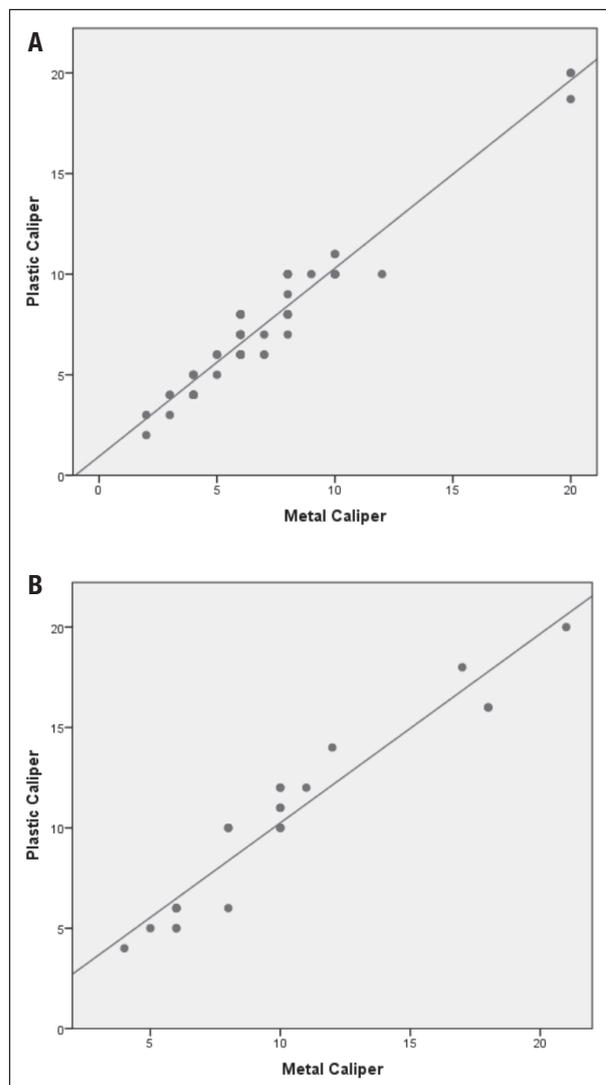
and rs = 0.94; p < 0.001 for T0 and normal to high BMI, also rs = 0.96; p < 0.001 for T1+T2 and low BMI and rs = 0.90; p < 0.001 and normal to high BMI).

DISCUSSION

Malnutrition is high prevalent in hospitalized patients and strongly associated with prolonged hospital stay, higher health care costs, increased morbidity and mortality. (24-26) PEG fed patients often present speech difficulties and therefore teams taking care of gastrostomy patients frequently need to rely on anthropometric data (12), namely triceps skinfold obtained with

the use of calipers. The aim of the present study was to compare TSF measurements using two different calipers in order evaluate the possibility of switching from a heavy, large and expensive tool to a lighter, smaller and cheaper caliper, more adapted to everyday use in the hospital practice.

To the best of our knowledge, few studies aimed to compare different calipers in hospitalized patients, and no one in PEG fed patients. This may represent an important limitation for the teams taking care of the nutritional support of these patients. Nevertheless, there are other studies available that aimed to compare the accuracy of different models of calipers in different population settings. Léger et al. aimed to determine the validity of plastic skinfold caliper measurements for two different plastic calipers (Ross and McGaw) in comparison with a Harpenden metal caliper. In a study with 27 healthy subjects, they concluded that the plastic calipers gave valid skinfold thickness measurements when compared with the Harpenden caliper and also, that even if the plastic calipers could suffer from scale and pressure problems, those were clinically irrelevant (19). Also, Burgert et al. compared values for triceps skinfold measured by the plastic McGaw caliper and with those measured by the metal Lange caliper in 91 volunteers and 14 obese patients. They also found a very high correlation between the two calipers, although the measurements taken with the plastic caliper were generally lower than the ones obtained with the metal caliper (27). The same findings were reported by Rombeau et al. in a study with 107 surgical patients. They reported that skinfold measurement with the McGraw caliper were almost identical to those obtained by the Lange caliper, despite a minor tendency for greater values when the plastic caliper was applied (28).

The present study compared a lightweight, smaller Ross caliper costing around 2 euros with a heavy, large and expensive metal Lange caliper costing around 280 euros in our country, which is equivalent to more than 100 plastic calipers. Paired metal and plastic caliper measurements were quite similar and we found significant associations between the measurements performed with both calipers (rs = 0.94; p < 0.001). High significant associations were also present when patients were evaluated by gender, age, BMI, underlying disease and just before or during the PEG feeding period. These data suggests that these plastic calipers may be adequate for everyday clinical practice of teams taking care of PEG patients in a wide range of demographic and clinical settings. Plastic calipers may also be interesting for teams receiving a large number of dietetics students and young dietitians wishing to have special training with artificial feeding patients. For these students and trainees, a plastic caliper may be assigned to each one, with an insignificant cost. Nevertheless, we are not confident to support the use of plastic calipers for long periods with a very large number of skinfold evaluations. We set an arbitrary limit for the present study on 50 measurements, but with longer uses, these tools may distort and become unreliable. In addition, for research purposes, the authors would not advocate the use of other calipers than well-calibrated metal calipers. The use of plastic tools should be restrained to clinical settings where a lighter, smaller and cheaper caliper may have a clear advantage in everyday routine practice.

CONCLUSIONS

In our experience, skinfold values obtained using a small, light and cheap caliper are similar and equivalent to those obtained with a larger, much heavier and much more expensive caliper. For everyday clinical practice of teams taking care of PEG fed patients who are dispersed all over the hospital wards, in the outpatient clinic and even in home visits, plastic calipers may be suitable.

REFERENCES

1. Kubrak C, Olson K, Jha N, Jensen L, MacCargar L, Seikaly H, et al. Nutrition Impact Symptoms: Key determinants of reduced dietary intake, weight loss, and reduced funcional capacity of patients with head and neck cancer before treatment. Head Neck 2010;32(3):290-300.
2. Arends J, Bodoky G, Bozzetti F, Fearon K, Muscaritoli M, Selga G, et al. ESPEN Guidelines on Enteral Nutrition: Non-surgical oncology. Clin Nutr 2006;25(2):245-59.
3. Mitchell SL, Teno JM, Kiely DK, Shaffer ML, Jones RN, Prigerson HG, et al. The Clinical Course of Advanced Dementia. N Engl J Med 2009;321(16):1529-38.
4. Limousin N, Blasco H, Corcia P, Gordon PH, De Toffol B, Andres C, et al. Malnutrition at the time of diagnosis is associated with a shorter disease duration in ALS. J Neurol Sci 2010;297(1-2):36-9.
5. Katzberg H, Benatar M. Enteral tube feeding for amyotrophic lateral sclerosis / motor neuron disease. Cochrane Database Syst Rev 2011;(1):CD004030.
6. Grilo A, Santos CA, Fonseca J. Percutaneous endoscopic gastrostomy for nutritional palliation of upper esophageal cancer unsuitable for esophageal stenting. Arq Gastroenterol 2012;49(3):227-31.
7. Santos CA, Pereira M, Martins VS, Fonseca J. Traqueoesophageal fistula patients fed through percutaneous endoscopic gastrostomy/gastrojejunostomy : nutritional status and clinical outcome. Nutr Hosp 2015;32(2): 691-5.
8. Fonseca J, Santos C, Brito J. Malnutrition and clinical outcome of 234 head and neck cancer patients who underwent percutaneous endoscopic gastrostomy. Nutr Cancer 2016;68(4):589-97.
9. Nunes G, Santos CA, Santos C, Fonseca J. Percutaneous endoscopic gastrostomy for nutritional support in dementia patients. Aging Clin Exp Res 2016;28(5):983-9. doi:10.1007/s40520-015-04852
10. Nunes G, Santos CA, Grunho M, Fonseca J. Enteral feeding through endoscopic gastrostomy in amyotrophic lateral sclerosis patients. Nutr Hosp 2016;33(5):1108-15.
11. Correira Pereira MA, Santos CA, Brito JA, Fonseca J. Scored patient-generated subjective global assessment, albumin and transferrin for nutritional assessment of gastrostomy fed head or neck cancer patients. Nutr Hosp 2014;29(2):420-6.
12. Fonseca J, Santos CA. Clinical anatomy: anthropometry for nutritional assessment of 367 Adults who underwent endoscopic gastrostomy. Acta Med Port 2013;26(3):212-8.
13. Fonseca J, Adriana Santos C, Brito J. Predicting survival of endoscopic gastrostomy candidates using the underlying disease, serum cholesterol, albumin and transferrin levels. Nutr Hosp 2013;28(4):1280-5.
14. Santos CA, Fonseca J, Carolino E, Guerreiro AS. Serum trace elements in dysphagic gastrostomy candidates before endoscopic gastrostomy for long term enteral feeding. Clin Nutr 2016;35(3):718-23.
15. Madden AM, Smith S. Body composition and morphological assessment of nutritional status in adults: a review of anthropometric variables. J Hum Nutr Diet 2014;1-19.
16. Brodie D, Moscrip V, Hutcheon R. Body composition measurement: A review of hydrodensitometry, anthropometry, and impedance methods. Nutrition 1998;14(3):296-310.
17. Amaral TF, Restivo MT, Guerra RS, Marques E, Chousal MF, Mota J. Accuracy of a digital skinfold system for measuring skinfold thickness and estimating body fat. Br J Nutr 2011;105(3):478-84.
18. Cyrino ES, Okano AH, Glaner MF, Romanzini M, Gobbo A, Makoski A, et al. Impact of the use of different skinfold calipers for the analysis of the body composition. Brazilian J Sport Med 2003;9(3):150-3.
19. Léger LA, Lambert J, Martin P. Validity of plastic skinfold caliper measurements. Hum Biol an Int Rec Res 1982;54(4):667-75.

20. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation (WHO Technical Report Series 894). World Heal Geneva; 2000. pp. 252.

21. Powell-Tuck J, Hennessy EM. A comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalized patients. Clin Nutr 2003;22(3):307-12.

22. Pereira M, Santos C, Fonseca J. Body mass index estimation on gastrostomy patients using the mid upper arm circunference. J Aging Res Clin Pr 2012;1(3):252-5.

23. Stewart A, Marfell-Jones M, Olds T, de Ridder H. International standards for anthropometric assessment. Lower Hutt: International Society for the Advancement of Kinanthropometry; 2011.

24. Pirlich M, Schutz T, Norman K, Gastell S, Lubke HJ, Bischoff SC, et al. The German hospital malnutrition study. Clin Nutr 2006;25(4):563-72.

25. Planas M, Audivert S, Pérez-Portabella C, Burgos R, Puiggrós C, Casanelles JM, et al. Nutritional status among adult patients admitted to an university-affiliated hospital in Spain at the time of genoma. Clin Nutr 2004;23(5):1016-24.

26. Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clin Nutr 2008;27(1):5-15.

27. Burgert S, Anderson B., Anderson F. A comparison of triceps skinfold values as measured by the plastic McGaw caliper and the Lange caliper. Am J Clin Nutr 1979;32:1531-3.

28. Rombeau J, Carson K, Apelgren L. Clinical comparison of the Lange and McGaw skinfold calipers. J Parenter Enter Nutr 1977;1(35A).