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TEMPORAL ASSOCIATION BETWEEN BODY COMPOSITION AND FUNCTIONAL CAPACITY ON LONG TERM FOLLOW-UP OF BARIATRIC SURGERY

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ABSTRACT

Background: Severe obesity reduces functional capacity. Total and segmental body composition after bariatric surgery may more accurately estimate functional capacity as assessed by the 6-minute walk test (6MWT) than the body mass index(BMI). **Objective:** To correlate the distance walked during 6MWT(6MWD) with BMI and body composition in the early (T1:6 months) and late (T2:36 months) postoperative period of bariatric surgery. **Methods:** Functional capacity was evaluated in 77 patients classified according to obesity grade before bariatric surgery(T0) in: Morbidly obese(MO: BMI 40 to 49.9 kg/m^2) and super obese(SO: BMI 50 to 59.9 kg/m^2) and according to the percentage of excess weight loss(%EWL) in T2: success group(SG: EWL≥50%) and failure group(FG: EWL<50%). **Results:** A significant increase (p<0.001) was found in the 6MWD between T0/T1 and T0/T2. There was also an increase (p<0.05) of the 6MWD between T0/T1 and T0/T2 in MO and SO participants, with no significant difference (p>0.05) between T1/T2 in both groups. There was a significant increase (p<0.05) in 6MWD between T0/T2 in SG and FG participants. No significant difference (p>0.05) was found in the 6MWD between MO/SO and SG/FG. At all times and groups, the 6MWD showed a moderate correlation (p<0.05) with the percentage of fat free mass (FFM%) and fat free mass of lower limbs (FFMLL%) but not with BMI. **Conclusion:** Fat free mass (FFM) indicate better functional capacity on long-term follow-up after bariatric surgery independently of obesity grade or successful weight loss. BMI is not the best predictor of functional capacity.

KEYWORDS: Obesity, morbid; Exercise test; Movement; Body composition; Anthropometry; Bariatric Surgery.

INTRODUCTION

Obesity is characterized by an excessive accumulation of adipose tissue associated with chronic systemic low-grade inflammation, with risk for the development of cardiovascular diseases, musculoskeletal disorders and some cancers.[1]

Severe obesity impacts the locomotive system as a consequence of bio-mechanical overload in the joints of higher weight discharge[2], which may negatively affect the functional capacity and quality of life.[3-9]

Functional capacity may be evaluated by the ability to perform basic activities of daily living (ADL's). One of the most important ADL's is walking since motor displacement is necessary to perform most of the ADL's.[10-17] The deleterious effects of adipose tissue distribution in relation to cardiovascular and metabolic risks are well established but musculoskeletal changes determined by obesity and d and segmental fat mass accumulation needs further studies. The association between increased BMI with osteoarthritis and decreased functional capacity are well known.[18-23] Excess fat mass in the lower limbs determines biomechanical disadvantage with consequent changes in gait pattern. Segmental fat accumulation favors misalignment of the knee joint (geno valgus), with altered motor performance such as reduced speed, shorter swing time and increased lower limbs support base during motor displacement.[24-28]

In fact, body composition after bariatric surgery may more accurately estimate functional capacity as assessed by the 6-minute walk test (6MWT) than the body mass index (BMI). A recent longitudinal trial[30] determined that fat free mass and skeletal muscle mass reduced significantly in the first postoperative year and remained stable between one and five years after bariatric surgery. Santarém et al.[29] observed in patients with severe obesity that distance walked during 6MWT (6MWD) was similar to healthy individuals (514.9 ± 50.3 m). There were a better correlation of 6MWD with the percentage of fat free mass (FFM %) and fat free mass of lower limbs (FFMLL %) (r: 0.5; p <0.001) than with BMI (r: -0.3; p <0.001).

We hypothesise that patients with higher FFM % after bariatric surgery will have better functional capacity.

The aim of our study was to correlate the distance walked during the 6MWT (6MWD) with BMI and body composition according to the obesity grade and surgical success or failure in the early and late postoperative period of bariatric surgery.

MATERIALS AND METHODS

Participant recruitment

Seventy-seven participants with severe obesity (age: 39.3 ± 9.5 years, BMI: 47.9 ± 4.8 kg/m^2) were recruited at Metabolic and Bariatric Surgery Unit, Hospital das Clínicas, University of São Paulo Medical School. All participants had a BMI between 40 and 60 kg/m^2 and age between 18 and 60 years.

The study protocol was performed according to the ethical recommendations of the Declaration of Helsinki and was approved by the Ethical Committee of the Hospital das Clínicas, University of São Paulo Medical School (protocol number 01038912.6.0000.0068) and conducted after the participants signed the consent form. Body composition and 6MWT were before, 6 (T1) and 36 (T2) months after Roux-en-Y gastric bypass. Twenty-two participants did not attend and were excluded after 36 months. The participants were classified before surgery (T0) according to obesity grade in morbidly obese (MO: BMI 40 to 49.9 kg/m^2; n =49) and superobese (SO: BMI 50 to 59.9 kg/m^2; n =28). In T2, participants were classified according to the percentage of excess weight loss (%EWL) in success group (SG: % EWL ≥ 50; n =35) and failure group (FG: % EWL <50; n =20).

Anthropometric measurements and body mass composition

Body composition was evaluated by anthropometry and bio-electrical impedance analysis (BIA). Height and body weight were measured with participants barefoot and light clothing to the nearest 0.5 cm and 0.1 kg, respectively. BMI was calculated by dividing the body weight in kilograms by the height in square meters (kg/m^2). Body composition was determined by BIA (Biospace Co., InBody 230®, USA) under constant conditions (proper hydration and same time of day). The participant was positioned in orthostatic position on a platform with lower electrodes for feet and the hands holding the upper electrodes. The body impedance vector components, resistance and reactance were measured using two different frequencies (20 and 100 KHz). BIA determined in percentage values: fat mass (FM %), fat free mass (FFM %), fat free mass of upper limps (FFMUL %), fat free mass of trunk (FFMT %), fat free mass of lower limbs (FFMLL %), fat mass of upper limps (FMUL %), fat mass of trunk (FMT %) and fat mass of lower limbs (FMLL %).

Six-minute walk test

All participants performed a standardized[31], self-paced 6MWT in a 36-meter long corridor marked every 3 m with colored tape on the floor. They were instructed to walk the longest distance possible within six minutes without running. Participants were allowed to stop any moment of the test, but were encouraged to restart as soon as possible. Standardized encouragement and announcement of remaining time were given to all participants.[31] The basal heart rate (HR), oxy-hemoglobin saturation (Ana Wiz. ANP 100®. China), fatigue and dyspnea scores (Borg scale)[32] and arterial blood pressure (Omron Healthcare Co®. LTD. Japan) were obtained from all participants before and after the test.

Statistical analysis

A convenience sampling of participants in the preoperative bariatric surgery was used (n =77) in this prospective observational study. All data were presented as mean, standard deviation and 95% confidence intervals. The association of the studied variables (6MWD with anthropometric measurements and body mass composition) was evaluated through the Pearson and Spearman correlation. Unpaired T-test and Mann-Whitney was used to determine inter-group (MO and SO, SG and FG groups) differences in numerical data. A p <0.05 value was considered as significant.

RESULTS

Anthropometric measurements and body mass composition

The anthropometry and body mass composition data of the participants are presented in Table 1. There was a significant difference (p <0.001) between T0/T1 and T0/T2 in BMI and all body composition variables, but no significant difference (p > 0.05) between T1/T2.

The anthropometry data according to obesity grade are presented in Table 2. There was a significant difference (p <0.001) between T0/T1 and T0/T2 in MO and SO groups in body composition variables without difference (p > 0.05) between T1/T2. There was a significant difference (p <0.05) between MO and SO in T0 and T1 in all anthropometrics variables, except FFMT % and FMT % in T0. Only FM % had a significant difference (p < 0.001) between MO and SO in T2.

The anthropometry data according to % EWL are presented in Table 3. There was a significant difference ($p < 0.001$) between T0/T2 in both SG and FG and between SG and FG in T2 in all anthropometric variables.

Six-minute walk test

The 6MWT results are summarized in Figure 1. All participants completed the 6MWT without premature end or breaks, and no complications have occurred during the test. There was a significant increase ($p < 0.05$) in the 6MWD between T0/T1 and T0/T2 without difference ($p = 0.073$) between T1/T2.

The 6MWT results according to obesity grade are presented in Figure 2a and 2b. There was a significant difference ($p < 0.05$) in the 6MWD between T0/T1 and T0/T2, but no significant difference ($p > 0.05$) between T1/T2 in MO and SO groups. There was no significant difference ($p > 0.05$) between MO and SO in T0, T1 and T2. The 6MWT results according to %EWL are summarized in Figure 3a and 3b. There was a significant difference ($p < 0.05$) in the 6MWD between T0/T2 in FG and SG. No significant difference ($p = 0.468$) was found between FG and SG in T0, T1 and T2.

Correlation between body composition and 6MWD

The correlations between body composition and 6MWD are presented in Table 4. A positive correlation ($p < 0.001$) was found between 6MWD and FFM%, FFMUL %, FFMT %, FFMLL% and a negative correlation ($p < 0.05$) with FM %, FMUL % and FMT %.

In MO group the 6MWD presented a positive correlation ($p < 0.05$) with FFM %, FFMUL %, FFMT % and FFMLL % and a negative correlation ($p < 0.05$) with FM %, FMUL % and FMT %.

In SO group the 6MWD presented a significant correlation ($p < 0.05$) FFM %, FFMUL %, FFMT % and FFMLL % and a negative correlation ($p < 0.05$) with FM %, FMUL %, FMT % and FMLL %.

In FG group the 6MWD presented a positive correlation ($p < 0.05$) with FFM %, FFMUL %, FFMT % and FFMLL % and a negative correlation ($p < 0.05$) with FMUL %.

In SG group the 6MWD presented a positive correlation ($p < 0.05$) with FFM %, FFMUL %, FFMT % and FFMLL % and negative correlation ($p < 0.05$) with FM %, FMUL % and FMT

%.

There was no significant correlation ($p > 0.05$) between the 6MWD with BMI in all groups.

DISCUSSION

In the present study, 6MWD in patients with severe obesity was 518.6 ± 50.2m, a performance similar to healthy individuals, a result in agreement with previous studies.[33-37] Other series[38-40] observed a lower 6MWD, considering the low performance a consequence of excess body weight, increased sensation of dyspnea, lower limb fatigue or skin friction during motor displacement. Nevertheless, a critical analysis suggests that inadequate methodology (not using ATS recommendations) and factors related to the individual (age, cardiopulmonary or musculoskeletal diseases) may had negatively influenced the 6MWD in these series.[31,41] Our patients with severe obesity had adequate functional performance when evaluated according to ATS recommendations.[31] The better preoperative functional capacity found in our study could be at least partly explained by total and segmental FFM % (r: 0.4 to 0.6; $p < 0.001$). BMI was not correlated with the 6MWD (r: -0.1; $p > 0.05$) and cannot be considered a predictor of functional capacity. Our data corroborate a study[29] that showed a poor correlation between the 6MWT and BMI ($r = -0.3$; $p < 0.001$) and better correlations with body composition, unlike other series that suggests with weak to strong correlations (r: -0.45 to -0.85) between the 6MWD and BMI.[33-36,42]

The significant improvement in 6MWD observed after surgery was assigned to decreased body weight and improved sensation of dyspnea.[27-30] We observed an increase in the 6MWD after surgery with significant difference ($p < 0.001$) between patients at T0/T1 (23 m) and T0/T2 (41 m). The no significant improvement ($p =0.073$) in 6MWD between T1/T2 (18 m) could be explained by the no significant increase ($p > 0.05$) in FFM % and FFMLL %. There was also a significant increase ($p < 0.05$) in 6MWD between T0/T1 (23 m) and T0/T2 (41 m) in MO patients without improvement ($p > 0.05$) between T1/T2 (3 m). Previous studies[28-30,34] showed a greater motor displacement than our study (120 m) after surgical intervention (6-12 months). However, in these studies patients had a lower 6MWD before, which could explain greater motor displacement after surgery. Our results suggest the FFM % and FFMLL % are the best predictors of functional capacity in MO with moderate to strong positive correlations (r: 0.4 to 0.7; $p <0.05$) with the 6MWD. Similarly, SO participants showed a significant improvement ($p <0.05$) in motor displacement between T0/T1 (28 m) and T0/T2 (45 m), but also without significant improvement between T1/T2 (15 m). The 6MWD also showed positive and strong correlations with FFM % and FFMLL %.

Our results showed a significant increase in the 6MWD between T0/T2 in SG and FG patients (38 m and 36 m, respectively; $p < 0.05$) and moderate to strong positive correlations (r: 0.4 to 0.7; $p < 0.05$) with total and segmental FFM %. Only one study was found in the literature correlating %EWL with 6MWD, showing a moderate positive correlation with 6MWD (r: 0.48; $p < 0.05$). No studies were found in the literature that assessed long-term functional capacity in patients after surgical intervention. Independently of obesity grade or surgical success, we observed an improvement in functional capacity justified by body composition alterations rather than by a significant reduction in body weight and BMI.

A better functional capacity was observed in patients undergoing physical exercise programs after surgery.[37-39] Our data corroborate that the treatment of severe obesity should not be exhausted in bariatric surgery. Continuous interventions aiming ~~at~~ a significant increase in FFM and, especially FFMLL, should be considered to promote better long-term functional capacity after surgery.

CONCLUSIONS

Total and segmental body fat free mass indicates better functional capacity than BMI. The best functional capacity is associated with FFMLL %, independently of obesity grade or weight loss after bariatric surgery. Continuous interventions aiming to increase total FFM, especially FFMLL, should be considered in order to promote better long-term functional capacity after bariatric surgery.

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