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Bioimpedance: do we actually have to use gel?

Bioimpedancia: ¿Necesitamos utilizar gel?

To the Editor:

Medical techniques and expertise have evolved during the last decades. Nevertheless, various methods are still tiresome and time consuming. Our team specialises in obesity measurements, being one of the largest centres in Obesity in London, UK, and forming part of a worldwide plan which aims at diagnosing obese patients and thus help in preventing all co-morbidities that result from obesity and morbid obesity. We hereby would like to provide some preliminary results of a pilot study we performed in order to simplify obesity measurements.

Body composition measurements are useful in obesity to distinguish adiposity from fluid retention and/or muscularity[1]. Various bioimpedance techniques have been described and used to evaluate body composition. Early bioimpedance methods used invasive type of electrodes, but have been replaced by plate electrodes. Gels were used to optimize electrical contact in much of the early literature validating bioimpedance methodology. Modern bioimpedance analysis (BIA) systems use simple touch-pad electrodes without the need for invasive techniques[2,3]. Although it is not considered the gold-standard method for determining body composition, bioimpedance generally compares well with techniques such as DEXA, isotope dilution and underwater weighing. It is cheaper and more readily applicable than such methods. For example Mally et al[4] reported their experience using a Tanita BC-418-MA compared to DEXA and found that the device performs well but they suggest some improvements. One issue not addressed by Mally et al was whether gel can enhance the electrical connection and remedy the deficiencies they identify. Valid BIA requires a good contact between the subject's bare foot and the touch-pad electrode. Our Tanita machine's manual suggests moistening the feet if the impedance measurement is problematic. Historically hydroscopic gel has been used to optimise electrical contact with skin. This recommendation may be based upon the finding of Nunez et al[5] who compared a BIA method with and without the use of gel. Those authors found small but significant differences in parameters when gel was used. If gel improves the electrical connectivity, that would be a powerful reason to use it routinely. Use of gel is however time consuming, unpopular with patients and renders the foot plate of the device slippery (which can be hazardous in the sort of morbidly obese or disabled patient we see). We therefore followed the approach of Nunez using an MC-180, a modern machine with performance comparable to that used by Mally et al. Our objective was to compare BIA estimates of body composition obtained with and without the use of gel.

We studied 18 lean, agile subjects, 15 of whom were female and 3 male. Body mass index (BMI) ranged between 19-31 kg/m^2 and the bioimpedance machine used was a Tanita MC-180MA (Tanita Corp, Japan). Patients were measured standing barefoot on stainless-steel foot pads and holding two hand grips. All subjects in this study had normal agility and balance. Each foot pad and each hand grip contained a pair of two contacts (8 in total). Measurements were repeated within 10 minutes with and without

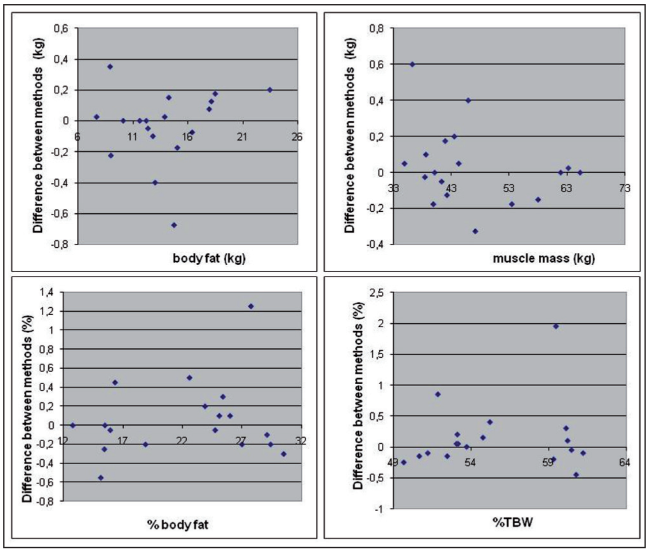

Figure 1. Bland Altman plots comparing difference between measurements with and without gel to mean value. TBW is total body water. Differences between methods were (mean ± SEM) 0.031 ± 0.055 kg, 0.031 ± 0.051 kg, 0.055 ± 0.093 % and 0.144 ± 0.125% for body fat, muscle mass, % body fat and % TBW respectively.

(in random order) the use of hydroscopic gel (ECG gel) applied thinly to the ball of the foot and the heel. The touch-pad and feet were thoroughly cleaned after each use of gel. We compared all regional and whole body composition parameters. Bland Altman[6] plots and paired *t* tests were used for statistical comparisons. Bland Altman plots are considered the optimal way to compare two different methods.

We compared the various parameters obtained from the bioimpedance machine including total body fat (kg), percentage body fat, fat free mass, muscle mass, percentage total body water, bone mass, total body water (kg), intracellular water (kg), extracellular water (kg) and intracellular water/ total body water (%). The results with and without gel were very similar for all parameters. There were no statistically significant differences between gel

and non-gel measurements ($p > 0.4$ for all). All parameters were compared with Bland Altman plots, for comparing two different methods[6]**.** Plots for selected parameters are shown in Figure 1.

The number of patients studied is small, but all results were extremely comparable with no significant difference when gel was used. The high degree of reproducibility suggests that the chance of missing a clinically significant effect of gel by a type 2 error is relatively small. For example, one can estimate that for total body fat (kg) we have an 80% power to exclude a statistically significant difference ($p < 0.05$) of less than 0.23 kg. For both percentage body fat and percentage body water the equivalent difference that can be excluded would be less than 0.25%. This would suggest that use of gel does not change BIA estimates by clinically important amounts. In contrast, the added slipperiness of the measuring platform with gel was clear and unwelcome by the subjects.

Our patients were all normally-hydrated with no clinical skin problems. Clearly one cannot predict from this study whether gel or moistening might change the results for subjects with dermatological problems. The ideal method of measuring body composition is accurate, precise, cheap, correlates well with reference methods and is convenient and acceptable to patients. Bioimpedance using modern machines seems to possess most of these attributes and its convenience and acceptability are increased by not using gel. Our results suggest that using gel is generally unnecessary.

In conclusion, for patients without dermatological conditions, the use of a thin layer of hydroscopic gel does not change body composition as measured by BIA.

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