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Impact of Hydration on Body Status Pre &Post Dialysis: A Radiological Appraisal by Dexa Scan

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Abstract

Aims & Objectives: The aim of this study was to evaluate the impact of haemodialysis on the estimation of body composition & status using DEXA scan as a model to understand whether any fluctuations in tissue turgescence cause errors in estimation of fat by DEXA scan.

Material & Methods: Twenty-four patients (11men, 15 women), age 65-75years-old, BMI 23-31 Kg/m2, underwent a whole-body DEXA scan immediately pre and post haemodialysis (approx after 2hrs).

Conclusion: Hydration status must be considered when measurements of body mass are performed. The major rate of fluid accumulation was noted in legs as there is dependence on venous competence and muscle tone against gravity, and also there is postural variance.

Keywords: DEXA; Hydration; Body; Composition; Imaging;

Introduction

DXA is a low-cost, accurate, easy to perform and widely available technique that allows to quantify bone mass and soft tissue with very low radiation dose to the patient; all these advantages make this density method ideal for clinical use and research studies.

DXA machine uses a source that generates X-rays at two energies, a detector, and an interface with a computer system for imaging the scanned areas of interest. The underlying concept of DXA technology is that photon attenuation in vivo is a function of tissue composition. Rectilinear scanning divides the body into a series of pixels, within each of which the photon attenuation is measured at two different energies. The ratio of the attenuations at these two energies is referred to as the R value.

DXA measurements are based on the molecular level that can be simplified in a threecompartment model with Fat Mass (FM), non-bone Lean Mass (LM) and Bone Mineral Content (BMC) (Figure 1); each of these components are distinguishable by their X-ray attenuation properties [1,2].

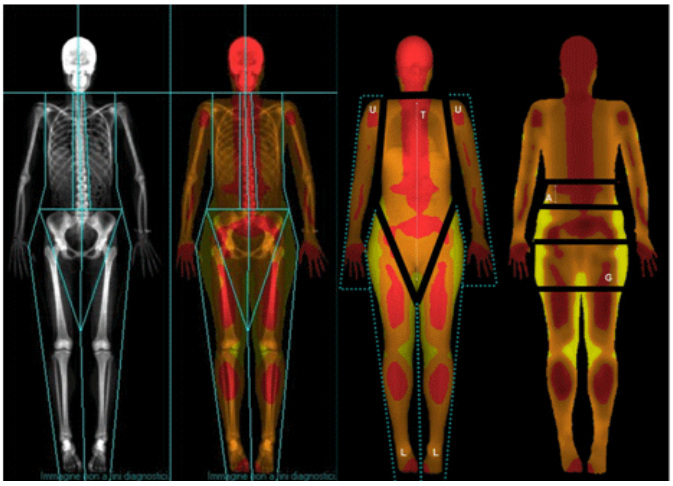

Figure 1: [Dual-energy x-ray absorptiometry whole-body analysis. The body is conventionally represented by coloured areas according to the percentage of fat mass. In the colour scale, ranging from red (low fat mass percentage) to yellow (high fat mass percentage), red is set for regions with composition under 25% of fat mass, orange for regions between 25% and 60% of fat, and yellow for fat over 60%. According to the regional assessment of body composition the figure shows U as upper limbs, T as trunk, L as lower limbs. A and G stand respectively for android and gynoid.

DXA technique can measure FM, LM, BMC not only in the whole body but also in specific regions of the body and this is of great interest because it is well known that the distribution of bone, lean and fat mass is not uniform throughout the body.

Now, a fundamental assumption is that the soft tissue is normally hydrated for accurate partitioning into fat and lean fractions [3,4,5].

DXA soft tissue analysis algorithms assume that 73% of the lean body mass is water [6]. However, hydration can vary from 67% to 85% and, in patients with fluid retention or with severe overhydration, such as ascites or oedema, this is a potential source of errors. As a consequence, the error in lean body mass quantification causes a proportionally larger error in estimating fat.

So DXA is gaining international acceptance as a body composition reference method but an important and incompletely resolved question is the influence of hydration status on the quantification of soft tissues' components.

Material & Methods

Twenty-four patients (11 men, 15 women), age 65-75years-old, BMI 23-31 Kg/m2, underwent a whole-body DEXA scan immediately pre and post haemodialysis (approx after 2hrs). All patients were included in the study after obtaining clearance by the ethical committee attached to the associated **Sardar Patel Medical College, Bikaner.**

A whole-body DXA scan was performed to measure total and regional body composition using a new fan-beam densitometer (Lunar iDXA, enCORETM 2015 software version 13.6). The subjects were placed in a supine position with arms at sides slightly separated from the trunk and correctly centered on the scanning field. Region Of Interests (ROIs) were defined by the analytical program including six different corporeal districts: total body, trunk, upper limbs, lower limbs, android region (a portion of the abdomen included between the line joining the two superior iliac crests and extended cranially up to the 20% of the distance between this line and the chin) and gynoid region (a portion of legs from the femoral great trochanter, directed caudally up to a distance double of the android region). For each region, DXA scanned the weight (in g) of total mass, FM (fat mass), LM (lean mass), and BMC (bone mineral content).

Visceral fat analysis was performed by CoreScan, a new software option for the assessment of visceral fat (mass and volume) in the android region [6]. The measurement of SAT (subcutaneous) thickness at both sides of the android region allowed the software to map the total SAT compartment. The amount of android VAT (visceral thickness) was derived by subtracting SAT from total android FM.

Statistical methods

The relationship between parameters derived from the different techniques was investigated by using DXA as reference technique. In particular, total body FM/LM (a), android/gynoid FM (b), android FM/LM (c), VAT (d), VAT/SAT (e), and SAT (f) were considered as the pivotal markers of body composition, in terms of general mass balance (a), central/peripheral distribution of FM (b), central or VAT compartment (c, d, and e for fat abdominal distribution), and SAT depot (f), respectively.

Pearson's test was used to evaluate the correlations between the BC parameters provided by DXA and the anthropometric and ultrasound values. The analysis was performed separately in males and females. Since three methods (DXA, anthropometry and US) were simultaneously applied to the study of body composition in the whole population, the statistical significance was set according to Duncan's multiple range as $p < 0.025$. Statview statistical package (version 5.0.1 for Windows; SAS Inc.,Chicago,IL,USA) was used for the analysis.

Results

The average removing of ultrafiltrate between pre- and post-haemodialysis was approximately 2L (3% of the total body mass) (Figure 2). A statistically significant change of total non-bone lean mass was observed (5%), especially in the leg compartment (7%). No statistically significant change was found for total fat

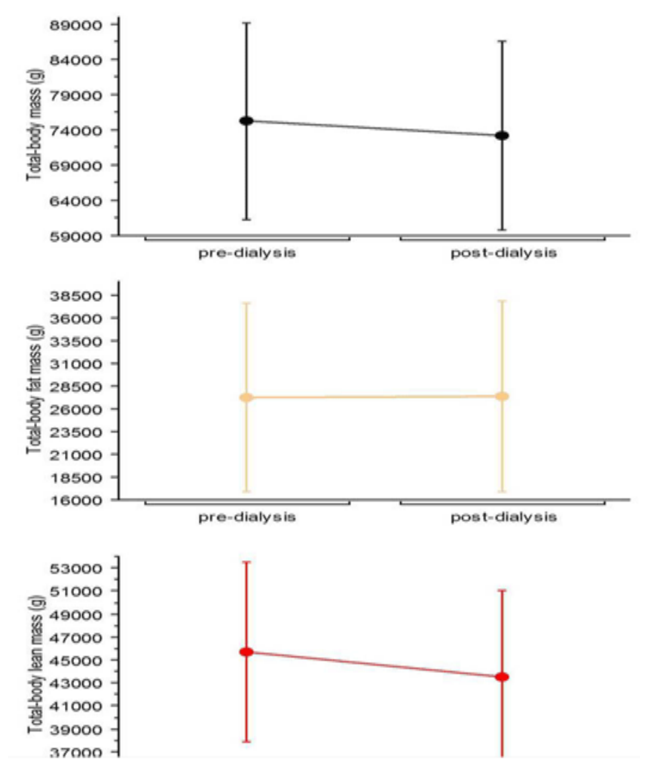

Figure 2: The figure shows the changes of total-body mass (in grams) pre- and posthaemodialysis: the average loss of total-body mass was approximately 2.1 Kg. The total-body fat mass did not present a statistically significant change between pre and post-haemodialysis, while a statistically significant change in total-body lean mass was observed (-4.9%).

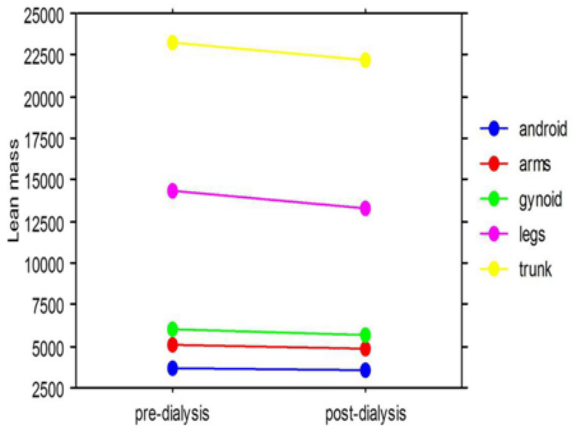

Figure 3: [A statistically significant change of total non-bone lean mass was observed especially in the leg compartment (-6.5%) while in the other compartments these modifications are less important.

Conclusion

Hydration status must be considered when measurements of lean body mass are performed. The major rate of fluid accumulation was noted in legs as there is dependence on venous competence and muscle tone against gravity, and also there is postural variance.

The fat estimation errors due to variation in soft tissue hydration was also present but it was minor than the LSC; and this should not represent a limitation to the accuracy of DXA in clinical practice.

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