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Original Article

Clinical Observations in Total Body DXA: Technical Aspects of Positioning and Analysis

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Abstract

Total body (TB) dual-energy X-ray absorptiometry (DXA) can assess regional body composition, which may necessitate greater attention to patient positioning and analysis than required for whole body assessment. This report describes technical challenges experienced in performing TB DXA, explores the frequency with which autoanalysis inaccuracies occur, assesses their effect on regional body composition results, and describes a uniform clinical approach for TB DXA positioning and analysis. Patient positioning followed manufacturer recommendations with additional facility-imposed procedures. On visual inspection, it was apparent that automated analysis often did not meet manufacturer guidelines, thus requiring manual alteration. To explore the frequency with which manual adjustments were needed, and the impact on results, TB scans were obtained in 20 men and 20 women aged 18–93 yr. The head line was altered in 98%, one or both shoulder lines in 93%, and the lateral hip boundary in 40%. Manual and automated TB analyses were highly correlated ($r^2 = 0.98–1.00$). However, regional result correlation was less robust, that is, automated and manual appendicular lean mass differed by more than our least significant change in 33%. In conclusion, manual correction of automated TB DXA scan analysis is often needed. Such alterations do not affect TB measures but may affect regional body composition results.

Key Words: Body composition; confounders; pitfalls; positioning; total body DXA.

Introduction

Dual-energy X-ray absorptiometry (DXA) is the current gold standard for osteoporosis diagnosis based on bone mineral density (BMD) measurement and widely used in fracture risk estimation *(1,2)*. Additionally, DXA can measure body composition (fat, lean, and bone mass) both total body (TB) and regionally, leading to its use in a variety of fields, including obesity, cancer, sarcopenia, human immunodeficiency virus (HIV), and physical performance *(3–9)*. However, DXA scanning pitfalls exist *(10,11)* and, unfortunately, technical errors in acquisition, analysis, and interpretation are not rare *(12)*. As such, it is appreciated that correct acquisition and analysis, with meticulous attention to detail, are required for clinical spine and hip BMD assessment. However, less emphasis has been placed on the technical aspects of TB DXA *(13)*. Although excellent TB DXA precision has been reported *(14)*, it seems likely that technical errors would adversely affect body composition assessment reproducibility over time. Consistent with this, it has been our clinical observation that technical positioning and analysis errors occur quite commonly and may confound regional body composition evaluation using DXA. To begin exploring this hypothesis, we evaluated the prevalence with which obvious analysis abnormalities were present in 40 TB DXA scans. Additionally, we report an approach to potentially enhance standardization of TB DXA positioning in our research facility.

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Materials and Methods

Participants

At our research facility, we have performed approx 1000 TB DXA scans over the past 5 yr. These scans were performed primarily on 2 groups of volunteers, older adults (aged 60−95 yr; weight: 100−250 lbs), to assess appendicular lean mass (ALM), and young division I athletes (aged 18−23 yr; weight: 100−325 lbs), to assess total and regional body composition. All scans were performed by International Society for Clinical Densitometry (ISCD)−certified densitometrists using a GE Healthcare Lunar iDXA densitometer (GE Healthcare, Madison, WI). These scans were obtained as part of institutional review board (IRB)−approved or IRB-exempt protocols.

TB DXA Scan Acquisition: Clinical Observations and Approach

GE recommendations for TB DXA acquisition were followed. Additionally, facility-specific acquisition and analysis parameters were implemented due to demonstrated or perceived confounders to regional TB assessment. Examples of such procedures include requirement for specific clothing and use of hand binding. These techniques resulted from efforts to obtain regional measurements free of artifact and including only correct body parts within the region of interest (ROI). In the following sections, we describe and illustrate specific instances leading to the implementation of facility-specific scan acquisition and analysis protocols. Positioning aids, such as sponges, pillows, solid positioners, rice bags, and so on, may be measured as tissue; consequently, such objects are excluded from the scan field. Patients are instructed to remove all external metal and artifacts, for example, buttons and zippers. They are then positioned as recommended by GE—centered and straight on the densitometer table with knees and ankles bound together by a Velcro strap. As the software may identify clothing as soft tissue (Fig. 1A and B), bulky clothing, for example, sweatshirts, cargo pants, and layered clothing, is avoided. Specifically, patients are required to wear T-shirts, shorts, pants, or hospital clothing made of thin material.

For regional body composition evaluation, it is essential to ensure that these regions only include the appropriate anatomy. To facilitate subsequent correct analysis, the individual's arms are positioned to maximize the space between the arms and torso. This allows clear separation of the arms from the abdomen and buttocks. However, this practice often results in the hands being close to the outer limits of the scan field. To help ensure that individuals do not spread their fingers and move them outside the scan field or under their buttocks (thereby confounding regional measurement), the fingers and thumb are bound together with an elastic or flexible plastic band. Additionally, the knees and ankles are strapped together as recommended by the manufacturer; this reduces the likelihood of patient movement (Fig. 2).

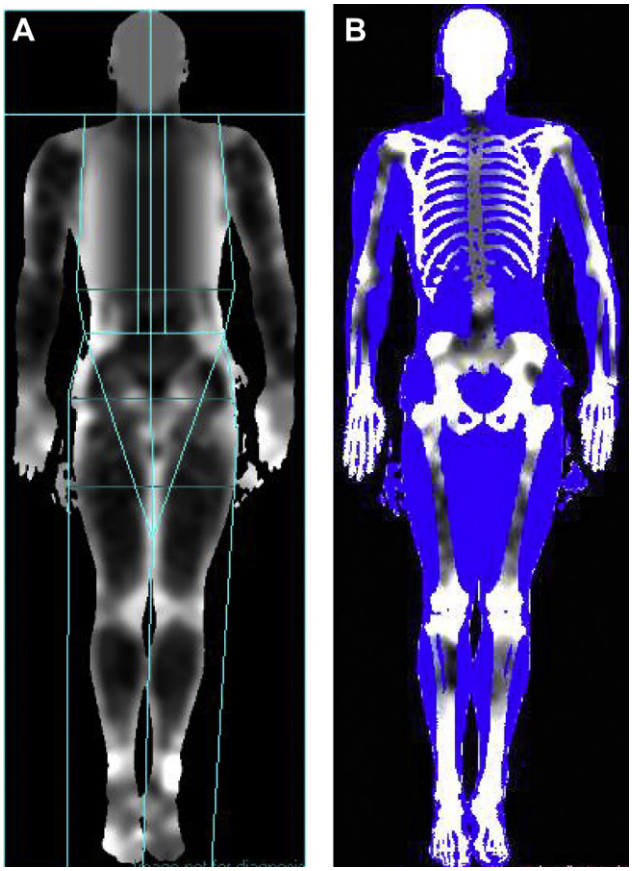

Fig. 1. Clothing artifact in total body scans. Bulky clothing, such as hooded sweatshirts or layered shirts, can appear on a scan as soft tissue. (**A**) This is an example of an individual wearing cargo pants in which the pockets are being imaged (**B**) and point typed, as soft tissue.

Patient positioning may also affect body composition assessment at the android and gynoid regions. Specifically, android and gynoid region size and placement are dependent on the head cut positioning. A confounder to head cut placement is hair or other items behind the head. For example, if a person's hair is bound behind his/her head such that it tips his/her chin forward when laying down, incorrect head cut placement occurs thereby affecting android/gynoid size and also potentially altering trunk and arm ROIs. In extreme cases, such forward flexion of the head will result in the head cut impinging on the shoulders (Fig. 3A and B). To minimize this potential acquisition confounder, long hair is let down and evenly distributed across the back before laying down the patient on the densitometer.

When performing TB DXA on a diverse patient population, individuals will be encountered who are either too tall or too wide to fit into the scan field (65.8-cm wide by 196.8-cm long on iDXA). As composition of the cranium (primarily cortical