Ann Diagn Paediatr Pathol
(1998) 2:49–51

CLINICAL ARTICLE

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Application of DEXA in body composition assessment in children

Presented at the 8th International Workshop of the European Childhood Obesity Group, 8–10 May 1998, Wisła-Jawonik, Poland

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Abstract Clinical and research applications of dual-energy X-ray absorptiometry in childhood are reviewed. Originally used for bone mineralization assessment in adults with osteoporosis, total body dual-energy X-ray absorptiometry is now also used currently alone or combined with other techniques for assessment of fat mass and fat-free mass. Low invasiveness, accuracy, swiftness and availability of pediatric software make total-body dual-energy X-ray absorptiometry suitable for studying body composition in a wide variety of metabolic and nutritional disorders in childhood such as simple or genetic obesity, insulin-dependent diabetes mellitus, congenital hypothyroidism, celiac disease, asthma, growth hormone deficiency and cachexic states.

Key words Body composition · Dual-energy X-ray absorptiometry · Review · Children

Dual-energy X-ray absorptiometry (DEXA) is a technique that allows simultaneous accurate and precise assessment of total and regional bone mineral content (BMC), bone mineral density (BMD), fat mass (FM) and non-mineral–non-fat mass (FFM) [10, 12, 25]. A total-body scan can be done in a short period of time (5–12 min) during which the subject receives a negligible radiation dose (0.02 mrem). Software suitable for adult and paediatric subjects is now available.

Clinical applications were limited until recently because the FDA required that body composition as assessed by DEXA be used only in research. However, in 1995 DEXA was cleared for use in body composition assessment in clinical practice. Osteoporosis, Cushing disease, prolonged steroid treatment, hyperparathyroidism, hyperthyroidism, hypogonadism, disorders of calcium metabolism, regional enteritis, idiopathic proctocolitis, intestinal malabsorption, chronic renal failure, vitamin D deficiency, and pathologic fractures are the main diagnostic applications for DEXA that are currently covered by Medicare.

Studies using DEXA over the last 5 years have shown that it accurately measures fat and lean content in meat samples and animal carcasses [16, 19, 27, 35]; dozens of studies have shown that DEXA compares well with such noninvasive approaches as neutron activation and hydrodensitometry. Three main companies are now involved in DEXA equipment production (Lunar, Hologic and Norland). Compared with DPX-Lunar, QDR-Hologic underestimates FM by 20% and BMC by 15–25% and Norland overestimates FM by 5% [34].

Originally DEXA was used mainly for BMC and BMD measurement in adults with osteoporosis. Following the validation of this technique for FM and FFM assessment, DEXA was taken in many studies as a “gold standard” for validation of other techniques for body composition assessment, such as body mass index (BMI), skinfolds or body impendance analysis [6, 7, 14, 15, 39]. A recent paper concludes that BMI, compared with DEXA, underpredicts adiposity both in children with disease states and in healthy subjects [39]. According to one of the most popular online databases, Medline (Healthgate), more than 60 papers have been published on clinical applications of DEXA in the last 3 years, 30% of them relating to children.

In normal and obese children DEXA showed that both total and regional BMC are related more to the FFM than

to the FM [24]. Moreover, BMD in children was found to correlate with their own age, pubertal stage height and BMI and with the BMD of their parents, but not with calcium intake, suggesting that heredity plays a major part in osteoporosis [22]. However, recent studies have shown that BMD is not useful in children and in cross-sectional studies, as it is significantly influenced by bone size [26]. Therefore, as suggested by Prentice et al., when bone mineralization is assessed BMC should be adjusted for bone area [28].

The clinical use of DEXA in children is mainly applied to basal assessment and follow-up of body composition changes in chronic diseases such as insulin-dependent diabetes mellitus, celiac disease, asthma, and chronic renal failure. Most of the papers on DEXA report studies on tissue changes induced by growth hormone [4–6, 11, 17] treatment. While growth hormone does not increase bone density, it does increase muscle mass and decrease fat mass. Children with Prader-Labhart-Willi syndrome who were studied with DEXA showed a peculiar body composition, to some extent similar to that found in subjects deficient in growth hormone or even in sedentary and elderly people [8, 9, 23]. The changes induced by corticosteroids are deleterious (specifically, an increase in fat mass and a decrease in muscle and bone mass). Recent studies on body composition assessed by DEXA in children chronically treated with inhaled steroids showed no adverse effects of the treatment on BMC and soft tissue body composition [1]; however, these results have yet to be confirmed by further studies, which are in progress at present. DEXA showed that spine BMD and FM in untreated and late-diagnosed celiac patients are significantly lower than in those diagnosed early [3, 33]. An obvious use of DEXA has been to assess changes to bone and lean tissue after weight loss [30, 36]. Another clinical use of DEXA is the measurement of body fat distribution; however, for accurate assessment of intraabdominal fat, the DEXA technique must be supplemented by a single-slice CT or RMI scan [20, 37].

Changes in muscle and fat mass associated with chronic physical activity have been measured using DEXA. Several studies have shown that athletes have a higher lean tissue mass and lower fat tissue mass [2, 18, 21, 38].

It has been assumed that diabetics will have some muscle wasting and often show osteoporosis, but recent studies conducted with DEXA did not show this, although water and potassium content were abnormal [29, 31]. DEXA also is useful for monitoring loss of fat, muscle and mineral bone in cachexic states such as AIDS [13], anorexia nervosa [32] or neoplastic disease.

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