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DXA in Children- What the Pediatrician Must Know?

KEYWORDS

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Introduction:

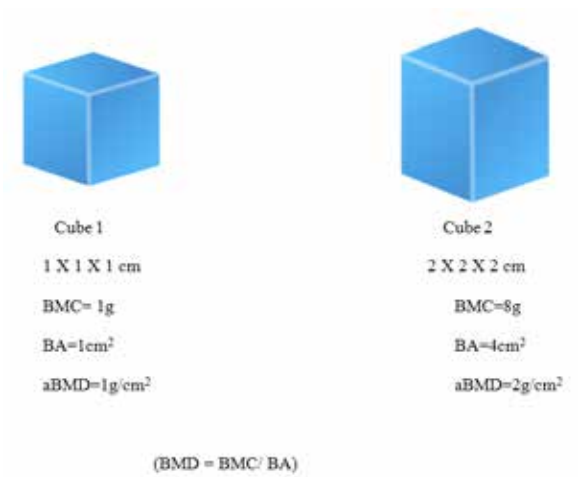
Dual energy X-ray Absorptiometry (DXA) has now become a widely available tool not only in the evaluation and management of adult bone diseases but also in pediatric bone diseases. The clinical indications for measuring bone densitometry in children as per National Osteoporosis Foundation includes:

1. Systemic long term corticosteroid usage
2. Chronic inflammatory diseases [juvenile idiopathic osteoarthritis, systemic lupus erythematosus, dermatomyositis, inflammatory bowel diseases, chronic liver disease]
3. Hypogonadism [Primary/Secondary]
4. Prolonged immobilization states [such as spastic quadriplegic cerebral palsy]
5. Osteogenesis imperfecta
6. Idiopathic juvenile osteoporosis
7. Recurrent low trauma fractures
8. Apparent osteopenia on radiographs [1]

Technique:

DXA is the most commonly used bone densitometric technique in children because it is widely available, precise and has low radiation exposure (radiation dose less than the dose of a standard PA chest radiograph) [2]. DXA uses a differential absorption of X-rays to differentiate tissues of different radiographic density. At low energy (30-50 keV) bone attenuation is more than soft tissue attenuation and at high energy (>70 keV) bone attenuation is similar to soft tissue attenuation [3]. DXA examination in children should include scans of the lumbar spine and whole body as both these sites are highly reproducible (coefficience of variation 0.64 – 1.03 at the spine and 0.66- 1.22 of the total body) as observed from the studies performed in healthy children aged 6-16 years. Lumbar spine is an easily identifiable bony land mark and has good precision of measurement in children. Total body measurements has the advantage of not only measuring total bone mass but also gives details about the fat mass and lean body mass. For evaluation of the lumbar spine, the LS spine should be straight and centered in the image with visualization of last rib pair and the upper sacrum. Other sites of bone mineral content and density measurements that are not routinely done in children include hip (total hip and proximal femur as it has significant variability due to skeletal development and lack of reproducible regions of interest), forearm and lateral distal femur (due to lack of normative reproducible data at these sites).

Bone mineral content and bone mineral density measurements in DXA are clearly explained from Fig 1.



[BA= bone area, BMC= Bone mineral content, BMD= Bone mineral density]

DXA derived bone mineral density is an areal (aBMD) rather than a true volumetric bone mineral density (vBMD). The BMD which is measured on DXA is based on two dimensional prejected area of a three dimensional structure. The third dimension "depth" cannot be measured because it is in the same direction as the x-ray beam. Therefore BMD measured in DXA is an areal BMD (aBMD) rather than volumetric BMD(vBMD). Unlike in adults where the bone volume does not change over a period of time, children's bone grow over time and the growth of the terminology "at risk for low BMD/BMC for chronologic age bone is not uniform in all 3 dimensions. This leads to an inherent error in the DXA process. The factors which influence BMD include age, sex, ethnicity, weight, height and puberty.

Interpretation:

DXA values are given as a Z-score. T-score should not be used in children and the terms " osteopenia" and "osteoporosis" should not appear in the Pediatric DXA reports. A Z-score of zero is equivalent to the mean, the Z score of -1 is equivalent to one SD below the mean, Z-score of +1.5 is equivalent to 1.5 SD above the mean respectively. When aBMD/ BMC Z-score is between -1.0 and -1.9 the is used and when Z-score is less than or equal to -2.0, the terminology " low BMD/BMC for chronologic age" is used[3,4].

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The current [2013] International Society for Clinical Densitometry [ISCD] position prefers measurement of BMD/ BMC for whole body less head and lumbar spine. The skull is excluded because growth of the skull is relatively static when compared to axial/ appendicular skeletal growth[4].

Limitations:
The limitations of DXA are as follows:

1. Availability of different normative reference databases tailored by different manufacturers such as Hologic and Lunar. Hence one cannot compare the BMC/BMD values obtained from one scanner with the other unless it is of the same manufacturer make and due to the availability of different DXA scanners in various hospitals/ laboratories.

2. Lack of normative database available for age- gender-ethnic specific populations.

Other methods available are peripheral quantitative computed tomography (p QCT) which is a low dose CT measure of bone mineral density. The advantage of p QCT is that it provides a 3 dimensional measurement of BMD and also differentiates cortical bone from that of a trabecular bone which is more metabolically active. The disadvantage includes absence of normative reference value for specific population, absence of normative reference value of BMD/ BMC for axial skeleton and increased radiation exposure.

Peripheral quantitative ultrasound (pQUS) is less expensive, portable, easy to use and lack radiation exposure. The limitation of pQUS is that there is limited availability of pediatric normative databases, lack of precision and reproducibility due to greater operator variability[3,4].

To conclude though DXA is the most common technique currently available for measuring bone mineral content and density in children. SEVERAL authors had reported ethnic differences in bone density parameters by using DXA. People of African origin have high aBMD than caucasian, people from Japan and China have low aBMD than caucasian, and Asian people have low aBMD than caucasian. Hence arrival of ethnic specific normative data for BMD using DXA is essential for its accurate interpretation and the need of the hour.

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