Bone mineralization during the first year of life

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ABBREVIATIONS

BMC  bone mineral content
BMD  bone mineral density
BW   body weight
DXA  dual X-ray absorptiometry
VLBW very low birth weight

INTRODUCTION

The goal of feeding regimens for low birth weight (LBW) infants is to obtain a prompt postnatal resumption of growth to a rate approximating that seen during intrauterine growth and to follow after term a growth rate similar to that of breast-fed term infants (1). Human intrauterine and postnatal growth, and body composition, have therefore been studied extensively in order to obtain reference values (2–8). Among the various body compartments, bone mineralization and calcium retention have received considerable attention and sophisticated techniques have been developed in order to define the most appropriate diet for preterm and term infants. For many years, body composition reference values at different gestational ages have been obtained from analyses of stillborn infants and neonates who died soon after birth. First values were reported in 1877, and around 169 infants have been analysed to date (8). The chemical reference values of whole body Ca content were recently reconfirmed by Ellis et al. (9,10) using gamma neutron activation in 19 preterm and term infants who died in the first 2 weeks of life (Fig. 1). Ca content was shown to be linearly related to birth weight, increasing from 10 g to 30 g as birth weight rises from 1500 g to 3500 g. From those data, it was calculated that intrauterine Ca accretion represents about 140 mg/kg body weight (BW) per day or 0.9% of BW gain (~15 g/kg per day). There are no reference values for whole body calcium content during infancy. Fomon et al. (11) studied body composition of reference children during infancy. They assumed that the concentration of osseous minerals in fat-free mass was constant from birth to 12 months and suggested that bone mineral content (BMC) represented around 92 g at 3500 g, 185 g at 8000 g and 233 g at 10 000 g.

Development of non-invasive techniques is necessary to permit collection of much of the needed information on body composition in healthy subjects during infancy.
Photon absorptiometry for the study of bone mineralization represents an example of an advanced technique that is of promise for use in the clinical setting. Dual X-ray absorptiometry (DXA) allows more precise estimates of whole body bone mineral content and is a novel step in determining whole body composition during development. Validation studies of dual X-ray absorptiometry for body composition have been performed in small piglets and term neonates (12–15). In a recent study using a new software program (QDR 2000 infants whole body software 5.64, 1993, Hologic Inc., Waltham, MA, USA), reproducibility of DXA measurements was 0.09% for BW and 1.95% for BMC (16). BMC estimated by DXA was significantly correlated with whole body ash weight ($r = 0.955$) and whole body chemical calcium content ($r = 0.991$) determined in 13 piglets with weights ranging from 1470 to 5500 g (Fig. 2). Equations for the conversion of BMC into ash and of BMC into calcium were calculated from these data and used to determine the precision of DXA measurements as ±10.99% for ash and ±4.44% for calcium content (Fig. 2). Since radiation exposure during whole body scanning of an infant is low (3 μSV or 0.3 mRem), we concluded that DXA is a non-invasive, safe and accurate method for evaluating bone mineral and calcium content in human newborn babies.

The aim of the present study was to evaluate the use of DXA for the determination of intrauterine and postnatal reference values of whole body composition and calcium content.