Monitoring of serum 25-(OH)D level in infants and its correlation with bone density and development

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Introductory

Vitamin D (VD) is an important nutrient necessary for humans. It can also play its role through receptors and is a hormone-like substance with a hormone-like mechanism (1). VD importantly participates in maintaining children's growth and development, bone health, and bone metabolism (2). In addition, it regulates calcium and phosphorus metabolism, promoting calcium absorption and calcium salt deposition (3). VD deficiency will elevate the danger of rickets in children and also lead to the occurrence of immune function impairment, autoimmune diseases, metabolic diseases, and other diseases in children (4,5). Therefore, early monitoring of vitamin D nutritional status in children is very important. 25-hydroxyvitamin D is an important indicator to evaluate the status of vitamin D (6).

When vitamin D is deficient or insufficient, less calcium and phosphorus are absorbed in the intestinal tract of the body, and the decrease of blood calcium and phosphorus levels will lead to the elevation of parathyroid hormone (PTH), accelerate the absorption of old bone, promote the release of calcium and phosphorus into extracellular fluid, and thus maintain the normal level of plasma calcium (7). Alkaline phosphatase (ALP) is mainly synthesized by osteoblasts. When vitamin D is deficient or insufficient, the level of bone calcification is decreased, and after the metabolic proliferation of osteoblasts, the activity and concentration of ALP in the blood are increased (8). VD is very important in promoting calcium and phosphorus absorption and maintaining bone health. bone density is a measure of bone mineralization.

Infants nutritional profile of vitamin D has been a focus of pediatric research in China. We investigated the association of infants (OH) D with levels of bone density, calcium, phosphorus, ALP, and PTH in infants aged 0 to 3 years. The objective of this work is to provide a reference for formulating intervention therapy for infants with abnormal bone density index and maintaining their vitamin D nutritional status.

Materials and Methods

General data

Children aged 0 to 3 years who were admitted to Tianjin Medical University General Hospital and subjected to bone density examination from January 2022 to March 2023 were enrolled. They had to satisfy the following conditions: 1) examining bone density and bone development by ultrasonic after admission; 2) no serious deformity; and 3) no vitamin D supplements. If any of the following items were found, the child had to be excluded: 1) with liver and kidney dysfunction; 2) with endocrine metabolism and immune dysfunction; 3) with malformed osteitis and osteogenic dysplasia may affect bone development; 4) with chromosomal disease and congenital appearance disease; 5) having received parenteral nutrition support therapy; and 6) with concomitant congenital thyroid or parathyroid disease. According to the results of the ultrasonic bone density examination, 150 children were rolled into a normal (N) group (n = 95) and an abnormal (ABN) group (n = 55). 56 males and 39 females were mentioned in the N group and they were 0 to 3 years, with a mean of (1.82 ± 0.71) years and an average birth weight of (2.92 ± 0.56) kg. 31 males and 24 females were in the ABN group

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and were 0 to 3 years old (2.07 ± 0.50 in average) and a mean birth weight of (2.83 ± 0.67) kg. Therefore, no visible difference was observed in general information of patients in different groups (P>0.05). The families of the included children have signed informed consent, and the study was approved by the Medical Ethics Committee of our hospital.

Detection of bone density
The middle part of the left tibia of the children was detected by an ultrasonic bone density detector, and the ultrasonic conduction velocity was recorded. The bone density in children was classified as follows: normal (Z value > -1.0), mild (-1.5 < Z value < -1.0), moderate (-2.0 < Z value < -1.5), and severe (Z value > -2.0). Mild, moderate, and severe bone density were all considered abnormal density.

Detection of serological indicators
The venous blood samples of children were taken from 3 mL, and subjected to centrifugation at 3,000 rpm/min for 10 min at 4°C to take supernatant. Serum 25(OH)D level was determined as insufficient (25(OH)D < 30 ng/mL) or adequate (25(OH)D ≥ 30 ng/mL or excessive (25(OH)D > 100 ng/mL). OCTEIA Intact kit was utilized to detect PTH levels in serum. Furthermore, the serum calcium, phosphorus, and ALP levels were determined by the automatic biochemical analyzer.

Methods for statistics
SPSS 19.0 was used. Data were displayed as frequency or percentage and compared with χ² test. Measurement data with normal distribution were given as mean ± standard deviation (X ± s) and compared using t-test. Pearson or Spearman test was applied to analyze the correlation among variables with normal or partial normal distribution. When P<0.05, the difference was statistically significant.

Results
Serum 25(OH)D levels in children with normal and abnormal bone density
The difference in serum 25(OH)D levels between normal and abnormal children was compared by ultrasound, as demonstrated in Figure 1. 25(OH)D levels in the N and ABN group were (98.41 ± 10.23) nmol/L and (56.38 ± 8.95) nmol/L, respectively, suggesting that in the ABN group was greatly lower and exhibited an obvious difference with that in the N group (P<0.01).

Calcium, phosphorus, ALP, and PTH levels in children
As illustrated in Figure 2, the calcium, phosphorus, ALP, and PTH levels in normal and abnormal children in the N group were (3.95 ± 2.16) nmol/L, (1.98 ± 0.21) nmol/L, (135.71 ± 15.23) U/L, and (1.78 ± 0.20) pmol/L, respectively; while those in the ABN group were (2.16 ± 0.28) nmol/L, (1.64 ± 0.19) nmol/L, (157.88 ± 18.65) U/L, and (2.46 ± 0.17) pmol/L, respectively. Based on the conditions in the N group, the calcium and phosphorus in the ABN group presented greatly lowered levels, while the serum ALP and PTH levels were increased, all showing obvious significances with P<0.01.

Correlation between 25(OH)D and bone density
Figure 3 below demonstrates the correlation between 25(OH)D and Z-values of bone density, which revealed that they were positively associated (r=0.918, P<0.01).

Correlations of 25(OH)D to calcium, phosphorus, ALP, and PTH levels
The correlations of 25(OH)D to calcium, phosphorus, ALP, and PTH levels were analyzed, as illustrated in Figure 4 and listed in Table 1. The results suggested that 25(OH)D was positively linked with calcium level (r=0.316, P<0.05), phosphorus level (r=0.209, P<0.05), ALP level (r=-0.428, P<0.01), and PTH level (r=-0.327, P<0.05).

Discussion
Children aged 0 to 3 years are at a critical stage of bone and body growth and development, and factors such as too little exercise, poor nutrition, and abnormal bone density have serious negative effects on infants’ growth, and increase the risk of osteomalacia and rickets of infants and
This work examined differences in 25(OH)D levels of infants in different states of bone density and found that infants and infants with abnormal bone density were sharply lower based on infants in normal states. Active VD greatly affects bone tissue metabolism, which can stimulate osteoblasts to synthesize osteopontin and osteocalcin, thus promoting bone formation (16-18). VD supplements can promote calcium absorption in the body and contribute to enhancing the prevention of osteoporosis (19). 25(OH)D is the best indicator to assess the nutritional status of vitamin D in children. Moreover, 25(OH)D levels of infants were positively correlated with the Z value of ultrasound bone density. The results indicated that the infants bone density increased with the increase of 25(OH)D level. Increased levels of active VD can regulate the metabolism of calcium and phosphorus, and thus affect the state of bone density (20).

Calcium and phosphorus are two kinds of minerals with the highest content in the human body, and their main role is to maintain normal metabolism and physiological functions of the body (21). The serum calcium and phosphorus levels of infants are associated with maternal calcium and phosphorus reserves and autoregulation mechanisms. Results in this work revealed that infants with abnormal bone density were significantly lower in serum calcium and phosphorus levels than infants in normal children, and showed a significant and positive link between infants and infants with abnormal bone density and 25(OH)D levels. VD deficiency or insufficiency can stimulate the increase of kidney 1α-hydroxylase activity, promote the generation of 1,25 (OH) 2D, increase the renal tubule reabsorption of calcium and inhibit the reabsorption of phosphorus, so the blood phosphorus level is reduced (22,23). In addition, the ALP levels of infants reflect the degree of disease and bone metabolism. When the level of ALP increases, the function of osteoblasts increases (24). Bone ALP is mainly synthesized by osteoblasts. When children are in the active stage of rickets, osteoblasts are active, and the level of bone ALP increases (25). PTH is a peptide hormone that works with vitamin D to maintain the stability of calcium and phosphorus in the body. PTH can maintain the serum calcium ion concentration at a normal level by stimulating the renal tubule's calcium reabsorption and bone absorption (26). In addition, the results herein suggested that infants with abnormal bone density were significantly higher than infants in normal infants, and serum ALP and PTH were negatively correlated with serum 25(OH)D levels. PTH can also stimulate bone formation, thereby increasing bone density and improving the microstructure in osteoporosis (27,28).

It was suggested that infants and infants of abnormal bone density were provided with early VD supplementation to upregulate 25(OH)D, and to maintain calcium, phosphorus, ALP, and PTH levels in infants and infants.

### Conclusion

Serum 25(OH)D reflects the VD nutritional status of infants (9,10). As an important nutrient for the human body, vitamin D also has hormone-like effects and is crucial in children's growth and development, bone health, and metabolism (11). VD supplements are the primary source of infants and infants in breast milk, infants, mainly obtained from sunlight, but adequate and safe vitamin D exposure to ultraviolet light is highly suspected (12,13). After VD enters the body, it is converted into serum 25(OH)D, which is realized by activating liver 25-hydroxylase, and has the characteristics of stability and high concentration (14). Bone density can reflect the development of human bone. Studies have confirmed that with the increase of age, bone growth and development gradually mature in children, and bone mineral deposition increases, so bone density also increases (15).
infants. Increasing the 25(OH)D level greatly prevented the infants from abnormal bone density and improved their bone metabolism. Moreover, 25(OH)D was important to reduce the osteomalacia and rickets caused by abnormal bone density in infants and to maintain normal bone growth and development and health of children. However, besides the nutritional status of vitamin D, infants bone metabolism was also affected by age, infection, nutritional diseases, and bone diseases. In the future, more samples should be included to analyze the important factors affecting bone metabolism and bone health in children. In conclusion, the results of this work were intended to offer a reference for improving the bone health status of infants and infants and improving the life quality of children.

References

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