

**MORPHOLOGICAL EFFECTS OF VITAMIN D DEFICIENCY ON BONE TISSUE:  
OSTEOPOROSIS AND OSTEOMALACIA****Djurayeva Ra'no Xayrulloevna**Department of Fundamental Medical Sciences of the Asian  
International University. Bukhara, Uzbekistan.**Annotation**

Vitamin D is an important endocrine regulator that controls bone metabolism. Its deficiency leads to disruption of calcium-phosphorus homeostasis, imbalance of osteoblast and osteoclast activity, and disruption of bone microarchitecture. This article analyzes the morphological changes caused by vitamin D deficiency in bone tissue, in particular its role in the pathogenesis of osteoporosis and osteomalacia, at the histological and ultrastructural levels.

**Keywords**

Vitamin D, calcium-phosphorus metabolism, osteoporosis, osteomalacia, osteoid, trabecula, histology

**Introduction**

Vitamin D (calciferol) has a steroid structure and is synthesized in the skin as a pro-hormone and subsequently converted to its active form, calcitriol, in the liver and kidneys. Calcitriol increases the absorption of calcium and phosphorus in the intestine, stimulates their reabsorption in the kidneys, and ensures mineralization in bone tissue.

Vitamin D deficiency is associated with the following factors:

- lack of sunlight
- malnutrition
- intestinal malabsorption
- liver and kidney diseases
- old age

This deficiency disrupts the process of bone remodeling and leads to various morphological pathologies.

**Vitamin D metabolism and its relationship to bone tissue**

Vitamin D is activated in the following stages:

1. Synthesis of cholecalciferol from 7-dehydrocholesterol in the skin
2. Conversion to 25(OH)D in the liver
3. Formation of 1,25(OH)<sub>2</sub>D (calcitriol) in the kidney

Effects of calcitriol on bone tissue:

- stimulates osteoblasts
- activates osteoclast differentiation via RANKL
- controls mineralization

**Normal morphology of bone tissue**

Bone tissue consists of the following components:

- organic part (osteoid) - mainly type I collagen
- inorganic part - hydroxyapatite crystals
- cells:
  - o osteoblasts (synthesizing)
  - o osteocytes (metabolic control)
  - o osteoclasts (resorbing)

Under normal conditions, bone remodeling is in equilibrium.

### Pathogenesis of vitamin D deficiency (in-depth analysis)

As a result of vitamin D deficiency:

1. Hypocalcemia develops
  - Ca absorption in the intestine decreases
  - Calcium levels in the blood decrease
2. Secondary hyperparathyroidism occurs
  - Parathyroid hormone (PTH) increases
  - Osteoclasts are activated
3. Bone resorption increases
  - Mineral component is broken down
  - Bone density decreases
4. Mineralization is impaired
  - Osteoid accumulates
  - Bone strength decreases

### Morphological and histological changes in osteoporosis

Osteoporosis is a disease characterized by a decrease in bone mass and microarchitecture.

At the microscopic level:

- the distance between the trabeculae increases
- the trabeculae are perforated
- osteoclastic lacunae increase
- the bone matrix becomes sparse

In cortical bone:

- the cortex thins
- Haversian canals expand

At the cellular level:

- osteoblast activity decreases
- osteoclast activity increases
- osteocyte apoptosis increases

Ultrastructural changes:

- disorganization of collagen fibers
- reduction in the number of mineral crystals

### Morphological and histological changes in osteomalacia

Osteomalacia is characterized by impaired mineralization of osteoid.

The main morphological signs:

- osteoid forms a thick layer
- the mineralization front decreases
- bone plates are deformed

Histological appearance:

- osteoid is located in large areas
- mineral salts are few or absent
- osteoblasts are active, but ineffective

At the level of electron microscopy:

- hydroxyapatite crystals are few
- collagen tissue is well preserved

### Molecular mechanisms of vitamin D deficiency

- RANK/RANKL/OPG system is disrupted
- osteoclastogenesis increases
- Wnt/ $\beta$ -catenin signaling pathway is weakened  $\rightarrow$  osteoblasts decrease
- cytokines (IL-1, IL-6, TNF- $\alpha$ ) increase

Clinical-morphological correlation

Clinical sign Morphological basis

Bone pain Osteoid accumulation

Fragility Trabeculae disruption

Deformation Mineralization deficiency

Muscle weakness Ca metabolism disorder

Diagnostic significance

Morphological examination methods:

- bone biopsy
- histomorphometry
- densitometry (indirect assessment)

Laboratory signs:

- 25(OH)D  $\downarrow$
- Ca  $\downarrow$  or normal
- PTH  $\uparrow$
- ALP  $\uparrow$

Prevention and treatment (scientific basis)

- vitamin D supplementation
- calcium supplements
- sunlight exposure
- physical activity

Conclusion

Vitamin D deficiency leads to profound morphological changes in bone tissue. While osteoporosis is characterized by a decrease in bone mass and microarchitecture, osteomalacia disrupts the mineralization process. A thorough study of these pathologies allows for their early detection and effective treatment.

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