ROLE OF VITAMIN A IN ORAL HEALTH

Dr.Gajapathi.B,

Professor, Dept of Prosthodontics and Crown & Bridge,

Sri Venkateswara Dental College and Hospital,

Chennai, India.

Dr.Arjun Badimela,

Associate Professor, Dept of Prosthodontics and Crown & Bridge,

Sri Venkateswara Dental College and Hospital,

Chennai, India.

Dr.Joanna Gracy P,

Assistant Professor, Dept of Prosthodontics and Crown & Bridge,

Sri Venkateswara Dental College and Hospital,

Chennai, India.

Dr.Priyanka Raju,

Post Graduate, Dept of Prosthodontics and Crown & Bridge,

Sri Venkateswara Dental College and Hospital,

Chennai, India.

Introduction

Biochemistry and Physiology of Vitamin A

Absorption

Transport from Liver to Tissues

Uptake by Tissues

Daily Requirements of Vitamin A

Role in Color

Role in Normal Epithelialization

Role in Mucus Formation

Role in Growth

Role in Transferrin Synthesis

Role in Immunity

Role in Normal Reproduction

Role in formation of Bones and Teeth

Role in GCF

Vitamin A as Antioxidant

Vitamin A Has Anticancer Activity

Oral Manifestation of Vitamin A

Deficiency of Vitamin A

Oral Complications - Deficiency of Vitamin A

Role of Vitamin A in Oral Leukoplakia

References

Introduction

In 1912, a biochemist named Casimir Funk extracted a water soluble compound from rice bran and named it “vitamine.” He thought that it was an “amine” which was “vital” for life.In 1932, Paul Karrer demonstrated chemical structure of vitamin A.1937, H. Holmes and R. Corbet extracted and crystallized vitamin A. Animal sources contain (preformed) vitamin A. The best sources are **liver**, **kidney**, egg yolk, milk, cheese, butter. **Fish** (cod or shark) liver **oils** are very rich in vitamin A. **Vegetable** sources contain the provitamin A-**carotenes**. Yellow and dark green vegetables and fruits are good sources of carotenes e.g. carrots, spinach, pumpkins, mango, papaya etc.

Biochemistry and Physiology of Vitamin A

It exists in nature in three distinct forms:

1. Retinol (vitamin A alcohol) : It is a primary alcohol containing -ionone ring. The side chain has two isoprenoid units, four double bonds and one hydroxyl group. Retinol is present in animal tissues as retinyl ester with long chain fatty acids.

2. Retinal (vitamin A aldehyde) : This is an aldehyde form obtained by the oxidation of retinol. Retinal and retinol are interconvertible. Previously, the name retinine was used for retinal.

3. Retinoic acid (vitamin A acid) : This is produced by the oxidation of retinal . However, retinoic acid cannot give rise to the formation of retinal or retinol.

4. -Carotene (provitamin A) : This is found in plant foods. It is cleaved in the intestine to produce two moles of retinal. In humans, this conversion is inefficient, hence -carotene possesses about one-sixth vitamin A activity compared to that of retinol.

Absorption

The absorption is along with other fats and requires bile salts. In biliary tract obstruction and steatorrhea, vitamin A absorption is reduced. It is carried by chylomicrons and transported to liver. In the liver cells, vitamin is stored as retinol palmitate

Transport from Liver to Tissues

The vitamin A from liver is transported to peripheral tissues as trans-retinol by the retinol binding protein or RBP.

Uptake by Tissues

Inside the cytoplasm of cells, vitamin binds to cellular retinoic acid binding protein (CRBP) and finally to hormone responsive elements (HRE) of DNA. Thus genes are activated.Vitamin A is stored in the liver as “retinyl palmitate.” Around 95% of vitamin A is stored in the liver.

It is released as retinol in blood circulation. Its normal plasma level is 18–60 μg per 100 ml of blood.

Daily Requirements of Vitamin A

The recommended daily allowance (RDA) for Children = 400 – 600 microgram. Men = 750 – 1000

microgram/day. Women = 750 microgram/day pregnancy = 1000 microgram/day

Role in Color

Vision Cones possess conopsin. It is composed of opsin and retinal moiety. Therefore,vitamin A is necessary for daylight vision and color vision.

Role in Normal Epithelialization

Retinol is necessary for normal epithelialization in the skin and mucous mem-

brane. It prevents excessive keratinization.

Role in Mucus Formation

Retinyl phosphate is helpful in the formation of glycoproteins. These are structural components of mucus which is secreted by mucous membranes in body cavities. Mucus keeps the surface of mucosa moist and healthy. Vitamin A protects mucosa from infection.

Role in Growth

Retinoic acid behaves like steroid hormone. It binds to nuclear receptors. The all-trans-retinoic acid binds to “retinoic acid receptors” (RARs), and 9-cis- retinoic acid binds to “retinoid X receptor.” Retinoic acid regulates transcription of genes. So retinoic acid regulates protein synthesis in the body. Therefore, retinoic acid is necessary for cell differentiation and growth of cells in the body.

Role in Transferrin Synthesis

The all-trans-retinoic acid has found to regulate protein synthesis. It enhances synthesis of transferrin protein. It binds with iron in blood circulation.

Role in Immunity

Vitamin A plays an important role in the development of immune system. It is necessary for appropriate immune response against various infections. In experimental model on mice, it has been found that retinoic acid stimulates proliferation and cytotoxicity of T cells. Retinoic acid can modulate activity of antigen-presenting cell. Retinoic acid can stimulate proliferation of B cells and antibody formation.

Role in Normal Reproduction

The all-trans-retinoic acid is necessary for normal reproduction. The fact has been proven by experiments on vitamin A-deficient (VAD) male and female rats. The development of testes in VAD male rats was affected. The VAD female rats were found to be sterile. Vitamin A is also necessary for normal embryo development.

Role in formation of Bones and Teeth

Vitamin A has a role in the formation of bones and teeth. Retinoic acid activates osteoblastic activity, and its deficiency decreases endochondral ossification.

Role in GCF

Vitamin A and carotenoids express a variety of immunological and anabolic properties, which combined could augment biological events during periodontal healing/regeneration.

Vitamin A as Antioxidant

Antioxidant is a chemical compound that inhibits oxidation of biomolecules in living system. They prevent lipid peroxidation and damage to proteins and DNA. The beta-carotene scavenges free radicals in the body and acts as antioxidants.

Vitamin A Has Anticancer Activity

The all-trans-retinoic acid (ATRA) has found to have anticancer activity. It can enhance anticancer effect of epigallocatechin-3-O-gallate (phytochemical in green tea) on subcutaneous growth in mice model.

The use of all-trans-retinoic acid has been approved by the US Food and Drug Administration for the treatment of lymphoma and melanoma. The (ATRA) is found to inhibit growth of tumor and metastasis.

 Oral Manifestation of Vitamin A

* It is also known as retinol and is the active form of the vitamin.
* It helps to build and maintain healthy tissues, such as skin, hair, nails, and mucous membranes.
* Vitamin A supports good vision and the immune system.
* Vitamin A is involved in the formation of rhodopsin, necessary for the normal maintenance of the retina, in the control of epithelial differentiation and in the secretion of salivary glands, nose, throat, in bone remodeling, and in reproduction.
* It is essential for the membrane structures of cells and supports the health of oral structures such as teeth, periodontium, and mucosa.
* Vitamin A has antioxidant properties throughwhich it supports the periodontal complex. Vitamin therapy with vitamins A, E, and K is used to treat periodontal diseases.
* Vitamin A and carotenoids express a variety of immunological and anabolic properties, which combined could augment biological events during periodontal healing/regeneration.

Deficiency of Vitamin A

**Night blindness or nyctalopia:** Visual acuity is diminished in dim light. The patient cannot read or drive a car in poor light. The dark adaptation time is increased.

**Xerophthalmia:** The conjunctiva becomes dry, thick and wrinkled. The conjunctiva gets keratinized and loses its normal transparency. Cornea is also keratinized. Infections may supersede.

**Bitot’s spots:** These are seen as greyish-white triangular plaques firmly adherent to the conjunctiva. This is due to increased thickness of conjunctiva in certain areas. All the ocular changes mentioned so far are completely reversible when vitamin is supplemented.

**Keratomalacia:** When the xerophthalmia persists for a long time, it progresses to keratomalacia (softening of the cornea). Later, corneal opacities develop. Bacterial infection leads to corneal ulceration, and total blindness.

**Preventable blindness:** The deficiency of vitamin A is the most common cause of blindness in Indian children below the age of 5. One-third of the world’s blind population are residing in India. About 40% of blindness is preventable.

**Skin and mucous membrane lesions:** Hyperkeratosis of the epithelium occurs. Epithelium is atrophied. The alterations in skin may cause increa sed occurrence of generalized infections.

Oral Complications - Deficiency of Vitamin A

* Oral complications from VAD include oral keratotic changes and disorders of mucosal keratinization, as well as enamel and dentin anomalies leading to an increased risk of dental caries, enamel hypoplasia, and periodontitis.
* Enamel damage, or amelogenesis imperfecta, can result in hypoplasia or opacity,raising the risk for early childhood caries due to compromised enamel integrity.
* Vitamin A hypovitaminosis is associated withdry and atrophic oral mucosa, often accompanied by angular cheilitis. The lips are dry, cracked, with the presence of crusts on them.
* Angular cheilitis can also be observed in vit. A hypervitaminosis.

Role of Vitamin A in Oral Leukoplakia

Oral leukoplakia, according to WHO, can be defined as “a white patch which cannot be diagnosed clinically or histopathologically as any other oral lesion.”Retinoids are new drugs derived from vitamin A. They are administered orally and applied topically. Retinoids act by inducing apoptosis of cancer cells.The isotretinoin, 13-cis-retinoic acid, is vitamin A analog. It has the highest potential in the prophylaxis of secondary tumors.

References

1. Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of Biochemistry for Dental Students. 3rd ed. New Delhi: Jaypee Brothers Medical Publishers; 2013.
2. Satyanarayana U, Chakrapani U. Biochemistry for Dental Students. 2nd ed. Kolkata: Elsevier; 2018.
3. Gupta A. Comprehensive Biochemistry for Dentistry: Textbook for Dental Students. 1st ed. New Delhi: Jaypee Brothers Medical Publishers; 2018.
4. Influence of Water- and Fat-Soluble Vitamins on Oral Health in Adolescence, Kristiyana Mineva, Milena Georgieva-Dimitrova, Scripta Scientifica Medicinae Dentalis, 2024;10(1):14-21 Medical University of Varna
5. Deficiency on Oral Health and Facial Structures. Int J Dent Res Allied Sci. 2024;4(2):1-8. https://doi.org/10.51847/QQ4M695DJh
6. Leši´c, S.; Ivaniševi´c, Z.; Špiljak, B.; Tomas, M.; Šoštari´c, M.;Vˇcev, A. The Impact of Vitamin Deficiencies on Oral Manifestations in Children. Dent. J. 2024, 12, 109. <https://doi.org/10.3390/dj12040109.>
7. Fawzy El-Sayed KM,  Cosgarea R,  Sculean A, Doerfer C.  Can vitamins improve periodontal wound healing/regeneration? *Periodontol 2000*.  2024; 94: 539-602. doi:[10.1111/prd.12513](https://doi.org/10.1111/prd.12513)