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Oral Health and Vitamin B_{12}: A Review.

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ABSTRACT

Vitamin B_{12} occurs in various forms and has a variety of names. It is unusual in its origin. Most vitamins can be made by a wide variety of plants and specific animals but no plant or animal has been found capable of producing Vitamin B_{12} and the most common sources of this vitamin appears to be small microorganisms like bacteria, yeasts, molds, and algae. Its deficiency causes nervousness, generalized weakness, megaloblastic anemia, dementia, etc. Intra-oral signs and symptoms include pale mucosa, recurrent aphthous stomatitis, candidiasis, angular chielitis, glossitis, etc. This paper reviews vitamin B_{12} structure, metabolism, function, sources, deficiency and correlation with oral health along with therapeutic measures.

INTRODUCTION

Vitamin B12 is one of the most controversial members of the vitamin "B-complex" family. It is unusual in its origins. Though, most vitamins can be made by a wide variety of plants and animals, but no plant or animal has been found capable of producing B12 and the important sources of this vitamin appears to be small microorganisms like yeasts, molds, algae and bacteria. Like other vitamins, Vitamin B12 can also occur in a number of forms and have a variety of names. Synonyms include: cobrynamide, cobamide, cobinamide, cobalamin, aquocobalamin, hydroxcobalamin, cyanocobalamin and nitrotocobalamin. Each of all these designations contains a form of the word “cobalt” since cobalt is the mineral found in the center of the vitamin.

Vitamin B_{12} is also unusual in that it is dependent upon a second substance which is known as intrinsic factor, to enter from the "GI" tract (gastrointestinal tract--the stomach and intestines) into the rest of the body. Intrinsic factor, which is a unique protein made in the stomach, is very important for vitamin B_{12} because vitamin B_{12} cannot gain access to the rest of the body where it is needed [1].

Metabolism and Functions

The metabolism of cobalamine is complex and involves many processes. The average daily requirement for cobalamin in adults is 1–2 µg. Most cobalamin in food is bound to proteins and released when the protein is subjected to acid-peptic digestion in the stomach. The released cobalamin rapidly attaches to a cobalamin-binding protein, R-binder, present in saliva and gastric juice. The R-binder in the R-binder complex is broken down in the alkaline environment of the jejunum by pancreatic trypsin and the released cobalamin binds to intrinsic factor produced by gastric parietal cells in the duodenum and transported to the distal ileum, where specific receptors bind the B_{12}-intrinsic factor complex resulting in B_{12} absorption. This attachment is calcium dependent, the calcium being provided by the pancreas. In the absence of intrinsic factor, cobalamin is absorbed only very inefficiently by passive diffusion. If one of these steps does not work properly, it may lead to cobalamin deficiency. Most cobalamin is stored in the liver (about 4–5 mg). Megaloblastic anemia occurs when the body’s cobalamin stores fall below 0.1 mg. Once metabolized, cobalamin acts as a cofactor or coenzyme in various biochemical reactions such as DNA synthesis, synthesis of methionine from homocysteine and conversion of propionyl into succinyl coenzyme A.

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Red Blood Cell Production

Perhaps the most well-known function of B12 involves its role in the development of red blood cells. During production of red blood cells, their maturation requires information provided by molecules of deoxyribose nucleic acid (DNA- which is the substance containing genetic information in the nucleus of any cell). Without vitamin B_{12}, DNA synthesis becomes defective, and so the red blood cell formation and maturation. The red blood cell morphology changes leading to oversized and poorly shaped cells, ineffective function leading to a condition called pernicious anemia.

Nerve Cell Development

A second major function of B_{12}, which is less clearly understood than the first one, is its participation in the development of nerve cells. Whenever vitamin B_{12} is deficient, the myelin sheath enclosing the nerves is formed less successfully. Although the role of vitamin B_{12} is indirect in this process, but supplementation of vitamin B_{12} has been found to be effective in relieving pain and other symptoms in a variety of nervous system disorders.

Other Roles of Vitamin B_{12}

Proper cycling of proteins (the component of food required for growth and repair of cells) through the body depends upon vitamin B_{12}. The main components of protein-the amino acids, become unavailable for use in the absence of vitamin B_{12}. As vitamin B_{12} is required for one of the steps in carbohydrate and fat processing for its completion, deficiency of the vitamin can also affect the transport of carbohydrates and fats through the body.

THERAPEUTIC USES

Vitamin B_{12} may be required in the prevention and/or treatment of the following health conditions:

- Alcoholism
- Anemia (Pernicious)
- Arthritis (Rheumatoid)
- Asthma (Bronchial)
- Atherosclerosis
- Cancer
- Celiac Disease
- Crohn's Disease
- Dermatitis (Seborrheic)
- Epstein-Barr Virus
- Fatigue
- Leukemia
- Lupus
- Multiple Sclerosis
- Neuropathies or Neuromuscular degeneration

Food Sources

Animals have more of the vitamin than plants because of the greater ability to store vitamin B_{12}. The main sources of vitamin B12 are therefore limited to animal foods mainly which includes snapper and calf's liver. Other good sources of vitamin B12 are scallops, shrimp and salmon. Within the plant world, sea plants (like kelp), algaes (like blue-green algae), yeasts (like brewer's yeast), and fermented plant foods (like miso, tempeh or tofu) are among the most commonly consumed and rich food sources of vitamin B_{12}.

DEFICIENCY

Serum cobalamin level < 150 pmol/L on two separate occasions or Serum cobalamin level < 150 pmol/L along with methylmalonic acid > 0.4 umol/L in the absence of renal failure and folate and vitamin B6 deficiencies. Although B12 is not the only nutrient deficiency that can contribute to occurrence of the following symptoms, but it should be considered as a possible underlying factor whenever any of the following symptoms are present. Common manifestations include Macrocytosis, hyper-segmentation of the neutrophils, aregenerative macrocytary anemia, medullary megaloblastosis (blue spinal cord), sclerosis of the spinal cord, classic polyneurites (especially sensitive ones), ataxia, Babinski's phenomenon, Hunter's glossitis, jaundice, lactate dehydrogenase and bilirubin elevation, resistant and recurring mucocutaneous ulcers [2].

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Impact of Cooking, Storage and Processing

When derived from animal foods, vitamin B_{12} is fairly well preserved under most cooking conditions. For example, about 70% of the vitamin B_{12} present in beef is retained after boiling for 45 minutes at 350 degree Fahrenheit. Similarly, about 70% of B_{12} is still present after cow's milk is boiled for 2-5 minutes.

Vitamin B12 and the gastro-intestinal system

Gastro-intestinal problems can contribute to a vitamin B_{12} deficiency in two ways. First, irritation and inflammation of the stomach which can prevent the stomach cells from functioning properly and when function is improper the cells may stop producing intrinsic factor (IF)-a substance required for vitamin B_{12} absorption. So vitamin B_{12} cannot be absorbed from the gastrointestinal tract into the body's cells. The second way for stomach problems to create B_{12} deficiency is through inadequate secretion of stomach acids. Lack of stomach acids, a condition called hypochlorhydria, gets in the way of vitamin B_{12} absorption since most B_{12} in food is attached to proteins and stomach acids are essential to release the B_{12} from these proteins.

Vitamin B_{12} and Vegetarianism

The ability of a strict vegetarian diet to supply adequate amounts of B_{12} is controversial. The controversy is because of two somewhat divergent schools of thought. One school of thought emphasizes on the fact that most animals, including humans can store long-term supplies of vitamin B_{12}. In humans, these stores may last for twenty years or longer. A second school of thought, however, points towards the unreliability of plants as sources of vitamin B_{12}. So, for strict vegetarians who eat no animal products, this unreliability may pose a problem. As no plant is capable of making vitamin B_{12}, its amount in plant food depends upon the relationship of the plant to soil and root-level microorganisms like bacteria, yeasts, molds, and fungi which make the vitamin. The content of vitamin B_{12} of sea vegetables also varies according to the distribution of microorganisms in the surrounding sea environment.

Oral Manifestations of Vitamin B_{12} Deficiency

The general symptoms related to vitamin B_{12} deficiency include generalized weakness, fatigue, shortness of breath and neurological abnormalities such as dementia. Oral signs and symptoms of B_{12} deficiency are angular cheilitis, angular scars, angular stomatitis and inflammation, glossitis, burning sensation of tongue, altered taste sensation, soreness, oral Candidiasis, recurrent oral ulcers, diffuse erythematous mucositis and pale oral mucosa [3,4,5]. The presence of these symptoms provides the dentist an opportunity to help in diagnosis of Megaloblastic anaemia.

Vitamin B_{12} and Elderly Population

Vitamin B_{12} deficiency in the elderly population is apt to be subclinical but any stress may result in an individual having detectable and prominent symptoms. The serum measurement of vitamin B_{12} metabolites has shown a high prevalence of undiagnosed vitamin B_{12} deficiency in elderly population. More often the protein bound vitamin B_{12} malabsorption leads to deficiency than a low vitamin B12 intake or lack of intrinsic factor. A vitamin B_{12} deficiency in older people may lead to dementia, generalized weakness, easy fatigue and shortness of breath. Synthetic vitamin B_{12} obtained from fortified foods or vitamin supplements is better absorbed than protein-bound vitamin B_{12} [6].

Nutrient Interaction

Vitamin B_6 is required for proper absorption of vitamin B_{12} and its deficiency has been shown to impair B_{12} absorption. Conversion of vitamin B_{12} from its non-active form into its biologically active form requires the presence of vitamin E. Individuals who are at risk for vitamin E deficiency may show signs of vitamin B_{12} deficiency as well. Excessive intake of folic acid can mask B_{12} deficiency. The individuals who are at risk for vitamin B_{12} deficiency and also taking folic acid in supplement form should consult healthcare practitioner.

Diagnostic Measures

Screening for cobalamin deficiency involves all elderly patients who are malnourished, all patients in psychiatric hospitals, all patients with haematological or neuropsychiatric manifestations of cobalamin deficiency. Testing the serum cobalamin level < 150pmol/L (± total homocysteine) confirms the diagnoses.

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Therapeutic measures

It involves administration of 1000 µg of cobalamin per day for 1 week, followed by 1000 µg per week for 1 month and then by 1 injection of the same dose once per month, normally till the symptoms continue or for the rest of the patient's life.

SUMMARY

Vitamin B_{12} being regarded as the unusual vitamin, owing to its availability and metabolism, has wide range of essential functions in human body. These include red blood cell formation, DNA maturation, myelin sheath formation, keratinisation, etc. Deficiency of Vitamin B_{12} is often rare as the body stores are sufficient for at least 4-5 years. However, if occurred, the role of dentist is very crucial in its diagnosis as more than half of early manifestations involve oral region.

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