InterClinical Laboratories
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STRONTIUM, BARIUM and TITANIUM
HTMA and the Lesser Known Trace Minerals

A common question that we are frequently asked is: *"Why do we test for the additional elements in a Hair Tissue Mineral Analysis (HTMA)?"*

The main reason is due to the fact we recognize that there is an inter-relationship between most, if not all, mineral elements that enter the body. By using analytical pathology assessment in a HTMA, the more reliable data we can provide will ultimately lead to better health appraisals and clinical outcomes. Like all elements, trace minerals enter the body from various sources including; dietary, supplementation, environmental and external pollutants (xenobiotics) and medications. Some serve as essential nutritional minerals for biological function and others are toxic such as heavy metals. Certain lesser known additional elements are also considered toxic while others are biologically inert. In any case, we need to consider that all mineral elements have the potential to have a cause and effect, with respect to maintaining normal homeostatic balance in the body.

A comprehensive analysis in a HTMA test (including the additional elements) gives us an indication of what is happening with all mineral element levels (nutritional, toxic and additional) within the body at an intra-cellular tissue level. We consider that the health of the human body as a whole begins at the cellular level. This assessment may give us some insight as to what mineral imbalances and toxic elements are impacting on our overall health.

In this newsletter we will focus on three of the lesser known additional elements; strontium, barium and titanium. We will discuss their relevance to human biological function, main sources from outside the body, toxicity, absorption, excretion and relevance in HTMA assessment. In following newsletters, we will continue to discuss more information on elements analysed in a HTMA which will include; germanium, bismuth, rubidium, nickel, platinum, thallium, vanadium, tin, tungsten and zirconium.

38
Sr
Strontium
87.62

Strontium

Chemical Structure

Strontium is a soft, silver-yellow, alkaline earth metal. It is highly reactive to air and water, hence this element always naturally occurs combined with other elements and compounds. It has physical and chemical properties are similar to calcium and barium.[1] Strontium commonly occurs in nature, forming about 0.034% of all igneous rock and in the form of the sulfate mineral celestite ($SrSO_4$) and the carbonate strontianite ($SrCO_3$).

Sources

Strontium is a naturally occurring element commonly found in many parts of the environment including rocks, soil, dust, coal, air and oil. Naturally occurring strontium is not radioactive and is either referred to as stable strontium or strontium. The stable isotope strontium is frequently found in all natural dietary sources of calcium. Grain, leafy vegetables, and dairy products contribute the greatest percentage of dietary strontium to humans. Strontium tends to be most concentrated in the bran of grains and peels of root vegetables. Brazil nuts, sea vegetables and sea water are also rich sources. The range of foods containing strontium varies from very low in corn (0.4ppm) and oranges (0.5ppm) to high in cabbage (45ppm), onions (50ppm) and lettuce (74ppm).[2] Drinking water concentrations of strontium are generally low.[3]

One of the isotopes of strontium (90Sr) is radioactive. This isotope is not related to the stable form and is not likely to occur naturally in the environment. It appears as part of the environment in small amounts from past nuclear accidents, fallouts from nuclear explosions, nuclear bomb testing and radioactive storage leaking.

Absorption and Excretion

Strontium is generally poorly absorbed. Ingested strontium that is unabsorbed is eliminated through faeces within the first day or so after exposure. Once it enters the bloodstream, it is distributed throughout the body, where it acts very much like calcium. A large portion of the strontium will accumulate in bone, approximately 99% of strontium in the body is found in the bones. Strontium levels in bones, teeth and the aorta have been shown to increase with age and vary among geographical regions.[4]

In adults, strontium attaches to bone surface. In children, it may be incorporated into the hard bone mineral growing, and as a result will be stored for a many years. As with calcium and magnesium, strontium

continued overleaf

is deposited in bone tissue and is mobilised from bone in response to decreased blood calcium levels. It may then be captured and reused by bone, or eliminated via urine (with minor amounts in faeces and sweat), which is a slow process.[5]

Functions

Strontium has physiological and chemical properties similar to calcium. In the periodic table strontium is just below calcium. Because of its chemical similarity to calcium, strontium can replace calcium in various biochemical processes in the body, including substituting a small amount of the calcium in hydroxyapatite crystals in bones and teeth. Strontium calcification in these crystals imparts additional strength to these tissues, and also appears to draw calcium into bones.[6] However, strontium is also antagonistic to calcium and therefore has the potential to interfere with normal calcium metabolism. [7]

Strontium is not an essential element and has not been found to be necessary for normal biological functions[8] with no established deficiency symptoms. Epidemiological studies indicate insufficient strontium may cause dental caries, but results are not conclusive. [9]

In recent years, interest in strontium has grown due to a number of studies using strontium supplements in osteoporosis. Randomized, double-blind studies have indicated that strontium ranelate (a salt of strontium consisting of two atoms of stable strontium and ranelic acid) reduced the risk of non-vertebral fractures in postmenopausal women with osteoporosis[10,11] and increased bone mineral density. [12]

Toxicity/Excess

There are no dangerous effects of stable strontium in humans at the levels typically found in the environment. When strontium uptake is extremely high, it can cause disruption of bone development. Excess strontium can be taken into bone, instead of calcium, weakening growing bones. This is exacerbated by a diet low in calcium and protein. Strontium levels in food and drinking water are not high enough to be able to cause these effects.

Exposure via inhalation to one chemical form of stable strontium, strontium chromate, is an occupational health issue. Strontium chromate, a known carcinogen, is used as rust and corrosion resistant pigment in paints, varnishes and oil colours and is very harmful mainly due to the toxic form of chromium it contains.

Radioactive strontium is much more of a health risk than stable strontium. The International Agency for Research on Cancer (IARC) has determined that radioactive strontium is carcinogenic to humans. As radioactive strontium is taken up by bone, bone itself and the soft tissues nearby may be damaged by radiation released over time. Cancer can result from damage genetic material (DNA) in cells. Because bone marrow is the source of blood cells, blood cell counts may be reduced, and anaemia, problems with clotting and the immune system dysfunction can occur. This has been seen observed in humans who received injections of radioactive strontium (89Sr) to destroy cancer tissue that had spread to the bone marrow. [13,14]

Analysis in HTMA

Everyone has small amounts of stable strontium in their bodies, mostly in bone. It can be measured in the blood, hair, faeces, or urine. Hair tissue levels correlate well with bone levels and are a good indicator of past strontium exposure. Urine measurements can indicate recent exposure to larger-than-normal amounts of strontium.[15] Strontium analysis results have a high degree of repeatability by ICP-MS.[16] Elevated hair strontium levels may indicate an issue with calcium balance and can provide a helpful marker for the risk of bone loss.[17] Observations of HTMA patterns have shown high levels of strontium in females with a history of malignancy. [18]

In cases of exposure to radioactive strontium, special pathology tests can be used to measure radioactive strontium in blood, faeces, or urine. Radioactive strontium quickly enters into bone (and takes many years to be completely removed), so such tests are most useful soon after exposure. Dedicated equipment can measure radioactive strontium incorporated into bone. [19]

56
Ba
Barium
137.327

Barium

Chemical structure

Barium is a silvery-white, alkaline earth metal that can be found in the environment. It exists naturally combined with other chemicals, such as sulfur, carbon or oxygen, is very light and its density is half that of iron.[1] Barium sulfate ($BaSO_4$) is the most common naturally occurring ore of barium. Barium oxidises in air, reacts vigorously with water to form the hydroxide, liberating hydrogen and reacts with almost all the non-metals, forming often poisoning compounds.

Sources

Barium is plentiful in the earth's crust and is the 14th most abundant element, so barium is sometimes found naturally in drinking water and food.[2] Barium sulfate and barium carbonate are common underground ore deposits, but amounts in water are small as these forms not very water soluble.

Barium sulfate ore is mined and used to manufacture other barium compounds that are widely used in industry. They are more soluble in water, provide a greater health risk and can end up in drinking water when the water is contaminated by barium compounds that are released from waste sites. Barium sulfate is used by the oil and gas industries in the manufacture of paints, bricks, tiles, glass, rubber and has an application in medical tests to x-ray the gastro-intestinal system.

Some foods, such as Brazil nuts, seaweed, fish, and certain plants, may contain high amounts of barium. Kelp extracted from polluted waters often contains excessive levels of barium.[3] High levels of barium in ecosystems and workplaces can originate from quarrying for barium ores and/or the use of barium in paper, foundry, welding, textile, oil and gas industries. Also from its use as an atmospheric aerosol spray for enhancing the signaling of radio waves along military jet flight paths and missile test ranges.[4] Barium is also found in chlorides (used in sucralose and Splenda), in nitrates and sulfides.[5]

Applications for barium compounds include the manufacture of ceramics, insect and rat poisons, oil and fuel additives, as components in paper manufacturing, refining of sugar, animal and vegetable oils.[6]

Absorption and Excretion

Ingested barium is poorly absorbed and little is retained by the body.[7] Ingested or inhaled barium is excreted mainly in faeces and urine, normally within 1–2 weeks. Most of the small amount of barium that remains in the body is deposited in the bones and teeth.[8]

Functions

Barium has not been shown to be an essential nutrient and it has been shown to inhibit absorption of calcium and have similar properties to lead and cadmium.[9]

Toxicity / Excess

The amount of barium that is detected in food and water usually is not high enough to become a health concern.[10] Information on health problems caused by long-term exposure to low levels of barium in food and water is still being established. Animal and human studies show exposure to barium in the air causes damage to the lungs and the EPA and IARC have not classified barium as to its carcinogenicity.

Those at greatest risk from toxicity are workers in the barium industry, due to inhalation of dust containing barium sulphate or barium carbonate.[11] People that live near hazardous waste sites are also at risk due to breathing dust, eating soil or plants, or drinking water that is polluted with barium. Skin contact may also occur.

Barium chloride and other water-soluble barium salts are highly toxic. Ingesting very large amounts of these compounds that dissolve in water or in the stomach can cause changes in heart rhythm or paralysis in humans.[12] Some people who ingest somewhat smaller amounts of barium for a short period may experience vomiting, abdominal cramps, diarrhoea, breathing difficulties, blood pressure alterations, muscle weakness and changes in nerve reflexes.[13]

It has been hypothesized that a high level contamination of barium that has been identified from the environment and workplaces, may be associated with a higher incidence of neurodegenerative disease such as Multiple Sclerosis, due to alterations in the growth and structural integrity of the myelin sheath.[14] High levels of barium in water supplies have been associated with high blood pressure and cardiovascular disease.[15] Attention must be given to calcium balance in order to normalise barium levels. Antioxidants such as Vitamin A, C and E are also useful. In addition, alginates like kelp can facilitate excretion of barium and may reduce the intestinal absorption.[16]

Analysis in HTMA

There is no routine medical test for determining barium exposure or potential health effects. Barium in body tissues and fluids can be measured using very complex instruments. This is normally done only for cases of severe barium poisoning and for medical research.[17] Transient high levels in hair may be of small clinical significance.[18] Persistent elevated levels of hair tissue barium are often a result of diagnostic medical tests.[19] The biological significance of low HTMA levels cannot be described at this time.[20]

22
Ti
Titanium
47.867

Titanium

Chemical Structure

Titanium is a hard, silvery-white metallic element. Its chemical behavior is similar with that of silica and zirconium, as an element belonging to the first group of transitional metals.[1] Titanium metal has a number of useful physical properties; it is very resistant to corrosion, is hard, has a high melting temperature, and is very lightweight. Its strength is similar to steel, but is 45% lighter and titanium alloys can be twice as strong as aluminum alloys.[2]

Sources

In nature titanium is bound to other elements and is present in most igneous rocks and their sediments and is the 9th most common element in the Earth's crust.[3] Most titanium ore extracted from the Earth is used as titanium dioxide (TiO2), an intensely white permanent pigment. Titanium tetrachloride (not found in nature that is made from metals that contain titanium) and is a colorless to pale yellow liquid that has fumes with a strong odor. When it comes in contact with water, it rapidly forms hydrochloric acid, as well as titanium compounds.[4]

Absorptions and excretion

Titanium is poorly absorbed by plants and animals. There is detectable amounts of titanium in humans and it has been estimated that approximately 0.8mg/day is taken in, of which most is not absorbed.[5] The main route of entry is via inhalation, skin or eye contact. Tissue concentrations vary widely and the main route of excretion is via faeces and urine. Titanium has been detected in blood and hair over a wide concentration ranges; this wide range may reflect contamination due to the high natural abundance of titanium.

Functions

Titanium has no known nutritional benefit for humans.[6] At present there is no indication of titanium's essential role in biological functions and low titanium levels in a HTMA are not significant.[7] Higher levels in a HTMA maybe of some clinical significance and may indicate previous exposure.

Applications

Most titanium is used in its oxide form. TiO_2 is a white pigment used in paint, varnishes and lacquers, plastics, paper, and other products such as special coated fabrics, printing inks, roofing granules.[8] Titanium is important as an alloying agent with aluminum, molybdenum, manganese, iron, and other metals. TiO_2 is used as a white and opaque material and is utilized as a component of some cosmetic and skin care products including sunscreens, lipsticks, toothpastes, as well as paints, plastics, paper and inks.[9] In medicine titanium is used for hip and knee replacements, pace-makers, bone-plates and screws, cranial plates for skull fractures and dental implants. Titanium is used in alloys related to dental and other metal prosthetic devices.[10]

Alloys of titanium are characterised by a very high tensile strength (even at high temperatures), is light weight and highly resistant to corrosion. Such alloys are principally used for aircraft and in missiles. Titanium has potential use in desalination plants for converting sea water into fresh water and has excellent resistance to sea water.[11]

Toxicity

There are no known toxicity indications for titanium.[12] Elemental titanium and TiO_2 has a low order of toxicity. Titanium is not considered to be a poisonous metal and research has shown that the body can tolerate titanium in higher doses.[13]

Health effects

In humans, excessive exposure may result in changes in the lungs which includes; a decline in lung function, pleural disease with plaques, pleural thickening, and mild fibrotic changes.[14] Dust inhalation may cause chest pain and tightness, breathing difficulties, coughing and Irritation to skin or eyes may result from contact.[15]

There is sufficient evidence in experimental animals for the carcinogenicity of TiO_2. The International Agency for Research on Cancer (IARC) has recently classified TiO_2 dust, when inhaled, as an IARC Group 2B carcinogen (possibly carcinogenic to humans).[16] The highest levels of occupational exposure to TiO_2 during its manufacture are associated with packing, milling, and also occupations such as site cleaning and maintenance.

References are available at www. interclinical.com.au

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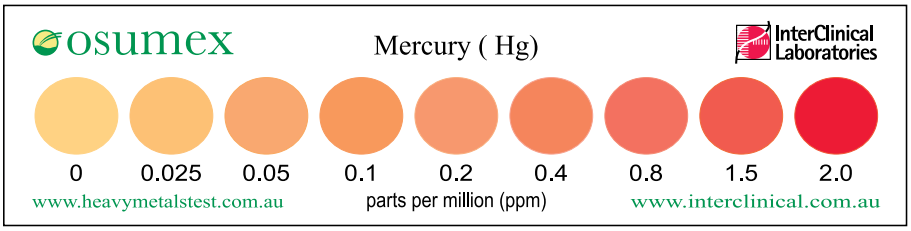

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