MedCrave
Step into the World of Research

MOJ Bioequivalence & Bioavailability

Mini Review

Open Access

CrossMark

Vanadium in therapy and toxicity; mini–review and recommendation of further study

Abstract

The purpose of this review is to propose and summarize the further research that should be done to determine the extent of vanadium's biological effects. One direction to investigate is the effect of vanadium on the level of cholesterol in animals. Such a study should be organized to compare between the effect of statins, vanadium and a combination of both as therapies for cholesterol. More studies are necessary to explore vanadium's occupational and environmental effects on the human central nervous system (CNS).

Keywords: vanadium, dyslipidemia, occupational health, toxicity

Volume 3 Issue 4 - 2017

Naser L Rezk,[1] Salma A Rezk[2]

[1]Department of Clinical Laboratory Sciences, Applied Medical Sciences, Taibah University, Saudi Arabia

[2]Department of Pathology, School of Medicine, University of North Carolina at Chapel Hill, USA

Correspondence: Naser L Rezk, Department of Clinical Laboratory Sciences, Applied Medical Sciences, Taibah University, Saudi Arabia, Tel 966–5041 80948, 919–698–5592, Email naser21@gmail.com

Received: May 11, 2017 | **Published:** July 14, 2017

Introduction

Over the last few decades, dyslipidemia or the presence of high levels of cholesterol in the blood of living organisms has been successfully treated with statins. Statins are showing clear indications of lowering cholesterol; however, they also showcase several undesirable side effects associated with the treatment. Vanadium is known to have toxic effects, but believed to have a simultaneous therapeutic use as well.[1] Vanadium is one of the heavy metals that exist in our food and many other products that we use on a daily basis. It is believed that vanadium could be a therapy agent which can lower cholesterol levels in living organisms. In literature, several reports support this direction while others deviated from this prediction due to the high toxicity levels of vanadium.

Food source of vanadium

Vanadium, as many other trace elements exists, in our food. The main food sources of vanadium are rice, oats, beans, radishes, barley, buckwheat, lettuce, peas, potatoes, dill, parsley, black pepper, shellfish, meat, mushrooms, soy, wheat, and olives. Other sources of vanadium are food additives, nutritional supplements, water, and air. Vanadium's omnipresence in food ranges from 1 to 30µg per kg of food. Lower concentrations of vanadium oxides are found in the air of rural areas with roughly 1ng per cubic meter and up to 100ng per cubic meter in urban areas. The risk of experiencing adverse health effects from vanadium occurs at its threshold at intake levels over 10mg per kg of body weight for a person.[2] Normal exposure to the metal is mostly below the threshold level. However, small dose accumulations of exposure can cause chronic health problems.

Vanadium medical use

Diabetes, cancer, chlorosis, anaemia, and tuberculosis are the most known diseases directly or indirectly affected by vanadium. Many vanadium salts prove to inhibit glucose levels. Anti–diabetic vanadium salts, for example, act via separate pathways: vanadate salt (in form of vanadium V) yields several beneficial effects interacting with glucose and fat metabolism within the cells (cytosolic activity), while vanadyl salts (IV) normalize glucose concentration in blood plasma by ameliorating the glucose uptake through cytoplasma membranes and inhibiting lipolysis. The mechanism by which vanadium restricts elevation of plasma cholesterol appears to involve both inhibition of cholesterol synthesis as well as accelerated catabolism of cholesterol.[3] Vanadium is considered an important element for normal cell function and its development.[4,5] Katheren H[6] and co–workers have investigated several metal compounds such as vanadium, zinc, cobalt, chromium and molybdenum to be therapeutic agents in treating diabetes mellitus.[6] Vanadium produced the highest effect in lowering glucose and lipids in Wister rats. The metabolic effects of vanadium are known to be dose dependent, requiring more than 4 weeks for a complete response.[7] The treatment for insulin resistance includes the use of vanadium compounds, which have been shown in animal models to enhance insulin responsiveness.[1]

Sanchez et al.[8] studied the bioavailability of vanadium and its hypoglycaemic effect in magnesium–deficient rats.[8] The group has generated data proving that vanadium plays an important role as a micronutrient and anti–diabetic agent. In that study, vanadium was supplied in the form of bis–(maltolato) oxovanadium (IV) in rats drinking water for a duration up to five weeks. Recently, Soveid M[9] and collages have studied long–term efficacy and safety on vanadium in the treatment of type 1 diabetes. This research team found that vanadium compounds can reduce blood glucose in experimentally–induced diabetic rats and type 2 diabetic patients.[9] They also, reported that the cholesterol level had declined but it was not shown to which extent.

Vanadium toxicity

Several studies have shown that vanadium exposure may cause respiratory dysfunction,[10] hematologic and biochemical alterations, renal toxicity,[11] reproductive and developmental toxicity immunotoxicity, mutagenicity,[12] and neurotoxicity may also occur[13] when readily exposed. In some instances, the cases of death due to exposure to vanadium compounds has also been reported.[14,16] Animal models are the basic tools for the most reported vanadium toxicological studies. There have been relatively few studies conducted on occupational workers, with some showing vanadium–induced neurotoxicity. However, the link between vanadium exposure and

related neurobehavioral alterations still poses unanswered question. Because the sensitivity of the central nervous system (CNS), an in–depth study on vanadium–induced neurobehavioral changes which focuses on chronic low–level occupational exposure, is necessary.

Between therapy and toxicity

An important question needs to be answered: "is vanadium a safe and efficient therapy in lowering cholesterol level or is it purely a toxic agent"? The evaluation of vanadium as a toxic agent or treatment has not been investigated in the presence of communally used cholesterol lowering agent such as statins. We believe comparing vanadium and statins individually, and in combination, can guide us to a clear description of the values of heavy metals, and specifically vanadium. Both vanadium IV&V salts were on–going in many animal studies but vanadium III was not. Because of the higher dissociation rate of vanadium (III) chloride salt, we believe using this salt may provide a better guide, if investigated, for biological effects in animal models. Using vanadium chloride also allows us to investigate the effect of the vanadium ion itself.

Steel workers' length of exposure to vanadium affects their normal neuronal functions including emotion, cognition, attention, short–term memory, reaction speed, coordination, and accuracy. This study provides[9] the initial epidemiological evidence demonstrating the association between vanadium exposure and altered neurobehavioral function. The findings of this study are valuable for policy makers to structure set regulations for preventing vanadium exposure in workplaces. It is apparent that vanadium's toxicity through occupational exposure requires further investigation into the effects on neurobehavioral functions.

Summary

Statins have been used as the primary therapy for lowering cholesterol levels in the blood to reduce the risk of heart attack and stroke in patients, while being known to cause undesirable side effects. We propose an in–depth analysis of vanadium's health and environmental effects on the CNS of humans and neurobehavioral functions. While Vanadium is known to be toxic at certain levels, it is present in our environment and in our food and is necessary for normal cell function and development. Testing vanadium, statins, and combinations of both, for their effects on cholesterol levels in humans should be compared and studied for further understanding and potential use as a therapeutic agent.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

References

1. Yuen VG, Orvig C, McNeill JH. Comparison of the glucose–lowering properties of vanadyl sulfate and bis(maltolato) oxovanadium(IV) following acute and chronic administration. *Can J Physiol Pharmacol*. 1995;73(1):55–64.
2. Rehder D. The future of/for vanadium. *Dalton Trans*. 2013;42(33):11749–11761.
3. Roess DA, Smith SM, Winter P, et al. Effects of vanadium–containing compounds on membrane lipids and on microdomains used in receptor–mediated signaling. *Chem Biodivers*. 2008;5(8):1558–1570.
4. Poucheret P, Verma S, Grynpas MD, et al. Vanadium and diabetes. *Mol Cell Biochem*. 1998;188(1–2):73–80.
5. Badmaev V, Prakash S, Majeed M. Vanadium: a review of its potential role in the fight against diabetes. *J Altern Complement Med*. 1999;5(3):273–291.
6. Thompson KH, Chiles J, Yuen VG, et al. Comparison of anti–hyperglycemic effect amongst vanadium molybdenum and other metal maltole compounds. *J Inorg Biochem*. 2004;98(5):683–690.
7. Liu J, Cui H, Liu X, et al. Dietary high vanadium causes oxidative damage–induced renal and hepatic toxicity in broilers. *Biol Trace Elem Res*. 2012;145(2):189–200.
8. Sánchez C, Torres M, Bermúdez–Peña MC, et al. Bioavailability, tissue distribution and hypoglycemic effect of vanadium in magnesium–deficient rats. *Magnes Res*. 2011;24(4):196–208.
9. Soveid M, Dehghani GA, Omrani GR. Long–term efficacy and safety of vanadium in the treatment of type 1 diabetes. *Arch Iran Med*. 2013;16(7):408–4011.
10. Woodin MA, Liu Y, Neuberg D, et al. Acute respiratory symptoms in workers exposed to vanadium–rich fuel–oil ash. *Am J Ind Med*. 2000;37(4):353–363.
11. Zaporowska H, Wasilewski W, Słotwińska M. Effect of chronic vanadium administration in drinking water to rats. *Biometals*. 1993;6(1):3–10.
12. Avila–Costa MR, Montiel Flores E, Colin–Barenque L, et al. Nigrostriatal modifications after vanadium inhalation: an immunocytochemical and cytological approach. *Neurochem Res*. 2004;29(7):1365–1369.
13. Li H, Zhou D, Zhang Q, et al. Vanadium Exposure–Induced Neurobehavioral Alterations among Chinese Workers. *Neurotoxicology*. 2013;36:49–54.
14. Sjoberg SG. Vanadium pentoxide dust: A clinical and experimental investigation on its effect after inhalation. *Acta Medica Scandinavica*.1950;138(Suppl 238):1–188.
15. Shechter Y, Goldwaser I, Mironchik M, et al. Historic perspective and recent developments on the insulin–like actions of vanadium; toward developing vanadium–based drugs for diabetes. *Coord Chem Rev*. 2003;237(1–2):3–11.
16. Sanchez DJ, Colomina MT, Domingo JL. Effects of vanadium on activity and learning in rats. *Physiol Behav*. 1998;63(3):345–350.