The Antiseptic

Estd.1904

Azadi Ka Amrit Mahotsav

Indexed in IndMED

A MONTHLY JOURNAL OF MEDICINE AND SURGERY

Email: admin@theantiseptic.in

www. theantiseptic.in

Vol. 119 • No. 8 AUGUST 2022 ISSN 0003-5998 • ₹ 100

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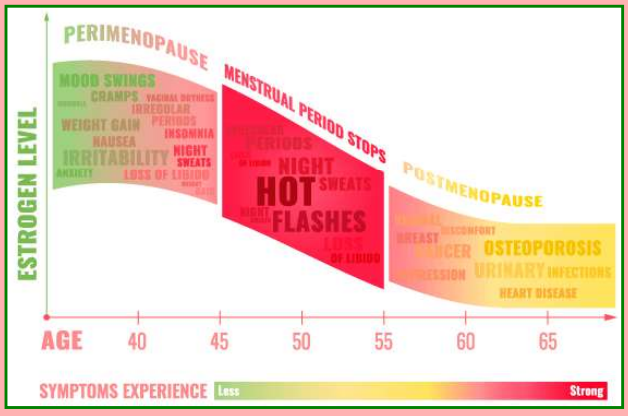

Magnesium and Heart- What's the Link?

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Introduction

Magnesium is a crucial mineral found in the human body. It is an abundant intracellular divalent cation which is found to be important for the maintenance of cellular physiology and metabolism[1]. Magnesium acts as a co-factor in more than 300 enzymatic reactions which are responsible for regulating blood pressure, glycaemic control and lipid peroxidation[2]. It is considered to be the fourth most common mineral found in the human body after calcium, sodium and potassium. Approximately, 24g of magnesium is available in an adult body, with 50%-60% present in bones and remaining being present in the soft tissues.[3]

In the heart, magnesium plays a major role in modulating neuronal excitation, intracardiac conduction and myocardial contraction by controlling a number of ion transporters which includes potassium and calcium channels. It also regulates vascular tone, atherogenesis and thrombosis, vascular calcification.[1] In most of the countries, less consumption of magnesium often leads to magnesium deficiency which increases the risk of cardiovascular diseases and death.[3] This article assesses the effects of magnesium on the heart.

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Specially Contributed to "The Antiseptic"
Vol. 119 No. 8 & P : 07 - 08

Magnesium homeostasis

On an average, 360mg of elemental magnesium is ingested through a normal diet. Sources rich in magnesium includes cereals, seeds, walnut, pulses, green vegetables and some kind of meat and seafood. Only 50% of magnesium in our diet is absorbed in the gastrointestinal tract, usually in the proximal jejunum and the ileum. Approximately, 40 mg/day of magnesium is secreted into the intestine and only 20 mg are reabsorbed in the colon and rectum. The magnesium homeostasis depends on a balance between its intestinal absorption and renal excretion.[4]

Magnesium and the heart

Magnesium plays a pivotal role in heart function by regulating myocardial metabolism, peripheral vascular resistance, calcium homeostasis and cardiac output.[5] Magnesium is considered to be predominant to the aetiology of various cardiovascular diseases, including coronary artery disease (CAD), congestive heart failure (CHF), hypertension, atherosclerosis.[6] The effects of magnesium are exerted in three ways: 1) regulates the activity of ion channels which in return affects the electrical properties of the myocardium, 2) regulates myocardial contractility and 3) possesses anti-inflammatory and vasodilatory effects.[5] It affects the cardiac excitation and automacity of cardiac myocytes and pacemaker cells by influencing the membrane potential phases 2, 3 & 4 of cardiac myocytes and phase 0 & 3 of pacemaker cells. The intracellular and extracellular magnesium concentrations control calcium influx into the cells by suppressing the L-type calcium-channels which in turn prevents the intracellular calcium overload and cell toxicity in phase 0 of pacemaker cells and phase 2 of cardiac myocytes.[7] The intracellular magnesium concentrations in phase 3 controls the outward movement of potassium through inward and delayed rectifier potassium channels.[8]

Several studies have shown that higher intake of magnesium exerts advantageous effects on the cardiovascular risk factors by strengthening the endothelium-dependent vasodilation, enhancing glucose and insulin metabolism and refining the lipid profile.[9]

Hypertension

Hypertension is the leading preventable risk factor for cardiovascular diseases, affecting more than 1 billion individuals globally.[10] Several clinical trials have recommended magnesium as it plays a major role in the pathogenesis of hypertension by affecting arterial smooth muscle contraction.Magnesium actuates Na+ K+ ATPase pump, which has a vital role in the regulation of sodium and potassium transport.[11] It has been suggested that a diet high in magnesium lowers down the blood pressure. In a study conducted by Y Kawano et al,[12] 60 patients with hypertension were given magnesium oxide at 20 mmol/ day during 8 weeks, significant reductions in ambulatory, home and office BP were observed. Patients with highest BP levels had greater reduction in BP. In a double-blind placebo-controlled trial of 91 women with mild-to

moderate hypertension,decrease in BP was observed using magnesium asparate-HCl (20 mmol/day) for 6 months.[13] A meta-analysis conducted by Zhang et al[14] suggested that magnesium supplementation at a median dose of 368 mg/day for 3 months lowers the systolic blood pressure (SBP) by 2 mmHg (95% CI 0.43 to 3.58) and diastolic blood pressure (DBP) by 1.78 mmHg (95% CI 0.73 to 2.82).

Congestive Heart Failure

Hypomagnesemia is commonly found in patients with CHF due to several mechanisms. Patients suffering from CHF may have an increased urinary excretion of magnesium. Hypomagnesemia also leads to hypokalaemia which further increases the chance of developing ventricular arrhythmias and hemodynamic derangements. It exacerbates cardiac contractility, increase vasoconstriction and deplete cardiac energy stores.[11] A study by Bashir et al found that oral magnesium supplementation lowers the mean arterial pressure, systolic vascular resistance. Similarly, a study by Gottlieb et al[15] found that patients with normal versus low magnesium levels had 2-year survival rates of 61% and 42% respectively.[16]

Atherosclerosis

Hypomagnesemia plays a major role in lipoprotein metabolism which contributes to atherosclerosis as a risk factor for cardiovascular diseases. Several animal studies have concluded that magnesium deficiency promotes atherosclerosis by activating an inflammatory response and causing hyperlipemia. In a study conducted by Altura et al[17] on rabbits suggested that higher magnesium intake is useful in reducing macrophage activation and corrects the lipid profile.

Cardiac Arrhythmias

Hypomagnesemia leads to QT interval prolongation, ST- segment depression and low amplitude T waves, therefore magnesium supplementation is essential in preventing arrhythmias in patients with CHF.[18] A meta-analysis of 22 studies by Shirvan Salaminia et al showed that magnesium sulphate can be used safely and effectively and is a cost-effective way in the prevention of cardiac arrhythmias.[19]

Conclusion

This article concluded that magnesium has a vital role in cardiovascular health. Magnesium is essential for the proper maintenance of cellular membrane potential, functioning of mitochondria. It has vasodilatory, anti-inflammatory, anti-ischemic and anti-arrhythmic properties. As a result, hypomagnesemia can lead to morbidity and mortality in multiple cardiovascular diseases such as hypertension, atherosclerosis, arrhythmias etc. Several studies have established the role of magnesium in the pathogenesis of cardiovascular diseases. Through this article, it has been believed that proper consumption of magnesium is important for heart health and should be included in the diet in an adequate amount. However, there is a dire need for several trials to determine the relationship among magnesium and cardiovascular disease.

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