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“The Magnesium Factor”

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Diet and Magnesium Deficiency

As the heart disease epidemic of the twentieth century was growing, so was the reliance on modern processed foods. There are many things wrong with such a diet. It is high in fat, especially saturated fat; high in cholesterol; and high in sugar and salt, among other things. But not emphasized in the training of many doctors – nor even in that of many nutritionists and dieticians – is that **such a diet is low in magnesium**. And hearts and blood vessels need magnesium to stay healthy.

The fact is that magnesium deficiency underlies much of the heart disease epidemic that consumes so many of our health-care dollars. Studies have linked low magnesium with many of the major risk factors for heart disease. Other studies show that the average Western processed-food diet is lower in magnesium than is commonly acknowledged. While several essential nutrients are imperative for heart and blood vessel health, the vast research on low magnesium and its impact on heart health have gone unheeded, so much so that much of the heart disease seen today is a direct result of low magnesium consumption. This vitally important nutrient is inadequate in much of our processed foods and water supplies, just when our stressful lifestyle demands that we have more. The effects of a low intake of magnesium can be worsened by the high levels of fat, sugar, sodium, and phosphate in our diets as well as, ironically, by the use of calcium supplements, which has become widespread because of our awareness of calcium’s value for bone health.

Let’s look at the evidence that magnesium deficiency can cause heart disease.

Low Magnesium and Heart Disease

Animal and clinical studies have shown that chronic magnesium depletion has direct consequences for both the heart and the blood vessels. These include the following:

- Arrhythmias (irregular heart rhythms) and tachycardia (too-rapid heartbeats) due to abnormal shifts of the mineral potassium into and out of heart cells.
- Abnormal electrical activity in the heart, shown by electrocardiogram (EKG or ECG) results.
- Arteriosclerosis (stiffening and inflexibility of the blood vessels). This can develop in children.
- Constriction of the arteries and spasms in blood vessels.

- High blood pressure.
- Angina (chest pain due to heart disease).
- Myocardial infarction (damage to heart cells – better known as a heart attack) due to ischemic heart disease (an insufficient flow of oxygenated blood to the heart) that is associated with too much calcium and not enough magnesium in heart cells.
- Sudden death due to arrhythmia or infarction.
- The formation of blood clots within blood vessels, which can lead to heart attack or stroke.
- Heart valve disorders such as mitral valve prolapse.

The medical profession has responded to this myriad of symptoms by treating each symptom individually, with drugs or surgery or both. The result is high-tech, expensive chasing after symptoms that may stave off death but does not restore health. How much better it would be to prevent much of the damage from this disease by treating the magnesium deficiency that underlies all of its symptoms, giving the body the simple nutrient it needs for healthy hearts and blood vessels. Animal studies show that low magnesium levels adversely affect the heart and blood vessels. Clinical studies show that treatment with magnesium, taken at the right time and in the right amount, can lessen heart disease risk factors and even save lives. Might adequate magnesium nutrition lessen the need for heroic surgeries? Might it lessen the need for, or even replace, medications, with their high cost and possible adverse side effects? Drug and surgical therapies could then be reserved for people with heart disease for whom adequate magnesium nutrition is not enough.

Additional Evidence

We know that there are connections between low magnesium consumption and the major risk factors for heart disease. In addition, research has found that there are very low levels of magnesium in the heart muscle of people who have died of heart disease. In one study, the hearts of such individuals had 24 percent less magnesium than did the hearts of people who had died in accidents. Other studies have been performed on cadaver hearts classified by cause of death – death due to heart disease versus death from other causes, usually accidents. The “heart-disease” hearts had anywhere from 12 to 27 percent less magnesium than the “other causes of death” hearts. What’s more, damaged areas of hearts from people who had died of heart disease had 40 to 50 percent less magnesium than undamaged areas of the same hearts.

Another interesting finding is that cadaver hearts from people who had lived in areas with hard drinking water (water that contains relatively high levels of dissolved minerals) had higher amounts of magnesium in them – 6 or 7 percent higher, on average, than cadaver hearts from soft-water areas. Maybe this is why death rates from heart disease are lower in hard-water communities. Although early nutritional studies in animals proved magnesium to be vital to both heart and blood vessels, this knowledge was not linked to the rising level of human heart disease seen in the first half of the twentieth century. In

the late 1950s, some epidemiological studies (research on populations) pointed to the association.

In 1957, an important Japanese study showed that when hardness of drinking water went up, the rate of death from cardiovascular disease went down. Then more studies from other parts of the world showed the same trend; there was something about hard water that protected people from heart disease death. Whether in South Africa, Greenland, Finland, England, Wales, Canada, Australia or the United States, cardiovascular and overall death rates were found to be lower in hard-water areas than in soft-water areas.

Further evidence for this water factor came with a study of British towns observed between 1951 and 1961, a time of rising cardiovascular disease. The towns whose water supply became softer during that decade experienced a 20 percent rise in heart disease death rates, while towns with no change in water hardness showed a rise of only 11 percent in such deaths. Towns whose water supply became harder have only an 8 percent rise in heart-disease deaths.

There was something about soft water that went with higher rates of heart disease death. Coming as it did at the peak of the rise in heart disease, this information was very intriguing, and medical scientists and doctors naturally wondered what it was in hard water that was protective, or what was it about soft water that was dangerous to hearts. Research soon showed that the protective water factor, in most cases, was magnesium. Calcium, another hard water component, also can be protective because it makes water less corrosive and less likely to leach toxic trace minerals, such as cadmium and lead, out of metal pipes. Calcium shares its direct effect – interfering with the absorption of fat from the intestines – with magnesium.

Hard water's protective effect is illustrated by the case of Finnish immigrants living in North Dakota. Finland, at the time of the study (the early 1960s), had a very high rate of heart disease – one of the highest in the world. The Finns also had high levels of tobacco and alcohol use, plus a high-saturated-fat, high-protein, high-calcium, high-salt diet that was low in fruits and vegetables. The Finnish immigrants in North Dakota had virtually the same dietary and lifestyle habits, and could be assumed to share the same basic hereditary characteristics, but surprisingly, had less than half the incidence of heart disease and a longer average life expectancy. How come? The water in North Dakota was high – very high – in magnesium. It was time to take magnesium seriously.

Magnesium in the Heart and Blood Vessels

Magnesium is a vital structural component of all muscle cells, and the heart is mainly muscle. Indeed, heart muscle, when healthy, contains even more magnesium than other muscles do. And when magnesium levels become low, they can drop more in heart muscle cells than in other muscles.

Each molecule of myosin (muscle protein) has an atom of magnesium in it. Muscles therefore have to have magnesium to work. About 27 percent of the body's magnesium is

in muscle tissue, including the small muscle cells that make blood vessels contract or relax as blood, driven by heart muscle's pumping, flows through them. If a magnesium deficiency begins to affect the heart's muscle cells and the "nervous conduction system" of the heart, this organ, which must beat regularly and continuously, may run into trouble. The availability of magnesium within the heart affects the rhythm of the heart both directly and indirectly by controlling potassium and calcium levels. This also affects the conduction system. A low level of magnesium in the heart muscle cells can bring on heart arrhythmias ranging from the merely disturbing, such as palpitations, to the severe, including disturbances that can be life-threatening.

Blood vessel muscle cells need healthy amounts of magnesium to relax properly after each contraction. They can become stiff and inflexible if their magnesium gets too low.

Early in 2002, a pharmaceutical ad on television stated that each human being has thousands of enzymes, and that their proper function is needed for health. This is true. Enzymes are what make the body's chemical reactions take place at the proper times, at the proper speed, and in the proper amounts.

Any biochemistry student can tell you that including Mg^{++} (the symbol for magnesium ion – magnesium in its electrically charged form) in a reaction has a good chance of giving you the right answer to test questions. That is because magnesium is a necessary catalyst for all sorts of life reactions. Among the enzymes that have been studied intensively, over 350 need magnesium, directly, to do their jobs properly. For the sake of comparison, the mineral zinc, for example, is required for about 200 enzymes; copper, for less than 20; and selenium, for 10 that have been identified in animal studies so far. To mention just a few, magnesium is directly necessary to the enzymes that break down glucose (blood sugar), control the production of cholesterol, make nucleic acids such as DNA, make proteins (all enzymes are proteins), and break down fats. Importantly, magnesium is necessary to the enzymes that keep potassium inside cells – including those of the cardiovascular system – where it is necessary for cellular activity, and to keep sodium outside the cells, thereby preventing edema or swelling. Without adequate magnesium, these enzymes either will not act or will act at the wrong rate or at the wrong time – or both.

In addition to the more than 350 enzymes for which magnesium is directly necessary, it is indirectly required for thousands of others. One especially important reaction that needs magnesium is the one that controls the molecule adenosine triphosphate, or ATP. ATP is present in the entire living world. You can think of it as life's batteries – a substance that can store and release energy back and forth, like a switch. But to do so it needs magnesium. Literally every energy-consuming reaction in life involves ATP and thus needs magnesium to proceed. This is what puts the number of enzymes that need magnesium into the thousands.

It would be hard to overestimate magnesium's importance in enzyme function, both directly, as a cofactor, and indirectly via ATP reactions.

Muscle contraction requires energy, and thus requires ATP and magnesium. The pumping heart is a muscle that alternately contracts and relaxes. The contracting and dilating of blood vessels are due to muscles contracting and relaxing. All of this activity requires magnesium, both directly and indirectly through ATP. No wonder low magnesium can affect the heart and its blood vessels.

Magnesium in the Cells

In addition to all of its enzyme functions, magnesium is an important component of cell membranes. As a result, it is vitally important in regulating what goes into and what comes out of all the body's cells. This makes magnesium crucial to mineral balance.

In simple solutions, such as salt water, all dissolved minerals are evenly dispersed. This is not so in living cells, where they are distributed differently, depending on their functions. This specialized distribution requires energy and is vital to life processes and health. Calcium and sodium ions, for the most part, are kept outside cells, while magnesium and potassium are kept inside cells. These four minerals are the most plentiful in the body, and collectively they are known as electrolytes. Magnesium is crucial to other specialized distribution.

If the level of magnesium within cells falls below normal, calcium and sodium rush inside, while potassium and magnesium leak out. This can cause big problems. If this occurs in heart muscle cells, normal function is impaired, and there is a tendency toward excess contractility. During cardiac surgery, this can cause what doctors call a "stone heart." In the arteries, this phenomenon can lead to stiffness and high blood pressure. Drastic results, indeed. Doctors routinely prescribe calcium-channel-blocking drugs to forestall this abnormal movement of calcium into cells because it is so dangerous for hearts and blood vessels. Magnesium is nature's calcium-channel blocker.

Magnesium and Calcium; A Delicate Balance

Magnesium and calcium are very similar in their chemistry, but biologically, these two elements function and react very differently. In effect, they are two sides of a physiological coin; they have actions that oppose one another, yet they function as a team. For example:

- Calcium exists mainly outside of cells, whereas almost all magnesium is found inside cells.
- Calcium excites nerves, whereas magnesium calms them down.
- Calcium (with potassium) is necessary for muscle contractions, whereas magnesium is necessary for muscles to relax.
- Calcium is necessary for the blood-clotting reaction, which is so necessary for wound healing, whereas magnesium keeps the blood flowing freely and prevents abnormal coagulation within blood vessels, where clotting reactions would be dangerous.

- Calcium is mostly found in bones and gives them much of their hardness, whereas magnesium is found mainly in soft structures. Bone matrix, the soft structure within bone, contains protein and magnesium, and gives the bones some flexibility and resistance to brittleness.

The normal concentration of magnesium ion inside cells is easily 10,000 times that of intracellular calcium ions – under healthy conditions. But if the amount of magnesium in a cell falls, for any reason, calcium ions flow into the cell. With this abnormal situation, a couple of things happen:

1. Higher than normal calcium inside a cell excites a lot of reactions. It puts the cell into hyperactive state. Heart and blood-vessel cells are especially excitable because they need to react rapidly during sudden stress situation. As such, they are truly vulnerable to deficits in magnesium that allow abnormal rises in calcium, with resulting hyperactivity.

Sometimes, a hyperactive state is just what you want. It is the essence of the body's fight-or-flight reaction to danger. For example, when in danger, the body needs muscles to contract rapidly and strongly so that one can fight or flee. The cells need to have calcium rush inside, get things excited, and, together with several other substances, make muscles contract. Without calcium, there is no muscle contraction, and without muscle contraction there is no fight or flight.

But in usual circumstances, you do not want excess muscle contractions. The muscles would soon cramp, bringing on severe muscle pain. To relax, the muscles need magnesium. Magnesium, physiologically the opposite of calcium, relaxes muscles. Under normal, healthy cellular conditions, magnesium levels inside muscle cells are high and calcium levels are low, so that the muscles can relax. This is just one way in which calcium enhances and allows the fight-or-flight reaction while magnesium calms it all down.

2. If calcium levels inside a cell get especially high because of low magnesium, the cell physically changes. High calcium tends to make things stiff and hard. But if soft tissue begins to get hard, it is a problem – the problem of *calcification*. In artery and heart cells, the stiffness caused by calcification hampers proper function and can be an important aspect of heart disease.

If magnesium intake is low, a high calcium intake can make people more vulnerable to heart disease than are people who do not have a high calcium intake. The current promotion of calcium-rich foods and supplements to protect our bones encourages the consumption of calcium. This is fine as long as magnesium nutrition is adequate. But calcium intakes that are unduly high relative to magnesium can intensify the problems caused by the low magnesium content of most modern diets.

Calcium is an important essential nutrient, but it must be guarded and controlled, and balanced by adequate magnesium if it is not to cause damage to the cells and the body as a whole.