

About uses of magnesium during perioperative period

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Magnesium (Mg) is an essential mineral needed for cell function, and the necessary amount required by the body is obtained through consumption of food and mineral water. Leafy vegetables, grains, and legumes, which are a staple of Asians diets, have abundant Mg, while the dairy products of nomads or diets using meat of Western society lack ample consumption of this mineral [1]. As a result, there are assertions that those in the Western population are more likely to develop cardiovascular or hyperlipidemic diseases [2]. Recently, Mg-abundant foods and a daily intake of Mg have been recommended to forge improved public health [3].

It is difficult to identify cases of Mg deficiency. A long half-life period (radio-labeled Mg half life; 41–181 d) is required to equalize its concentration in the body tissues [4], and while it is mostly present in intracellular compartment of bones, muscles, and soft tissues, the concentration of Mg is merely 1% in extracellular fluids and 0.3% in plasma. As a result, it is difficult to make a diagnosis of hypomagnesemia on the grounds that the concentrations of Mg are less than the normal concentrations of the total plasma magnesium ranging from 0.7 to 1.0 mM (1.7–2.5 mg/dl) [5]. A Mg retention test or loading test, which evaluates the excreted amount of Mg after an injection of the mineral, is used to make an accurate diagnosis, however the time required to obtain test results is longer than desired [6].

Mg reportedly blocks, reduces, or enhances the flow of ions by controlling several ion channels in the cell membrane [7], and it is involved in cell division, metabolism, and genetic expression by the activation of sub-cellular enzymes triggered by phosphorylated energy transfer through formation of ATP-Mg complexes which anchor substrates to the active sites of

enzymes [8]. In addition, it acts as an anticonvulsant by blocking the N-methyl-D-aspartate (NMDA) glutamate receptors, which is one of the excitatory amino acid receptors [5]. And, the release of acetylcholine from the pre-synaptic endings is reduced by Mg, where it mainly inhibits the entry of calcium into the pre-synaptic endings, playing an antagonistic role against calcium [9]. The vasodilatory effect, antiadrenergic action affecting on adrenal medulla and sympathetic nerve ending, and antiarrhythmic effect of Mg indicates that it could be used for hypertension, pheochromocytoma, and sudden increase of blood pressure and heart rate during intubation [10,11].

Clinically, Mg replacement therapy is expected to be effective when it is deficient. However, unexpectedly, 7–11% of hospitalized patients and 40% of patients with deficiencies in other electrolytes and 65% of the clinically-ill patients in Intensive Care Unit have coexisting hypomagnesaemia [12-14]. Even so, it is difficult to find appropriate cases to provide a definitive indication for the administration of Mg, which can lead to controversy over the argument that mortality would be reduced with normalization of plasma Mg concentration [15].

In cases of anesthesia, temporary Mg deficiency may occur in patients who are vulnerable to excessive expansion of extracellular fluid or who receive large volume of blood transfusions. In addition, patients who take diabetic medication, diuretics, parathyroid hormone after receiving thyroidectomy, angiotensin converting enzyme inhibitors for hypertension, laxatives for abdominal surgeries, and patients who have received bowel preparation for major intestinal resection are also at risk [5]. Mg administration is a well-known treatment for preeclampsia and eclampsia, and is also effective in torsades de pointes, when routine anti-arrhythmic treatment is refractory

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[5,10,16]. Recently, Mg has been reported as having analgesic effects in postoperative pain control, and attracting more attention [17]. But, there are many controversies over its efficacy because of many different variables impossible to compare in clinical trials or reviews [18].

In general, Mg supplements is orally administered in healthy person with mild hypomagnesemia, but in cases of emergencies such as in eclampsia or arrhythmia or in treatments for severely-ill patients, resulting from severe Mg deficiency, which require IV injections of Mg. Infusion speed is important when Mg is intravenously injected. Deep tendon reflexes and the muscle contracting power begin to reduce when the blood concentration rises above normal value [19], and artificial ventilation is sometimes required due to dyspnea and unconsciousness if the concentration is too high [20]. Although Mg sulfate is commonly used intravenously, Mg chloride can be used in replacement therapy of Mg deficiency among Mg salts, and reportedly, more useful than Mg sulfate in absorption and retention [21]. The main differences between Mg sulfate and Mg chloride are anions which decide the biological properties and the interaction with water, do not make any reason to prefer Mg sulfate over Mg chloride [22].

There are diverse interactions between muscle relaxants and Mg according to the blocking mechanism of depolarizing or non-depolarizing muscle relaxants. Mg prevents muscular fasciculations and reduces the release of potassium outside the cell induced by succinylcholine injection, but it does not affect its onset and duration [23,24]. Mg affects the pre-synaptic membrane more than the post-synaptic membrane in enhancing blocking effect of non-depolarizing muscle relaxants [25]. Onset time was shortened and recovery time was prolonged when vecuronium-induced block was potentiated by Mg [26].

This month, a report by Kim et al. [27] stated that the onset of cis-atracurium was meaningfully shortened, but the duration had no significant differences when Mg was pre-injected before the injection of cis-atracurium. In particular, the reasons why a shortened onset and no significant differences in duration were found were assumed to be due to a small dose of Mg being given and the blood flow around the neuromuscular junction increasing at an initial stage, specifically when hemodynamic change occurred. It is interesting that Mg could be used under emergency circumstances including rapid sequence inductions, where activities require a short onset. However, it is necessary to investigate whether small dose of Mg will be influential on the other nondepolarizing muscle relaxants or not.

Research that investigates the efficacy of Mg in anesthesiology is currently growing, but they are structured mostly in animal testing or in vitro testing. Therefore, the value of perioperative use of Mg has not been estimated completely when considering

its use for the human body. However, we are certain that its mechanism will be more clearly revealed in the near future and will be used effectively in the perioperative period.

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