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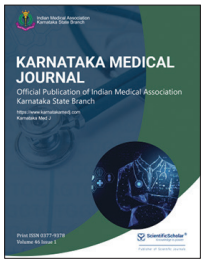

Review Article

Magnesium sulphate: Current application in anaesthesia

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ABSTRACT

The role of magnesium in medicine has advanced considerably over the two decades. It is now generally accepted that magnesium is a crucial nutrient, and its deficiency has adverse effects on a variety of physiological processes. Magnesium deficiency should be avoided in the perioperative period. Magnesium has been developed as a drug with various clinical uses. It is a key cation in physiological processes, and its homeostasis is essential for the normal function of human body organs. Magnesium sulphate is a mineral pharmaceutical preparation of magnesium. It has a high therapeutic index and cost-effectiveness. Magnesium sulphate is readily available, affordable and its use in clinical practice is associated with less complications. Recently, the potentiation of effects of muscle relaxation and perioperative analgesia has drawn the attention of anaesthetists to the use of magnesium sulphate in anaesthesia and pain management. The characteristics features of magnesium sulphate as a vasodilator, ability to protect the blood brain barrier, reduction of cerebral oedema and central anticonvulsant action make it very useful in intensive care.

Keywords: Magnesium sulphate, Application, Anaesthesia

INTRODUCTION

Magnesium plays a critical role in a variety of physiologic processes. The study of magnesium sulphate drew attention in the speciality of clinical anaesthesia in 1906.[1]

The importance of magnesium and its relationship to the origin of life has been traced from the composition of the earth's crust (rich in iron–magnesium silicate) and the primaeval ocean rich in magnesium, to the formation of chlorophyll with magnesium at the centre of the molecule, and finally to its incorporation into the animal cell containing adenosine triphosphate with its dependence on magnesium.[2]

Magnesium has several mechanisms of action; however, the blockade of the N-methyl-D-aspartate receptor and calcium channel has an interesting meaning to the anaesthetists. In clinical medicine, hypermagnesemia occurs rarely unless the renal status of the patient is compromised.

Magnesium is the fourth most common cation in the body and the second most common intracellular cation after potassium. It is essential and serves as a cofactor in different enzymatic reactions involving nucleic acid synthesis and cell metabolism. It is also involved in several processes including Hormone receptor binding, gating of calcium channels, transmembrane ion flux and regulation of adenylate cyclase, muscle contraction, neuronal activity, control of vasomotor tone, cardiac excitability and neurotransmitter release.[3]

APPLICATION OF MAGNESIUM SULPHATE IN ANAESTHESIA

Reduction of hypertensive response to laryngoscopy

Magnesium sulphate can be used to suppress the hypertensive response to laryngoscopy during intubation; it causes cardiovascular depression by acting as a calcium channel blocker. The consequent inhibition of catecholamine release reduces plasma epinephrine and norepinephrine concentrations after endotracheal intubation and, therefore, reduces hypertensive responses during anaesthesia induction.[4] However, it should be used with caution in hypovolemic patients and in patients with limited cardiac capacity. In addition, slow administration (>10 min) of a loading dose of magnesium sulphate may minimise cardiovascular side effects, such as hypotension and bradycardia.

Muscle relaxants property

Magnesium acts as a calcium channel blocker at presynaptic nerve terminals and decreases acetylcholine release at the motor end plate, which diminishes muscle fibre excitability and reduces the amplitude of endplate potential, resulting in the potentiation of a neuromuscular blockade by non-depolarising neuromuscular blocker.[5] In contrast, others concluded that a perioperative magnesium sulphate administration reduced requirements for non-depolarising neuromuscular blockers.[6-8]

Potentiation of muscle relaxation by magnesium sulphate can have diverse clinical implications. Magnesium sulphate can be used as an adjuvant for tracheal intubation. Until recently, when used during the induction of general anaesthesia, magnesium has been highlighted on its efficacy to attenuate cardiovascular responses associated with tracheal intubation.[9,10]

In addition, Kim *et al*.[11] reported that magnesium sulphate, when combined with rocuronium priming, improved rapid-sequence intubation conditions, compared with either magnesium sulphate or priming used alone.

In the operating room, the patient sometimes exhibits resistance to non-depolarising muscle relaxants, which may result from a drug or a disease of the patient. In such cases, magnesium sulphate can be used effectively.

Prevention of hypercalcemia with suxamethonium

Magnesium sulphate can also be helpful when suxamethonium is used for tracheal intubation. Magnesium may prevent hypercalcemia produced by suxamethonium.[12] Sakuraba *et al*.[13] reported that pre-treatment with magnesium sulphate is associated with less fasciculation induced by suxamethonium. However, magnesium was reported not to influence the clinical course of suxamethonium-induced malignant hyperthermia.[14]

Reduction of incidence of shivering

It has been observed that administration of magnesium sulphate decreases the incidence of shivering by up to 70–90%.[15-17] The fact that shivering is a leading cause of postoperative discomfort and increases oxygen consumption[18] the prevention of shivering is one of the most important benefits of magnesium sulphate use in surgical patients.

As adjuvants in Bier's block

The combination of magnesium sulphate with local anaesthetic agents has beneficial effects in intravenous regional anaesthesia (Bier's block). Turan *et al*.[19] reported that when magnesium was added to lidocaine for Bier block, the quality of anaesthesia and analgesia was improved. Specifically, the onset times of the sensory and motor blocks were shorter and postoperative analgesia was better when combined with magnesium sulphate. However, in this study, recovery after Bier's block was prolonged in the magnesium group.

Seizure prophylaxis

Magnesium sulphate has seizure prophylaxis property as described by Kim *et al*.[20] reported that valproic acid decreases rocuronium duration resulting in an increase in its requirement; however, magnesium sulphate administration attenuates this increase. Children with cerebral palsy show resistance to non-depolarising neuromuscular blocking agents. When magnesium sulphate was administered during operation in children with cerebral palsy, the rocuronium requirement was significantly decreased and postoperative opioid consumption was also decreased.[21]

Reduction of the incidence of nausea and vomiting

Intraoperative use of magnesium sulphate can be associated with decreased incidences of postoperative nausea and vomiting.[7,15] This could be due to the lower consumption of volatile anaesthetic (sevoflurane), rather than any antiemetic effect of magnesium sulphate. And again, because nausea and vomiting are one of the most common and distressing complications after surgery, this effect is helpful for surgical patients, especially patients undergoing day-case surgery.

Post-operative analgesia

In terms of postoperative analgesia, the use of magnesium sulphate during surgery can reduce opioid consumption in the first 24 h postoperatively and to a lesser extent, pain scores. A study by Ryu *et al*.[15] compared magnesium sulphate and remifentanil during middle ear surgery. In this study, either drug, when combined with sevoflurane to provide adequate level of hypotensive anaesthesia; however, the magnesium group had more favourable postoperative courses, showing better analgesia

and less shivering, nausea and vomiting postoperatively. In addition, there was less requirement of sevoflurane to maintain surgical anaesthesia in patients receiving magnesium sulphate than those receiving remifentanil.

CONCLUSION

Magnesium sulphate is an old drug but it has multiple properties which are very useful to anaesthetists. It has a wide variety of uses in clinical anaesthesia. It can contribute to improvement in the outcome of surgical patients.

Ethical approval

Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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