Intravenous Magnesium Sulfate for Multimodal Analgesia

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Abstract

Purpose Statement
Magnesium Sulfate has been used as a multimodal approach for analgesia as it may reduce opioid consumption in the first 24 hours after surgery and decrease post-operative pain scores.

Introduction
The use of intraoperative opioids for analgesia is associated with postoperative side effects such as respiratory depression, ileus, nausea, and vomiting. The side effects from opioids can prolong hospital stay and cause patient dissatisfaction. Magnesium acts as a N-methyl-D-aspartate (NMDA) receptor antagonist resulting in an analgesic effect, which can be used as an alternative or adjunct to opioids for pain control.

Literature Review
Magnesium sulfate may be beneficial for multimodal pain management as it reduces opioid requirements and postoperative pain. Targeting various receptors in the pain pathway can optimize analgesia and reduce side effects. Magnesium antagonizes the NMDA receptor and blocks calcium channels to modulate pain and inflammatory responses. Perioperative magnesium administration should be considered as a strategy to reduce postoperative pain in patients undergoing surgical procedures.

Description of the Case
A 67-year-old female presented for a bilateral breast revision, bilateral blepharoplasty of upper lids, neck rhytidectomy, and fat graft injection surgery. The patient had a history of postoperative nausea and vomiting. During the maintenance phase of anesthesia, fentanyl 50 mcg was given as needed for signs of pain, rocuronium was re-dosed to maintain paralysis, and ephedrine and phenylephrine were administered to maintain blood pressure. Intravenous magnesium sulfate 2 g was administered as a multimodal approach to analgesia to decrease post-operative opioid consumption and to prevent post-operative nausea and vomiting. The following day the patient tolerated a regular diet, pain was well controlled, and was hemodynamically stable. The patient was discharged home without complications.

Discussion and Conclusion
Magnesium sulfate may be beneficial for multimodal pain management as it reduces opioid requirements and postoperative pain. Magnesium antagonizes the NMDA receptor and blocks calcium channels to modulate pain and inflammatory responses. It is unclear which mode of magnesium administration provides an advantage to the analgesic effects. The differences in age and gender-related responses to magnesium for analgesia is undetermined. Further research is necessary to examine the use of intravenous magnesium sulfate for postoperative pain in different patient populations, safe and effective dosing ranges, and the effects of analgesia in various surgeries. Intravenous magnesium sulfate should be considered in multimodal analgesic treatment as an adjunct for postoperative analgesia.
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Introduction
A multimodal analgesic approach with intraoperative magnesium sulfate may reduce opioid consumption in the first 24 hours postoperatively and decrease pain scores. Opioids can cause a range of side effects such as respiratory depression, postoperative ileus, nausea, vomiting, and hypercarbia. Inadequate pain relief impacts patient satisfaction and contributes to delays in recovery and increased hospital length of stay. Magnesium sulfate may be considered as an adjunct for intraoperative analgesia and an alternative to opioid-based therapy. Intravenous (IV) magnesium sulfate may minimize postoperative pain and decrease opioid consumption. Opioid tolerant patients present a challenge in achieving adequate postoperative pain control. Magnesium sulfate may be implemented to reduce opioid reliance and provide time-effective and safe postoperative recovery. Magnesium is a noncompetitive antagonist at the N-methyl-D-aspartate (NMDA) glutamate receptor, which exerts a depressant effect (Figure 1). Magnesium prevents central sensitization from peripheral nociceptive stimuli at the spinal cord action site by blocking NMDA receptors. Magnesium also acts as a calcium channel blocker to inhibit calcium influx, which may contribute to the antinociceptive effects (Figure 1).

Case Description
A 67-year-old, 88 kg, 172 cm, female presented for a bilateral breast revision, bilateral blepharoplasty of upper lids, neck rhinolift, and fat graft injection surgery due to malignant neoplasm of the breasts. Past medical history included breast cancer, osteopenia, celiac disease, and basal cell carcinoma of the face. Past surgical history included Mohs surgery, breast lumpectomy, rhytidectomy, and fat graft injection surgery due to malignant neoplasm of the breasts. Maintenance medications: fentanyl 50 mcg IV was given as a multimodal approach to decrease pain and decrease opioid consumption. Opioid tolerant patients present a challenge in achieving adequate postoperative pain control. Magnesium sulfate may be implemented to reduce opioid reliance and provide time-effective and safe postoperative recovery. Magnesium is a noncompetitive antagonist at the N-methyl-D-aspartate (NMDA) glutamate receptor, which exerts a depressant effect (Figure 1). Magnesium prevents central sensitization from peripheral nociceptive stimuli at the spinal cord action site by blocking NMDA receptors. Magnesium also acts as a calcium channel blocker to inhibit calcium influx, which may contribute to the antinociceptive effects (Figure 1).

Safety Considerations for Magnesium Sulfate Administration
- Avoid magnesium sulfate in patients with renal insufficiency because magnesium is excreted by the kidneys.
- Hypomagnesemia and toxicity can occur in renal insufficiency.
- Hypomagnesemia can cause sedation, cardiac arrhythmias, diarrhea, respiratory depression, and potentiation of neuromuscular blockade.
- Magnesium potentiates neuromuscular blockers; therefore, it should be avoided in patients with neuromuscular diseases because it can produce further muscle weakness by inhibiting acetylcholine release.
- Magnesium inhibits calcium channels at the presynaptic nerve terminals that trigger the release of acetylcholine (Figure 1). Also, magnesium ions have an inhibitory effect on post-junctional potentials and decrease the excitability of the muscle fiber membranes.
- The dose of nondepolarizing neuromuscular blockers should be reduced in patients that receive magnesium sulfate and titrated carefully with a nerve stimulator to ensure adequate recovery of neuromuscular function at the end of surgery.
- Loss of deep tendon reflexes and respiratory or cardiac depression can occur at plasma magnesium concentrations above 10-12 mEq/L.
- Magnesium slows sinoatrial node impulses and prolongs conduction time, which can cause heart block and should be avoided in patients with atrioventricular conduction abnormalities.

Conclusion/Recommendations
- Opioids have traditionally been the basis of pain management, although significant risks and side effects are associated with opioids.
- Increased opioid administration is related to a higher incidence of respiratory depression, constipation, emesis, confusion, and prolonged length of hospital stay.
- IV magnesium sulfate bolus of 30 mg/kg before induction followed by an intravenous infusion at 10 mg/kg/hour resulted in significantly lower pain scores compared to a placebo group and decreased opioid consumption 24 hours following surgery.
- Dabbagh et al. found that the group that received magnesium versus the control group that received normal saline required significantly lower doses of IV morphine in the first 24 hours postoperatively.
- Postoperative administration of magnesium sulfate alone did not demonstrate a significant reduction in morphine consumption.
- Lusakowski et al. discovered in a systemic review of randomized trials for magnesium sulfate as an adjunct to postoperative analgesia there was no evidence that perioperative magnesium had favorable effects on postoperative pain intensity and analgesic requirements.
- Further research is necessary to examine the use of IV magnesium sulfate for postoperative pain in different patient populations, safe and effective dosing ranges, and effects on analgesia for various surgical procedures.
- Perioperative magnesium sulfate administration should be considered as a strategy to reduce postoperative pain in patients undergoing surgical procedures.
- IV magnesium sulfate is an alternative analgesic that may be valuable in reducing opioid consumption and beneficial for opioid tolerant patients.

References: