

Muscle cramps and magnesium deficiency: case reports

DOUGLAS L.J. BILBEY, MD, PHD
VICTOR M. PRABHAKARAN, MD, FRCPC

SUMMARY

Magnesium deficiency is more common than is believed. This article discusses florid magnesium deficiency in two patients and the results of treatment. While neither case was difficult to diagnose, the severity of symptoms was unusual. Magnesium deficiency should always be included in the differential diagnosis of patients who present with persistent or severe muscle pain.

RÉSUMÉ

L'hypomagnésémie est plus courante qu'on ne le croit. Cet article présente deux cas d'hypomagnésémie floride et les résultats du traitement. Malgré l'absence de difficulté à poser le diagnostic dans les deux cas, la sévérité des symptômes était inhabituelle. La carence en magnésium devrait toujours faire partie du diagnostic différentiel chez les patients qui consultent pour douleurs musculaires persistantes ou sévères.

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MAGNESIUM IS THE FOURTH MOST abundant cation (after sodium, potassium, and calcium) in the body, with about half in bones and the remainder in muscles and soft tissues. Its functions are either structural (in the bone) or biochemical, primarily in neuromuscular transmission and muscle contraction, as an enzyme cofactor.

It is through these biochemical functions that a deficiency of the ion becomes manifest. Because the effects are direct, replacing lost magnesium results in dramatic recovery. We report on two patients with magnesium deficiency who presented with muscle cramps. We expect this to alert readers to magnesium deficiency in general practice, specifically in patients who present with muscle cramps.

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Dr Bilbey is a general practitioner at the Trinity Medical Clinic in Trinity Bay, Nfld.

Dr Prabhakaran is Chief of the Division of Biochemical Pathology at The General Hospital in St John's, Nfld, and is Associate Professor of Pathology (Clinical Chemistry) in the Faculty of Medicine at Memorial University of Newfoundland.

Case report 1

A 17-year-old military recruit presented on sick parade with aching in his muscles and thighs, and generalized tenderness in all his skeletal muscles. He walked gingerly on tiptoe, as his calf muscles contracted spasmodically when his feet became dorsiflexed. He admitted to having exercised over and above his normal army training and later listed his excesses: repeated runs of between 10 to 15 km, weight training, 16 sprints varying from 100 m to 400 m, followed by half an hour of swimming.

Three days before reporting sick, he experienced weakness of his legs, which "began to wobble." The day before becoming sick, his legs "felt like jelly," and on the morning when he reported sick, he could "hardly move" his limbs due to muscle spasm. On examination he was a lean, muscular young soldier unable to walk, because his gastrocnemius-soleus muscles would go into acute spasm and bulge visibly, causing him to cry out with pain. Other muscle groups were likewise affected when tensed, and his tendon reflexes responded to the proportions as shown in Table 1.

At rest, the muscles felt soft and doughy and were exquisitely tender. Tendon reflexes were brisk, with the muscles concerned going into tetany. Physical examination of his other systems was unremarkable: temperature, 36.5°C; pulse rate, 58 beats per minute; and blood pressure, 110/80 mm Hg.

The only abnormality indicated by laboratory investigations was a serum magnesium concentration of 0.54 mmol/L (reference range 0.7 to 1.5 mmol/L). Investigations included immediate and daily electrocardiograms during the time that he received treatment. Full blood count and differential and serum electrolyte, fasting blood sugar, and glycated hemoglobin levels were done as a baseline, and serum electrolyte measurements were repeated daily.

Calcium and lactic acid levels were both normal.

The soldier was admitted to hospital, placed on bed rest, and given orphenadrine and acetaminophen for muscle relaxation and analgesia. When results of the serum magnesium levels became available, an immediate intravenous infusion of 3 g of magnesium sulfate 50% weight-to-volume ratio in 500 mL N saline was given over 6 hours. On the following day, he received a further intravenous infusion of 5 g of magnesium sulfate in a total of 1500 mL N saline. Within 48 hours, he had fewer muscle pains, and the tetany had resolved. Apart from a transient mild generalized headache, he had no adverse symptoms. His serum magnesium levels during treatment were as follows: initial, 0.54 mmol/L; 48 hours, 0.85 mmol/L; 72 hours, 0.77 mmol/L; 96 hours, 0.79 mmol/L; and 118 hours, 0.77 mmol/L.

After 4 days he was completely pain free, and the tetany was gone. His only complaint was mild tenderness in the left calf. He was then discharged, and after 2 weeks, in which time he refrained from excessive physical exercise, was symptom free. He

returned to military training but was warned not to participate in extra-curricular runs and exercise. Three months later he underwent a 19-km run with full pack and equipment and experienced normal muscle aches and pain but no further tetany.

Case report 2

An 81-year-old woman was admitted to the central health care facility from an outlying area of Newfoundland because of severe abdominal cramps, poorly controlled by analgesics. She had had congestive heart failure for the last 2 years,

which had been relieved temporarily many times during that period.

Her history was usual for such a case: a childhood and life of hard physical work, many children, and no notable diseases or operations. In the preceding 4 years, her feet and ankles had swelled, and she experienced progressive shortness of

breath. Her blood pressure had been recorded as 160/100 mm Hg, and she had been placed on diuretics (initially hydrochlorothiazide, later furosemide), which were later increased because of "wet lungs." Potassium supplements (Micro-K) and digoxin (0.125 mg daily) were also prescribed.

On admission, her main complaint was of severe and more frequent abdominal pains and some pain in her lower limbs. A variety of analgesics, up to and including pethidine (Demerol) had been used, together with muscle relaxants and tranquilizers. On examination, the muscles of her lower limbs felt like putty. Her abdominal cramps came in bouts, which were severe and persistent. No indications suggested that this was a "surgical belly" or that the intestinal system was involved. The pain was so intense that morphine (5 to 15 mg intramuscularly) and muscle relaxants were given (diazepam and a combination of acetylsalicylic acid and methocarbamol), but with only temporary effectiveness.

Table 1. Intensity of tetany in muscle groups

MUSCLE GROUP	TETANY
Calf	++++
Hamstrings	+++
Quadriceps	+++
Abdominal recti	++
Pectoral and upper limbs	++
Muscles of mastication	+
++++ - acute spasm, + - mild spasm.	

Laboratory investigations were unremarkable except for serum magnesium levels of 0.49 and 0.51 mmol/L. Oral supplements of magnesium were initiated but caused fluid diarrhea. Slow intravenous infusion of 5 g of magnesium sulfate was started in a total of 2000 mL N saline over 24 hours, which resulted in her being completely pain free by the third day. She was discharged "never feeling better for years" after another week.

Discussion

Magnesium is an important element for normal biological function, especially for neuromuscular activity. However, magnesium deficiency is rarely considered in relation to clinical problems, mainly because of earlier difficulties in assessing magnesium status (serum magnesium measurement is now more readily available) and because this element is given little attention in medical education.¹ Severe hypermagnesemia is uncommon because of the kidneys' ability to excrete a magnesium load, but magnesium homeostasis can be easily disordered toward deficiency in malnutrition, malabsorption, renal tubular damage, diuretic therapy, and chronic alcoholism, some of the main nonendocrine causes.

Our second case of magnesium deficiency was almost certainly the result of diuretic therapy. However, it is also probable that malnutrition contributed to the condition, as it did in our first case. Inadequate dietary intake was also a contributing factor in both cases. Dietary sources of magnesium are associated with the chlorophyll in vegetables. About one third of magnesium intake is absorbed, and the remainder is excreted.

In the first case, the young soldier stated that he "did not eat any vegetables at all," as he did not like them. His main diet consisted of chips, shepherd's pie, lasagna, and lots of bread with high amounts of butter and jam. His active lifestyle, which in itself decreases serum magnesium through sweat,^{2,3} combined with his eating habits, undoubtedly resulted in a negative magnesium balance and eventually a deficiency. (We understand³ that this condition is recognized in soldiers of the South African Armed Forces, such that Slo-Mg is prescribed prophylactically.)

The diagnosis of hypomagnesemia in these two patients has made us more aware of the likelihood of magnesium deficiency in other patients. In cases of muscle cramping, muscle weakness, or neuromuscular dysfunction, we obtain a magnesium blood level. In cases of magnesium deficiency, 6 to 15 g of 50% magnesium sulfate in 300 to 1000 μ L N saline is administered according to age and body weight of the patient. Unfavourable reactions, either immediate or delayed, have not been reported, and the only secondary effect is a flushing and transient hypotension if the fluid is given too quickly.

Considering that the quantity of circulating Mg^{++} is only 0.3% of the total body content, it appears to be a poor indicator of intracellular inadequacy. Some of our patients have had muscle symptoms, which have been treated empirically and beneficially in spite of a normal Mg^{++} blood level. In both these case reports, no electrocardiographic changes were apparent during intravenous replacement of magnesium.

In general practice, oral supplements of magnesium are available and have been beneficial for treating muscle cramps and discomfort. One such supplement is magnesium gluconate (Maglucate). However, the pill is dry, large, and difficult to swallow. The preferred medication is magnesium glucoheptonate (Magnesium-Rougier), which is more convenient and palatable.

The beneficial effect of magnesium sulfate in acute myocardial infarction (AMI) has been reported from various sources. Shechter et al⁴ found that treatment improved the survival rate of AMI patients. They randomized the treatment, which, however, was not based on the circulating Mg^{++} level, and reported nine deaths in 53 patients without magnesium and one death in 50 patients who were administered the element. Rasmussen et al⁵ reported a morbidity of 7% in AMI patients receiving magnesium compared with 19% in the placebo group. Necropsy studies have shown low levels of intracellular magnesium in cardiac tissue. Roden and Iansmith⁶ have investigated the role of potassium and magnesium and indicated that the abnormalities of electrolyte concentrations provoke arrhythmia.

CME

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Robert Whang⁷ found that hypomagnesemia can be expected in 7% to 11% of hospitalized patients and that magnesium depletion is implicated in aggravating potassium depletion. Meanwhile Bigg and Chia⁸ indicate that Mg^{++} is essential for controlling potassium flux across the heart muscle cell membrane. An association between diabetes mellitus complications and hypomagnesemia has been suggested, but the exact nature of the relationship is yet to be explained.⁹

Magnesium deficiency is more common than many realize and occasional patients are likely to present with skeletal muscle cramps. We are learning more about magnesium metabolism, particularly about how it changes in disease states, such as AMI and type II diabetes mellitus. Assessing magnesium status in many clinical situations appears to be important. Until we have more efficient alternatives, serum magnesium levels should continue to be used for assessing magnesium status. ■

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Correspondence to: Dr V.M. Prabhakaran, Biochemistry, The General Hospital, HSC, 300 Prince Phillip Dr, St John's, NF A1B 3V6

References

1. Masters PW. Audit of automated requesting of serum magnesium measurement in patients with hypocalcemia. *Ann Clin Biochem* 1993;30:248-51.
2. Rose LI, Carroll SL, Lowe EW, Peterson EW, Cooper KH. Serum electrolyte changes after marathon running. *J Appl Physiol* 1970;29:449-51.
3. Bellar GA, Maher JT, Hartley LH, Bas DE, Wachter WEC. Serum Mg and K concentrations during exercise in thermoneutral and hot conditions. *Physiologist* 1972;15:84.
4. Shechter M, Hanoch H, Marks N, Behar S, Kaplinsky E, Rabinowitz B. Beneficial effects of $Mg SO_4$ in acute myocardial infarction. *Am J Cardiol* 1990;66:271-4.
5. Rasmussen HS, Norregard P, Lindeneg O, McNair P, Backer V, Balslev S. Intravenous magnesium in AMI. *Lancet* 1986;1:234-6.
6. Roden DM, Iansmith DHS. Effects of low potassium or magnesium concentrations on isolated cardiac tissue. *Am J Med* 1987;82(3A):18-23.
7. Whang R. Magnesium deficiency: pathogenesis, prevalence and clinical implications. *Am J Med* 1987;82(3A):24-9.
8. Bigg RPC, Chia R. Magnesium deficiency. *Med J Aust* 1981;1:346-8.
9. White JRJ, Campbell RK. Magnesium and diabetes: a review. *Ann Pharmacother* 1993;27:775-80.

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