MAGNESIUM TREATMENT FOR SUDDEN HEARING LOSS

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Magnesium treatment has been repeatedly shown to reduce the incidence of both temporary and permanent noise-induced hearing loss. We hypothesized that it might also improve the permanent threshold shift in patients with acute-onset hearing loss. In a prospective, randomized, double-blind, placebo-controlled trial, 28 patients with idiopathic sudden sensorineural hearing loss were treated with either steroids or oral magnesium (study group) or steroids and a placebo (control group). Compared to the controls, the magnesium-treated group had a significantly higher proportion of patients with improved hearing (>10 dB hearing level) across all frequencies tested, and a significantly greater mean improvement in all frequencies. Analysis of the individual data confirmed that more patients treated with magnesium experienced hearing improvement, and at a larger magnitude, than control subjects. Magnesium is a relatively safe and convenient adjunct to steroid treatment for enhancing the improvement in hearing, especially in the low-tone range, in patients with sudden sensorineural hearing loss.

KEY WORDS — hearing loss, human, magnesium.

INTRODUCTION

Sudden sensorineural hearing loss (SSNHL) is traumatic for the individual and can seriously limit the quality of life. The specific cause is unknown, but possible causes include viral infection, vascular insult, perilymphatic hypoxia, intralabyrinthine membrane rupture, and inflammatory and metabolic factors. Studies of the natural history of SSNHL have documented a high rate of spontaneous recovery (about 65%). The most common factors affecting the rate of recovery are the severity of the loss, the audiogram pattern (flat or downsloping), and the presence of vertigo. The lack of understanding of the etiologic mechanism of SSNHL has rendered the development of a specific treatment very difficult, and currently, empiric guidelines are used. On the basis of the study of Wilson et al,¹ oral corticosteroids in moderate doses are the most widely accepted treatment option for idiopathic SSNHL in patients with intermediate audiograms (ie, neither limited to middle-frequency loss nor with profound loss at all frequencies).

Magnesium is a critical cation in intracellular metabolism and energy production and consumption. It also serves as a cofactor in enzymatic processes involved in protein construction and aerobic phosphorylation. There is a close functional relationship between magnesium concentration and calcium metabolism.² Magnesium has a known therapeutic effect in acute myocardial infarction.

Several researchers have examined the use of magnesium as a prophylactic agent against noise-induced hearing loss (NIHL) in animals and humans. Ising et al³ found that the severity of NIHL in guinea pigs was negatively correlated with magnesium levels in drinking water. Joachims et al⁴ induced NIHL in rats using impulsive noise and measured its severity with auditory brain stem responses. They found a lesser loss in the rats that were fed a high-magnesium diet than in controls. They also found a correlation between the severity of NIHL and magnesium levels in plasma and perilymph.

The first indication that magnesium may play a role in hearing loss susceptibility in humans was reported by Joachims et al⁵ in 1987. Using a retrospective design, the authors noted that subjective thresholds across frequencies of 3, 4, and 8 kHz were negatively and moderately correlated to serum magnesium levels. In a double-blind study, Attias et al⁶ showed a higher incidence of NIHL in a large group of soldiers who received a placebo than in those who received oral magnesium. In addition, there was a negative correlation between lymphocyte magnesium level and the severity of NIHL.

Gunther et al⁷ reported that magnesium also exhibits a preventive effect against hearing loss induced by ototoxic drugs. Rats that were given high doses of gentamicin had severe hearing loss, whereas rats that were fed magnesium showed significantly fewer auditory shifts. Likewise, auditory thresholds were
less affected by experimental cochlear ischemia in guinea pigs that were fed a high-magnesium diet than in guinea pigs that were fed a low-magnesium diet. The magnesium apparently enhanced the survival capability of the cochlear afferents, reducing the effect of glutamate-induced inner hair cell damage.

Besides the prophylactic effect of magnesium, several studies have recently investigated its possible therapeutic effect. Positive findings were noted in guinea pigs that were given magnesium injections immediately after use of the transient threshold shift strategy. This effect was later confirmed in humans. Patients with idiopathic SSNHL experienced greater improvement in hearing after receiving both carbogen inhalation and oral intravenous magnesium sulfate than after carbogen inhalation alone.

Using a prospective double-blind design complementary to the latter study, we sought to further investigate the efficacy of oral magnesium in the treatment of patients with SSNHL.

PATIENTS AND METHODS

The study sample consisted of 28 consecutive patients with a diagnosis of idiopathic acute-onset unilateral SSNHL who were hospitalized at the Rabin Medical Center, a tertiary-care referral facility, over an 18-month period. Diseases or environmental events that could cause hearing loss (noise, mumps, Meniere’s disease) and brain lesions such as acoustic neuroma were ruled out. Other inclusion criteria were normal blood biochemistry measures, normal kidney function, and a normal electrocardiogram.

A prospective, randomized, double-blind design was used. Patients who presented within 48 hours of SSNHL were given a combination of steroids (1 mg/kg) and 200 mL of lemonade containing 6.7 mmol (167 mg) of either magnesium aspartate or sodium aspartate (placebo). During hospitalization, all patients received a similar diet with a constant magnesium content. The blood serum concentrations of magnesium and the levels of erythrocytes and mononuclear cells for both groups before and after treatment were measured in a manner similar to that of a previous study done in our department. Standard pure tone audiometry and discrimination were recorded before and after treatment. Analysis of variance with repeated measures and unpaired t-tests were used to evaluate the statistical significance of the differences in parameters between the groups.

RESULTS

The study included 14 men and 14 women 22 to 75 years of age (average, 53 years). The right ear was affected in 54% of the patients, and the left ear in 46%. Improvement in hearing was defined as an improvement of 10 dB hearing level at each frequency tested. Group comparison yielded more patients with improved hearing in the magnesium-treated group than in the control group (F[1] = 4.8, p < .02; Fig 1). Regarding the degree of improvement, the mean thresholds across the audiological frequencies (0.125 to 8 kHz) in the magnesium-treated and control groups are illustrated in Fig 2. A significantly greater improvement (F[1] = 3.7, p < .05) was noted in the study group for all 6 frequencies tested, and especially for 4 kHz (t = 1.96, p < .03). The variability, indicated by the standard deviations, was similar in both groups. Compared to the placebo group, more patients in the study group showed improved hearing, and the improvement was greater. This effect was more evident in the lower frequency range. No side effects of magnesium, such as gastrointestinal symptoms, dizziness, or headache, were recorded during the study.

DISCUSSION

This prospective, randomized, double-blind study indicates that adding oral magnesium to steroids improves hearing in patients with SSNHL better than steroids do alone. This finding was evident on analy-
sis of both the mean group values and the individual data and strongly supports previous studies that demonstrated a beneficial, therapeutic effect of magnesium on hearing loss induced by noise exposure.

The most common direct causes of idiopathic SSNHL are believed to be viral and vascular events. The exact mechanism by which magnesium affects the inner ear is still unclear. It is well known that the extracellular level of magnesium is critical for maintaining membrane permeability in the ear, and that free extracellular magnesium influences the calcium channels and helps preserve the membrane polarization. An increase in free extracellular magnesium reduces the calcium ion influx and affects the activation of the voltage-dependent calcium channel at the membrane. Presumably, then, when magnesium levels are reduced, the magnesium concentration in the hair cell membrane decreases, leading to an overall increase in membrane permeability and a consequent increase in intracellular calcium and sodium; potassium decreases by passive flow diffusion. The decreased electrolyte gradients induce greater transport activity and, thereby, an increase in cell energy turnover. A lasting increase in the intracellular calcium level can lead to cell energy depletion, ultimately resulting in cell death. Magnesium can also influence hearing directly, by increasing blood viscosity and blood flow, or indirectly, via its effects on the cell energy cycle. Thus, in the presence of an extracellular deficiency of magnesium, the secretion of catecholamines and prostanoids increases, and in response, muscle tone decreases, leading to a further reduction in blood flow due to vasoconstriction in the vessels supplying the cochlea and a higher risk of energy depletion in the hair cells. Exposure to higher noise levels further aggravates these processes. Higher concentrations of intracellular free magnesium can prevent these effects by improving inner ear circulation.

Fettplace and Fuchs reported that the large-conduction (BK-type) calcium-dependent potassium channels are essential for neuronal activities and determine the resonant frequency of electrically tuned hair cells. The large-conduction chain-dependent potassium channels are activated by membrane depolarization and intercellular calcium and magnesium, which, in turn, further activate the channels. Distinct structural pathways for magnesium-dependent and calcium-dependent activation were noted by Shi et al. The fact that magnesium binds at the N-terminal in the BK-type channels places an energy constraint on the conformational change at the conserved activated site, thereby activating the channel. Therefore, it is reasonable to assume that any condition that aggravates this tendency may worsen hearing loss. The addition of magnesium may partially compensate for the relative magnesium deficiency in the ischemic tissue.

A recent study of oral steroid treatment of SSNHL showed better results in the treated group than in untreated control subjects. The present study suggests that the effect of steroids may be enhanced by adding magnesium to the diet.

CONCLUSIONS

Adding oral magnesium to the traditional steroid treatment of idiopathic SSNHL may enhance the improvement in hearing. This noninvasive treatment seems to be relatively safe and free of side effects.

REFERENCES

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