Frequency of Hypomagnesemia in Hypokalemic States

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Although both hypokalemia and hypomagnesemia have been linked with life-threatening cardiac arrhythmias, published studies disagree regarding the frequency of simultaneously low serum potassium and magnesium concentrations. To investigate the possible associations between the concentrations of these ions in serum, we carried out a retrospective study of all paired magnesium-potassium measurements reported from our laboratory during two separate two-week periods. Of 963 paired measurements in 421 patients, 12% of the samples were hypokalemic and 26% were hypomagnesemic. The frequency of hypomagnesemia was significantly greater in hypokalemic samples (38%) compared with nonhypokalemic samples (25%). The potential clinical importance of this relationship requires further investigation.

Additional Keyphrases: cardiac arrhythmia · potassium · magnesium

Potassium and magnesium are predominantly intracellular ions, the intracellular concentrations of which are closely correlated (1). Whether there is any relationship between the concentrations of these ions in serum has been a controversial issue (2, 3). Because of the potential clinical importance that such a relationship might have, we collated the results reported from our laboratory for all samples in which magnesium was measured concurrently with potassium during two separate two-week periods. We report below the significant associations we found between serum potassium and magnesium concentrations.

Materials and Methods

All paired serum measurements of potassium and magnesium made during January 18 through February 2, 1982, and June 7 through June 20, 1982, were collated from the data base of our laboratory computer system. Data from animal specimens or specimens with visible hemolysis were excluded from our study. Potassium was measured by ion-selective electrodes with either the SMAC (Technicon Corp., Tarrytown, NY 10591) or the ASTRA-8 (Beckman Instruments, Inc., Brea, CA 92621) analyzers; the lower reference limit we used for potassium was 3.5 mEq/L. Magnesium was measured by complexing with methylthymol blue, in the acc analyzer (Du Pont Co., Wilmington, DE 19898); the lower reference limit for this method is stated by the manufacturer to be 18 mg/L (1.5 mEq/L). Run-to-run standard deviations based on repetitive analysis of quality control specimens over four weeks for potassium ranged from 0.08 to 0.09 mEq/L and for magnesium ranged from 1.2 to 1.3 mg/L (0.09–0.10 mEq/L).

The resulting 1031 paired measurements were transferred via magnetic tape to a Control Data Corporation Cyber 730 Computer System for statistical analysis by use of the SPSS package (4). Robust estimates of the mean and standard deviation for potassium and magnesium were obtained by using the trimming procedure of Healy (5). All potassium and magnesium values lying outside 3 SD of the mean were eliminated from consideration (68 measurements total); subsequent statistical analysis was carried out with a reduced data set of 963 paired measurements.

Results

Of the 963 paired measurements from 421 patients, hypokalemia (K <3.5 mEq/L) was present in 119 samples and hypomagnesemia (Mg <1.5 mEq/L) was noted in 254. Histograms of these data are shown in Figure 1. The mean concentration of magnesium in the hypokalemic samples (1.51 ± 0.32 mEq/L, median 1.50) was significantly lower (p <0.007, t-test with separate variance estimate) than in nonhypokalemic samples (1.60 ± 0.28 mEq/L, median 1.60). Conversely, the mean concentration of potassium in hypomagnesemic samples (4.04 ± 0.62 mEq/L, median 4.02) was significantly lower (p <0.02, t-test with separate variance estimate) than in nonhypomagnesemic samples (4.15 ± 0.56 mEq/L, median 4.13). Hypomagnesemia was found in a significantly higher (p <0.003) percentage (38%) of hypokalemic samples than in nonhypokalemic samples (25%). Conversely, potassium values <3.2 mEq/L were twice as likely (p <0.025) to be found in the hypomagnesemic population (7.1%) as in the nonhypomagnesemic population (3.5%). A small but significant correlation (r = 0.10, p <0.002) was noted between potassium and magnesium measurements.

Discussion

Based on our data, there appears to be a significant relationship between the concentrations of potassium and magnesium in serum. Our findings support those of Whang et al. (2), who reported that 42% of hospitalized patients with hypokalemia also have hypomagnesemia. Although Watson and O’Kell (3) reported that they found no relationship between serum magnesium and potassium, their data showed a 0.2 mEq/L difference in median magnesium concentration between hypokalemic and normokalemic hospitalized patients. Watson and O’Kell considered this difference to be inconsequential and did not report statistical tests of its significance. We found that a similar difference in the mean magnesium concentrations of our hypokalemic and nonhypokalemic patient population was highly significant (p <0.007). Conversely, we observed hypokalemia in a significantly higher fraction of our hypomagnesemic patients than in our nonhypomagnesemic patients.

Our finding of a small (r = 0.10) but significant correlation between serum potassium and magnesium substantiates the data of Roberts (6), who reported the correlation between these constituents to be 0.28. He noted that, although the serum concentrations of both potassium and magnesium were significantly correlated with the subject’s age, the correlation between potassium and magnesium remained significant after correction for the effect of age.

The serum concentration of potassium has been reported in several studies (7–11) to be an important factor in the genesis of cardiac arrhythmias. The arrhythmogenic mechanisms of hypokalemia, particularly in mild degrees, have not
been clearly defined. However, evidence has begun to accumulate that magnesium deficiency may be a critical factor in the cardiac arrhythmias associated with hypokalemia (3, 12, 13). Because both hypokalemia and hypomagnesemia can be induced by the same mechanisms (e.g., diuretic administration, primary hyperaldosteronism, renal tubular acidosis) attention in recent years has been focused on their co-occurrence. Our investigation of the frequency of the simultaneous occurrence of these two disturbances indicates that hypomagnesemia is a frequent clinical correlate of hypokalemia. This, coupled with the high percentage of our patients who were hypomagnesemic (26% overall), suggests that the measurement of magnesium in hypokalemic states may have potential clinical value.

Further investigation regarding the precise role and the interrelationships of diuretic agents with both hypokalemia and hypomagnesemia, and their associated serious cardiac complications, is warranted. A prospective clinical study is in progress to define further the relationship between hypokalemia and hypomagnesemia.

We gratefully acknowledge the technical assistance of Janet Sakell in computer programming and data analysis.

References